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TEACHER KNOWLEDGE AND ITS RELATIONSHIP TO STUDENT SUCCESS IN LEARNING A GYMNASTICS SKILL

DISSERTATION
Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
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****

The Ohio State University
1997

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College of Education
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1997
ABSTRACT

The purpose of this study was to examine the influence of teachers content and pedagogical content knowledge on student acquisition of the cartwheel. Seven elementary school physical education specialists identified as experienced teachers from Franklin County of the State of Ohio served as subjects. Three research questions guided this study: (1) What do teachers know about the cartwheel and how to teach it and how did they come to that knowledge? (2) How do teachers present cartwheel tasks and provide feedback to more or less skilled novice children? (3) How do more or less skilled children respond the these learning opportunities and what do they understand about how to do the cartwheel?.

Data were collected during two fifteen to thirty minute lessons taught by the seven teachers by: (1) Semi-structured interviews, (2) researcher observations, (3) video and audiotaping of the lessons and interviews, and (4) a survey. A multi-case replication design was applied to the study. The study focused on cross-case and cross-interview analysis using the multiple cases as basic data sources.

Results indicated differences among the participating teachers in content knowledge (knowledge of the cartwheel skill), but in terms of pedagogical knowledge (general teaching principles), teachers were more alike than different. There was evidence that teachers differed markedly in both experience and knowledge about the
cartwheel and were grouped based on those differences into content-richer, content-
medium, and content-poorer. Content-richer teachers who knew more about the
cartwheel also identified student errors more successfully than content-poorer teachers.
Correct teacher knowledge of the cartwheel was also associated with correct student
understanding of what is important to know about the cartwheel. There was also
evidence of a relationship between teacher pedagogical content knowledge and student
learning in that student learning seemed to be mediated by teachers instructional
activities. When the teachers knowledge was strong the students were most successful in
learning the cartwheel, but when the teachers knowledge was weak, the students were
less successful. Implications for teacher education and recommendations for future
research are given.
To my late parents and my wife Mamie-Mariama

for all their love and support of my academic pursuits
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I am deeply indebted to my advisor, Dr. Daryl Siedentop, for directing me towards this line of research, and whose ideas and suggestions helped fashion this dissertation. He provided invaluable ideas and bountiful constructive criticism. Without him, this work may never have been completed.

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To my family who have had to endure the pain of my long absence from Ghana to pursue studies in the United States, but who have never lost faith in me, I am grateful.
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CHAPTER I

INTRODUCTION

While effective teaching involves many varied skills, it certainly must include knowledge of the subject matter to be taught and an understanding of how to deliver that subject matter to students. Until recently, research on teaching has focused primarily on managerial and instructional skills, while leaving relatively unexamined the subject matter knowledge of teachers and how that knowledge is presented to learners (Shulman, 1987).

Early teaching effectiveness research utilized the process-process product paradigm, (Dunkin & Biddle, 1974), attempting to reliably observe discrete teaching behaviors and correlate them with outcome measures, with key contributions from Brophy (1983), Gage (1978), Kounin, (1970), Rosenshine (1979), and Soar & Soar (1979). The work of Berliner (1979) showed an evolution which began with a critique of the limitations of the process-product model and shifted the observational focus to include what was called pupil-pursuits (Harnischfeger & Wiley, 1976) or student- work (Berliner, 1979), expanding the previous model to include student process variables in what came to be called the mediating-process paradigm.
Variables such as Academic Learning Time (Berliner, 1979) were used as proxy variables for outcome-oriented achievement tests.

The evolution of teaching research continued with Doyle's (1979) critique of the mediating-process paradigm. Doyle argued for a more highly contextual, interactive understanding of classroom life in what has come to be called the ecological paradigm. This paradigm emphasized the dual-directional influences between teachers and their students and the interactions between managerial and instructional systems.

None of these paradigms, however, took into full account teacher knowledge of subject matter and how that knowledge was communicated to students as the major focus for observation and analysis. Shulman (1990) criticized the teaching research traditions as ignoring subject matter and teacher knowledge of that subject matter. Shulman suggested that domains of knowledge (for example, knowledge of the learner, pedagogical knowledge, content knowledge, and particularly pedagogical content knowledge) be brought to the foreground of teaching research and teacher education. Pedagogical content knowledge, how a teacher transforms his or her knowledge of a subject and represents it to particular learners to enhance their learning, became a key variable in the resurgence of interest in subject matter. According to Shulman (1986), we should be asking questions such as:

What are the sources of teacher knowledge? What does a teacher know and when did he come to it? How is new knowledge acquired, retrieved and both combined to form a new knowledge base? (p.8).

An important assumption of Shulman's work was that teacher behavior is not static. Teachers must evaluate their work, refine their understandings, and generate new
ideas. His emphasis on the processes involved in teaching supported the notion that there is a relationship between teachers’ thinking and their actions. Shulman's model provided an important model to help in understanding how teachers learn to become teachers, to how they improve their professional practice.

The study of sources of knowledge is methodologically problematic at best. Our understanding of teachers’ knowledge and sources of that knowledge has come primarily from interviews and self-reports. Even though this study will attempt to utilize some of these methods, especially interviews, the nature of the problem examined which seeks to increase our understanding of a very complex issue, also includes direct observation. Even as we seek more reliable methodologies, the continuing dialogue on the subject speaks to its importance. Tinling (1992), provides a tone for the importance of both content knowledge and pedagogical content knowledge, by arguing that:

Practical knowledge in the weak sense is demonstrated by where an individual who can perform an activity (is physically able to do something) but cannot articulate how it is done. Practical knowledge in the strong sense is demonstrated by where an individual who can both not only physically perform the activity or skill but can also articulate how it is done. (p.3).

Tinning seems to suggest here that competence in sport skills, in and of itself, is insufficient for effective teaching of those skills. Teacher education practical experiences that provide the insights and understandings related to teaching an activity are important, but without an adequate knowledge of the skill, they too, in and of themselves, may be insufficient. The only way we can know is to investigate it using several different methods, that will lead us to a more complete understanding of the role of subject matter knowledge and pedagogical content knowledge in effective teaching.
Knowledge variables are beginning to be investigated in education (Brickhouse, 1990; Gudmundsdottir, 1990; Marks, 1990; McDiarmid, 1990; Shulman, 1986, 1987). Recent research about teacher knowledge in physical education has focused on the pedagogical content knowledge of preservice teachers and how the knowledge changes over time. Overall, the research shows that undergraduates do not have much pedagogical content knowledge and what they have is so weak that it is not a sufficient base for a teacher so that they can provide technical feedback, develop appropriate progressions, and provide clear explanations (Graber, 1995; Rovegno, 1991, 1992a,b, 1993 a,b, 1994, 1995; Rovegno & Bandhauer, 1994). Differences have also been found in the way experts and novices deal with the teaching environment (Graber, 1995; Griffey, Hacker, & Housner, 1988; Griffey & Housner, 1991) and in the amount of knowledge for teaching (Rink, 1993).

Pedagogical content knowledge in motor skill teaching probably relates to how skills are presented and how teachers respond to student learning opportunities (for example, task presentation and sequencing, task explanation and feedback, and prompting). This study attempted to analyze teacher knowledge and pedagogical content knowledge and relate it to how children behaved in the early stages of acquiring a sport skill. The skill chosen was the cartwheel. The cartwheel was chosen because it is a fairly complex skill, not easily learned, and it is part of the subject matter (gymnastics) that has traditionally been taught in physical education, where body control has always been a major developmental goal for children. The cartwheel requires body inversion and is not easy to learn: therefore, it is not easy to teach. Teaching the cartwheel to
young, novice learners probably requires both knowledge of the skill itself and knowledge of how to represent the skill to young learners so they can acquire it safely and quickly: that is, successful teaching of the cartwheel, it can be argued, requires both knowledge of content and pedagogical content knowledge.

This study, therefore, focused on examining the relationship between teachers' content knowledge, pedagogical content knowledge, and student responses to instruction with learning the cartwheel as the instructional goal.

**Statement of the Problem**

Research on teacher education programs in colleges and universities across this country has been rather unsystematic and concentrated on selected aspects of the program, such as student teaching (Locke, 1984, cited in Bain, 1990). Arguing that research should examine other aspects of teacher education, Shulman (1987), proposed that the knowledge base of teachers should become the focus of research in teacher education programs. Shulman (1987) identified seven categories of knowledge. Four of these categories included information appropriate for all teachers, regardless of subject matter specialty: knowledge of learners, knowledge of the goals and objectives, and general pedagogical knowledge. The other three categories of teacher knowledge according to Shulman are specific to the subject matter: content knowledge, pedagogical content knowledge, and curricular knowledge. Teacher educators cannot afford to continue to ignore Shulman's call and other recent calls (Carnegie, 1986; Holmes, 1986) for teacher education to reform itself. The need to examine teacher development and
reform of programs cannot take place without the examination of teacher content knowledge and how teachers represent this to students.

Physical education content encompasses a variety of activities and knowledges, including gymnastics. However, little research is available to assess the degree to which inadequate learning of gymnastics skills is due to lack of teacher knowledge or simply poor instructional skills. O'Quinn (1990) has argued that many children do not learn gymnastics skills well in school programs, maintaining that only 15% of children learn the cartwheel. Related evidence (Imwold & Hoffman, 1991) suggests that even veteran teachers correctly diagnose learner responses only 47% of the time and only then if they have the opportunity to observe the performance at least twice. The purpose of this study therefore was to examine the influence of experienced teachers content knowledge and pedagogical content knowledge on student skill acquisition of the cartwheel following instruction. To examine this problem, teachers' knowledge of the cartwheel was examined, as was their teaching of the cartwheel, and student responses to that instruction.

Research Questions

Three major questions guided this research.

1.0 What do the teachers know about the cartwheel and how to teach it, and how did they come to that knowledge?

1.1 What experiences have teachers had performing and/or teaching the cartwheel?
1.2. What do teachers perceive to be the sources of their knowledge about teaching the cartwheel?

1.3. What do teachers know about the critical and technical elements of the cartwheel?

1.4. What is their basic strategy in teaching the cartwheel to young, novice learners of varying skill levels?

1.5. What do teachers see as the main learner problems and how do they overcome them?

2.0. How do teachers present cartwheel tasks and provide feedback to more and less skilled, novice children?

2.1. What are the progressions of tasks children are asked to do and how are those tasks presented?

2.1. What types of feedback and prompts do teachers provide to learner responses?

3.0. How do more or less skilled children respond to these learning opportunities and what do they understand about how to do the cartwheel?

3.1. What are their patterns of success and errors?

3.2. After the lessons, what is their understanding of how to do the cartwheel?
Significance of the Study

Shulman (1986) suggested that in the last century the person who presumed to teach subject matter to children had to demonstrate knowledge of the subject matter as a prerequisite to teaching. Following the 1970's and the process-product research that dominated, policy makers have defined teaching effectiveness through research based teacher competencies. As an evaluative tool, Shulman claimed that policy makers oversimplified the complexities of classroom teaching by ignoring subject matter in the process of teaching.

Where the teacher cognition program has clearly fallen short is in the elucidation of teachers' cognitive understanding of subject matter content and the relationships between such understanding and the instruction teachers provide for students (Shulman, 1990, p. 63).

Shulman then suggested that there is a "missing paradigm". The missing paradigm, he claimed are the questions about content of the lessons taught, the questions asked and the explanations offered. Thus from a perspective of teacher development and teacher education, he argued for the study of "Knowledge Growth in Teaching". This study attempted to do that. If we can establish relationships between what teachers know and how they represent it we can convert the results into interesting theory and useful rules of practice.

Even though most states in the US have state standards for teacher preparation, certification and licensure standards are so varied that state licensure systems cannot seem to share a common view as to what teachers ought to know and be able to do or what good teaching is (Darling-Hammond, 1992). These differing standards should
ultimately rest on the question of what kinds of knowledge teachers should have and how this is to be acquired. Research into teachers subject matter knowledge and pedagogical preparation might provide these answers. This study taps the knowledge base for teaching the cartwheel and may thus provide some of the answers we seek on what teachers should know about their subject matter and how to acquire this.

Teaching as a profession has not fared well (Newman, 1990). In defining a profession, Newman identified three characteristics: a) a profession performs a unique essential service for society, b) a profession has a defined body of knowledge, and, c) a profession has autonomy. Newman argued that there is little agreement on what teachers should know and master. This lack of consensus on what teachers should know has affected teaching as a profession. By defining what it is that teachers should know and how to teach it, this study attempts to add to the knowledge about what teachers must master and helps to define physical education teaching as a profession.

Expert-novice research has suggested that prospective teachers' preparation needs improvement in four areas: pedagogical content knowledge, knowledge of the learner, organization and management skills, and planning and improvisation in instruction (Goldman & Barron, 1990, p. 21).

This study represents a beginning effort to develop an understanding of how expert/novice teachers integrate their knowledge of content and pedagogy into instruction that meets the needs and abilities of diverse students in physical education. In addition when we understand how specialists in their subject matter develop their understanding of content and pedagogical content knowledge, we might be able to accelerate the process of getting novices to become experts.
Rovegno (1995) suggested that there are several limitations of the research on teacher knowledge. She reported limitations on the number of topics studied and on the number of settings. This study aims to increase the number of studies on the topic and on the settings.
Definition of Terms

**Applying tasks:** A task that is practiced under conditions similar to competition.

**Content Knowledge:** This refers to the amount and organization of knowledge per se in the mind of the teacher (Shulman, 1986, p. 9).

**Extending tasks:** Variations in the conditions under which the task is practiced.

**Informing Task:** Newly introduced practice tasks

**Pedagogical Content Knowledge:** Shulman (1986) defines it as "the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word, the ways of representing and formulating the subject that makes it comprehensible to others. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preoccupations that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (pp. 9-10).

**Practice Task:** A unit of practice defined by a direction from the instructor followed by learner responses (Siedentop, 1990).

**Refining task:** tasks which emphasize qualitative dimensions of previously introduced tasks

**Student Response:** An observable and classifiable instance of any class of student behavioral events under investigation (Ward, 1993).
Tasks: A set of implicit or explicit instructions about what a person is expected to do to successfully cope with a situation (Doyle, 1981).

Limitations of the Study

The study was limited to:

1. Seven elementary physical education specialists from the Franklin County of the State of Ohio.

2. The cartwheel skill taught to elementary school children. The results are limited to the elementary school children of this study.

3. The two videotaped lessons recorded from each teacher, and the taped interviews.

4. A total of 16 lessons taught by the teachers.
CHAPTER 2

REVIEW OF LITERATURE

Research into teacher knowledge and pedagogical content knowledge has only recently been given attention by scholars. Grossman and Richert (1988), The Carnegie (1986), and Holmes (1986) reports have all emphasized the importance of subject matter expertise in the reform of teacher education. Educational critics have recognized the limitations of earlier research into teaching effectiveness that focused on teacher's skills and dispositions, but ignored what teachers know about their subjects, how that knowledge is acquired, and how that knowledge is transformed and represented to students to enhance their learning. This focus is seen as the missing element in the otherwise productive period of research characterized process-product and mediating-process paradigms. Since teaching has a lot to do with teachers and the transmission of knowledge, it has become critical to study what teachers know and how that knowledge is used in their teaching.

This chapter provides a review of the literature on teacher content knowledge and pedagogical content knowledge, and how students respond to teacher behaviors. The background on the subject offered by Shulman, (1986, 1987), Rovegno (1992a, 1994), and McEwan and Bull (1991) provided the theoretical framework for examining and analyzing teachers content and pedagogical content knowledge.
Research on Teacher Knowledge

Much of the research on teacher knowledge is conceptual rather than empirical. Carter (1990) observed that the emergence of systematic research on teachers' knowledge and its acquisition was signaled by growing concerns for cognition and context in social sciences in the late 1960's and of qualitative studies of classroom teaching. Qualitative studies, (Jackson, 1968; Smith & Geoffrey, 1968; Kounin, 1970) provided rich descriptions of classroom processes that influenced the development of research on teacher knowledge. From this broad field have emerged several approaches and several devices for arraying the literature on teacher knowledge: For example, Carter (1990) classified the literature under three headings: a) information processing studies, b) studies on teachers practical knowledge, and c) studies of pedagogical content knowledge. Information processing focuses on expert-novice teacher thinking, how they plan, make decisions, and evaluate potential courses of action. Teacher practical knowledge

refers broadly to the knowledge teachers have of classroom situations and the practical dilemmas they face in carrying out purposeful action in these settings (Carter, 1990, p. 299).

Pedagogical content knowledge focuses on what teachers know about their subject matter and how they translate that knowledge into classroom curricular events (Carter, 1990, p.305).

Ferstenmacher (1994), on the other hand, chose four questions to provide an overview of the literature on teacher knowledge: a) what is known about effective teaching? b) what do teachers know? c) what knowledge is essential for teaching? d) who

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produces knowledge about teaching. The first question addressed the concept of knowledge as is known in process-product research. The second question sought to understand what teachers know as a result of their experience as teachers. A variety of terms, which reflect different perspectives, have been used to answer the question. Some of these include, practical knowledge (Clandinin, 1985; Elbaz, 1983), personal (Schon, 1983), situated, local, relational, and tacit knowledge. These different terms and perspectives make critical examination of the literature difficult. The third question, mostly the work of Shulman and his disciples, focuses on subject matter or content knowledge; that is, the ways it is organized, perceived, and interpreted (Grossman, Wilson & Shulman, 1989).

The work of Shulman (1986, 1987) was most relevant to this study and was given most attention in this review. However, before examining Shulman's notions, another concept needed to be briefly reviewed for its importance and relevance to physical education teaching in general and this study in particular.

**Practical Knowledge:**

Practical knowledge refers broadly to the knowledge teachers have of classroom situations and the practical dilemmas they face in carrying out purposeful action in these settings (Carter, 1990, p.299).

Practical knowledge studies have included teachers personal practical knowledge and implicit theories, and ecological studies of knowledge structures and comprehension processes.
Research on teachers' personal practical knowledge focuses on the personal understandings teachers have of the practical circumstances in which they work. Researchers who have focused on the practical knowledge of teachers have included Elbaz (1983), Clandinin (1985), and Schon (1983). I focused on Elbaz’s work to clarify inquiry conducted in practical knowledge that was relevant to this study.

Practical knowledge of teachers was investigated in this study through experienced teachers and how they came to have the knowledge they have. Teachers cannot claim to be experienced unless they possess knowledge which others of less experience do not have. As Fenstermacher (1994) noted,

practical knowledge is bounded by time, place or situation. To claim to know something practically is to claim to know something about an action, event, or situation in this particular instance....This implies that the teacher cannot be relieved of the obligation to show how it is objectively reasonable to believe what we are contending (p.28).

Through a case study of a high school English teacher, Elbaz (1983) tried to define the structure of practical knowledge in teaching. Elbaz’s work provides an overall structure of practical knowledge of the teacher, the content and orientations. Elbaz distinguished between five domains of practical knowledge; the self, the milieu of teaching, the subject matter, curriculum development, and instruction. Under structure of practical knowledge, she identified three levels: rules of practice (statements of what actions to take in particular situations when purposes are clear), practical principles (focuses on reflection), and images (teachers' feelings, values, beliefs and needs as she forms images of what teaching should be).
Elbaz's conceptualization of practical knowledge suggests that the knowledge base for teaching is as much practical as it is acquired from generalizations derived from research on teaching, although the two most certainly interact in the lived teaching experience. Often teachers have to make complex decisions under very uncertain conditions, and to be able to do this, they must engage in practical thinking that will lead to dealing with the situation within that context. This suggests that experience becomes a bank from which the teacher can withdraw to deal with problems as they arise. Novices with smaller bank balances are more likely to be limited by how much to withdraw. Tinning (1992), however, cautions that we should make distinctions between weak and strong practical knowledge in physical education.

Practical knowledge in the weak sense is demonstrated by where an individual who can perform an activity (is physically able to do something) but cannot articulate how it is done. Practical knowledge in the strong sense is demonstrated by where an individual who can both not only physically perform an activity or skill but can also articulate how it is done (p. 3).

**Shulman's Notions of Teacher Knowledge**

In an interview with Sparks (1992), Shulman argued that he had been struck by how incomplete staff development programs are. Furthermore, Shulman argued that teachers never teach anything in a vacuum - they teach particular things to particular groups of kids in particular settings. Shulman made it clear that, generic forms of teacher staff development regardless of grade level or subject matter were incomplete at best. The idea that knowledge from one subject area could be easily transferred to another subject area, he added, was unexamined. He called on teacher educators to focus programs for staff development that improve the content knowledge and pedagogy
for particular subject areas. It is only through this approach that teacher education will be richer and more textured. Shulman’s message is clear. Teacher education needs to focus on staff development programs that prepare teachers to understand teacher problems, topics and issues about the curriculum; programs that both improve teacher content knowledge and pedagogical knowledge.

Shulman’s (1986) arguments for the type of staff development that emphasizes pedagogical content knowledge was first made in his Presidential Address to the American Educational Research Association conference in Chicago. In the address Shulman raised fundamental questions about teacher knowledge and its development and about research paradigms in teacher education. He distinguished between three forms of knowledge: content knowledge, pedagogical content knowledge, and curriculum knowledge. The first two were the most relevant for this study.

Content Knowledge

Content knowledge, in the sense Shulman (1986) used it, means the ability of the teacher to arrange the conditions appropriate for a particular subject matter. Content knowledge is of three types: a) subject matter content knowledge; b) pedagogical content knowledge; and c) curriculum content knowledge. Subject matter knowledge is composed of theoretical and practical components.

Subject matter content knowledge as conceptualized by Shulman must include both substantive and syntactic structures.

The substantive structures are the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate its facts.
The syntactic structure is the set of ways in which truth, or falsehood, validity or invalidity are established. (p. 9).

According to Shulman (1986),

Teachers must not only be capable of defining for students the accepted truths in a domain. They must also be able to explain why it is worth knowing, and how it relates to other propositions, both within the discipline and without, both in theory and in practice (p. 9).

Both these structures, therefore, define the subject and the way in which what counts for truth and validity in the field is accepted. For example, what is accepted in a gymnastics activity as comprising the critical elements of the skill may be determined by experts in the area. When several experts agree, it becomes the subject matter and may be used to determine acceptable performance.

In physical education, subject matter knowledge includes both practical and theoretical knowledge (Tinning, 1992). Practical knowledge are the various activities such as gymnastics or basketball, while the theoretical subject matter is made up of the foundational courses such as exercise science and biomechanics.

**Pedagogical Content Knowledge**

Research into teachers pedagogical content knowledge represents an attempt to determine what teachers know about their subject matter and how they translate that knowledge into classroom instructional events (Anderson, 1989; Ball, 1988; Buchanan, 1984). Carter (1990) has suggested that the knowledge both novice and experienced teachers get in their subject areas poorly equips them to transform that knowledge and present it to students in ways that positively impact student learning. The process whereby teachers get to know what they know and represent it seems to be complex.
Early in his writings Shulman criticized the research paradigms as being too limited particularly in not considering teacher content knowledge as important to study. He later acknowledged that he was wrong in his severe criticisms of the research paradigms (Sparks, 1992), maintaining that it was incomplete. His notions are often cited for the introduction of the concept of pedagogical content knowledge (PCK).

Pedagogical content knowledge as formulated by Shulman (1986):

represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction (p. 8).

The form of teacher knowledge Shulman advocated;

goes beyond knowledge of subject matter per se to the dimension of subject matter for teaching (p. 9).

The form of teacher knowledge that Shulman was talking about “embodies the aspects of content most germane to its teachability” (p. 9). Several attempts have been made to clarify what Shulman meant by this definition. Shulman and Sykes (1986), suggested that PCK includes:

Understanding the central topics in each subject matter as it is generally taught to children of a particular grade level and being able to ask the following kinds of questions about each topic; what are the core concepts, skills, attitudes which which this topic has the potential of conveying to the students?... What are the aspects of this topic that are most difficult to understand for students? What are the greatest intrinsic interest? What analogies, metaphors, examples, similes, demonstrations, simulations, manipulations, or the like, are most effective in communicating the appropriate understandings or attitudes of this topic to students of particular backgrounds and prerequisites? What student preconceptions are likely to get in the way of learning? (p. 9).

Tinning (1992) has described it as the knowledge concerned with how to teach the subject matter content knowledge. Tinning went further to suggest that there might be
two forms of pedagogical content knowledge, the theoretical (e.g., ability to perform well on knowledge tests) and the practical (applying the knowledge of theory in a practical teaching situation).

In 1987, Shulman put pedagogical content knowledge in proper perspective when he defined PCK as one of several categories of the knowledge base in teaching. Shulman described PCK as:

that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding...the category most likely to distinguish the understanding of the content specialist from that of the pedagogue (Shulman, 1987, p. 8).

By this definition, Shulman was making it clear that there was a difference between knowledge of teachers which he called pedagogical content knowledge and knowledge for "content specialist", the scholar, which he called content knowledge. This distinction drew some criticism from other educators.

Views from other educators

Shulman's model has attracted criticism from several educators. McEwan and Bull (1991) criticized Shulman's view that distinctions could be made between content (knowledge of the scholar) and pedagogical content knowledge (knowledge of the teacher). According to McEwan and Bull (1991), CK cannot be separated from PCK.
As McEwan and Bull (1991) stated:

In short, no formal difference exists between subject matter knowledge and pedagogic content knowledge. To the degree that it is addressed to particular evidences, all subject matter is pedagogic (p. 331).

They further argued that

This alternative, which neither Dewey nor Shulman explores, denies that there are pedagogic forms of subject matter knowledge by affirming that all expressions of subject matter are pedagogic (p. 331).

McEwan and Bull claimed their argument was based on the premise that "scholarship is no less pedagogic in its aims than teaching" (p. 331) and therefore how content comes to be represented to children in ways that makes it understandable to them becomes the responsibility of the scholar and the teacher. There lies the fundamental difference between Shulman's and McEwan and Bull's theories. While McEwan and Bull would argue that "all content knowledge whether held by scholars or teachers, has a pedagogical dimension" (p. 318), Shulman theory of PCK exists as "separate category of teacher expertise" (p.317) and that PCK exists as a "bridge between subject matter and pedagogy" (p. 317).

Socket (1987) produced the most forceful and complete critique of Shulman's ideas and strategy. Socket criticized Shulman's "intellectual strategy" (p. 208), as a strategy which sought to link the intellectual and political movements for reform in teacher education by claiming that it is "possible to diagnose the detailed knowledge base of teaching from the study of teachers in action" (p. 208). According to Socket, the flaws or weaknesses in Shulman's analysis for the reform of teacher education were:
First, in the relative lack of attention to context, as opposed to content; second, in the inadequacy of its language of description of the moral framework of teaching; and third, in the lack of sophistication in its account of the relation between reason and action in teaching (p. 208).

Socket tried to argue that teaching is very complex, and for Shulman to attempt to keep excellent teaching highly contextualized with respect to the content specificity of the pedagogical strategies employed by teachers, neglecting the fact that teaching is characterized by complexity, variability, uncertainty, and individual uniqueness, was to neglect teaching as an occupation. Stones (1992) also expressed criticism and strong reservations about Shulman's conceptual framework and research program. Stones criticized the view that it is sufficient for teachers to have a thorough knowledge of the subject matter and practical classroom experience, to ensure that not only could the teacher have appropriate knowledge to deliver, but also know how to deliver the knowledge. He argued that training institutions that adopt this view concede teaching is a simple skill and are in fact in great danger of taking a delivery view of teaching. He concluded that Shulman's ideas about the transmission of CK betrays this simplistic view, and suggested that there should be a place for theoretical knowledge about the nature of teaching.

Whatever the criticisms, Shulman’s model provides a lens for examining the relationships between content and pedagogy. PCK is the “missing paradigm” in research in teaching and about teachers and Shulman has provided the impetus for studying the knowledge base of teachers.
Shulman has not only drawn criticism, he has also attracted disciples from many disciplines, including English (Gudmundsdottir, 1990), mathematics (Marks, 1990), science (Hashweh, 1987), and physical education (Rovegno, 1989, 1990, 1992a, b, 1994, 1995). The importance of Shulman’s work was made manifest when a complete issue of the Journal of Teacher Education (1990, May-June) was devoted to the subject of PCK.

**Application of Shulman’s Notions in the Study of PCK in Physical Education**

The research tradition in physical education has often taken a pattern in which research paradigms developed in generic educational research lead and physical education follows. Following Shulman’s notions and studies carried out in general education, physical education is just beginning to emerge and to consider the issue of CK and PCK seriously. Studies of physical education teachers have shown that the amount and kind of PCK influences instruction (Ennis, Mueller and Zhu, 1991; Graber, 1995; Griffey, Hacker, & Housner, 1988; Rink, French, Lee, Solmon, and Lynn, (1994); Rovegno, 1992a, b; Walkwitz & Lee, 1992). In studies of undergraduate beginning teachers, several major findings suggest that even though undergraduates consider the development of PCK important to them (Rovegno, 1991, 1992a, b), overall, the undergraduates do not have much PCK, nor CK, and often what they have is weak (Graber, 1995; Rovegno, 1993a, b; 1994, 1995; Rovegno & Bandhauer, 1994).

Considering the relationship between CK and PCK, findings from the research studies investigating the relationship between CK, PCK, and student responding it is surprising that no research has appeared examining these relationships.
The lack of relational studies may be a result of PCK just emerging as a line of inquiry. This review examines some of the work done in this area which is relevant to this study.

Rink, French, Lee, Solmon, and Lynn (1994) compared the PCK structures about effective teaching of preservice teachers and teacher educators in the professional preparation programs of two different institutions. They examined two groups of preservice teachers at two different points in their preparation program at each of two institutions. The teachers completed a concept map about effective teaching. Using quantitative and qualitative analysis, many preservice teachers were found not to be able to represent their knowledge in meaningful framework. While it was not clear from the study whether students could not associate what they learned in the generic course with teaching physical education or whether the language on the word list affected the extent to which they could illustrate their knowledge, it was quite clear that preservice teachers had difficulty in making links between and about teaching processes. Teacher educators on the other hand were able to incorporate other knowledge bases in their conceptions about teaching and showed similarities in both institutions in concepts about teaching and learning.

This study was significant because it showed that experienced teachers (university faculty) may have a repertoire of knowledge from which they draw which less experienced teachers (the preservice teachers) do not have. Knowing how these experienced teachers came to their knowledge is of interest in this study. Moreover, it might also provide some tools for preparing teachers to meet the demands of effective teaching.
Housner, Gomez, and Griffey (1993) examined the relationships of prospective teachers pedagogical knowledge structures to performance in a physical education class. The Pathfinder network scaling algorithm was used to elicit knowledge structures prior to and after the prospective teachers completed the class. Findings indicated that the knowledge of key pedagogical concepts of students became more coherent and very similar to that of the instructors following the courses. An important conclusion of this research was that novices need several experiences in relevant course work before expert- like thought strategies will emerge. A single course is not enough for students to “contend with the difficult task of semantically organizing pedagogical knowledge” (p. 175).

Ennis, Mueller, and Zhu (1991) employed a semantic ordered tree technique to study the knowledge structures of three groups of teacher education students at different stages in their teacher education program. The study used quantitative measures. It was found that the knowledge structures of student teachers were far more advanced than those of novices who were still in the initial process of structuring their knowledge.

Walkwitz and Lee (1992) assigned four kindergarten teachers to a four hour knowledge training program on overhand throwing. The teachers then instructed students in a six week throwing unit. In a comparative analysis of trained and untrained teachers they found that trained teachers utilized their knowledge structures while instructing students. These concepts were missing in the lessons of the untrained teachers.
The above studies have often focused on knowledge structures of teachers and have relied on asking teachers to complete concept maps in which the relationships between and among ideas have been examined. The studies have also focused on prospective teachers and at the college level. Some of the assumptions of these studies have been that experienced teachers concepts maps would be more complex, better organized, and have larger aggregations of meaningful information units (Graber, 1995). Another conclusion to be drawn from these studies is that there are differences between what experienced teachers learn from training and experience that enables them to use new knowledge that novices are unable to utilize. These assumptions are of interest in this study.

Depending on the emphasis in teacher education programs, knowledge structures may vary. Conceptual maps may differ for pedagogical knowledge or pedagogical content knowledge. One is led to believe that from context to context, knowledge structures will be different, and Dodds (1994) has suggested that PCK is situated. Since many of these studies used quantitative measures which tend to aggregate results, different questions with multiple methods for investigating the questions might produce interesting insights and lead to a deeper understanding of teachers knowledge structures. Fortunately, studies using qualitative approaches have begun to emerge. The most systematic of these efforts has been the research program of Rovegno.

Rovegno's Contributions to the Study of Pedagogical Content Knowledge

The importance of Rovegno's work in the study of teachers CK and PCK may be explained in terms of her attempts to lay a foundation for the definition of PCK. In
trying to develop a clearer understanding of PCK for application in physical education, Rovegno (1992b) drew on McEwan and Bull's (1991) and Mark's (1990) beliefs about PCK to define the subject. Rovegno cited Mark's framework for dividing PCK into overlapping categories of: (a) subject matter for instrumentation; (b) students understanding; (c) media for instruction; and (d) instructional processes (p. 70), to further her understanding, and came to the conclusion that

Mark's conception of pedagogical content knowledge captures how a teacher's knowledge integrates content, the context of schools, how children learn, and classroom teaching (p. 70).

Rovegno's attempts to understand how PCK develops led her to research of preservice and novice teachers in particular. She examined what the pedagogical content knowledge of beginning teachers looked like and how it changed over time. Generally, she found the development of PCK was important for and to undergraduates, and often undergraduates reported that when their PCK was strong their self-efficacy increased and they taught better. On the other hand, these groups of teachers lacked pedagogical content knowledge and skills, and where it was present it was so weak it often created problems for them. Some of these studies are reported in this review.

Rovegno (1989), examined the pedagogical content knowledge of a female preservice teacher teaching basketball. From her analysis she found that while the teacher seemed knowledgeable about the foundations of physical education, she lacked the teaching skills to teach the activity to unskilled players. She did not know how students learned to dribble, how skill in dribbling was developed, and specific techniques for teaching the skill in ways that enables students to learn the skill.
Rovegno (1991), described how seven undergraduate students restructured their knowledge during a field based physical education methods course. The teacher educator in the study guided the student teachers in the planning, and implementation phases of the teaching process, and during post teaching reflection. The researcher observed and recorded all class sessions, conducted both formal and informal interviews with the seven teachers, and collected all pertinent document for analysis. She indicated in the findings that the students reported they were able to recognize and restructure their problematic prior knowledge about children and teaching to a more differentiated form. The students reported a change from "going through the motions" to understanding teaching as "going through after learning" (p. 208). The students also reported that they realized children were not bad or misbehaving purposefully, but were rather eager to learn. She concluded that the student teachers were active goal oriented learners who tried to find meaning in their teaching/learning environment.

Rovegno (1992a) examined how preservice teachers acquire knowledge about a nontraditional movement approach, and how these skills were applied to elementary physical education. Eight seniors in a college were the subjects. During field experience movement approach classes field notes were taken and observations of what occurred were recorded. Field experience lessons were observed and videotaped. Two formal interviews as well as informal interviews were conducted. In this study designed from an ecological point of view, she found that:

The preservice teacher content knowledge did not become pedagogical, rather their pedagogical content knowledge became differentiated in terms of teaching elementary physical education (p. 73).
She came to the conclusion that,

The development of pedagogical content knowledge in this study meant coming to know content from the new perspective of a teacher and discovering the relations among teaching, content, how children learn, context, and individual teaching capabilities and goals (p. 73).

Rovegno (1992b) described how seven students acquired PCK during a field based elementary PE methods class. Data was gathered from field notes, observations, three formal interviews, document analysis regarding classes, units from the preservice teachers and the teacher educator, and from journals kept by the preservice teachers. She found that the development of PCK was influenced by a complex process of “differentiating content knowledge in relation to interactions among a new task...” (pp.77-78).

Rovegno (1993a), described three aspects of learning to teach that twelve physical education teacher education (PETE) reported were instrumental in their development of understanding and commitment to the movement education approach distinct from traditional methods. Data were collected from field observations, document analysis, and interviews. Guided by research on teachers' knowledge acquisition she examined the role of teachers prior knowledge and beliefs and the effects of undergraduate experiences on curricular knowledge. She found that students knowledge, understanding, and commitment to the movement approach developed through a critique of their previous K-12 experiences, and they came to realize that traditional teaching methods were inferior to the movement approach.
She concluded that beginning teachers could be concerned with the ethical dimensions of teaching and utilize the theoretical bases from research in their teaching.

Rovegno (1993b) investigated what and how twelve K-8 physical education teacher education (PETE) majors learned about a movement approach to game play/strategy that was different from their traditional K-12 experiences. Data was collected from field notes, formal and informal interviews, videotape, and observations. She found that although the PETE students understood and accurately applied many aspects of the movement approach, they reported problems in their pedagogical content knowledge of game play/strategy.

Rovegno (1994) attempted to delineate the nature of PCK through a qualitative study. Two students were observed teaching games and a high school sport unit. Following lessons, in-depth interviews were conducted. During field experiences, observations and field notes were made and informal interviews conducted before and after each lesson. The results showed that the two teachers' units consisted of informing, extending, and refining tasks, and teachers were able to give group and individual feedback. While initially, they tried to teach a sequence of informing, extending, and refining tasks in their teaching, they quickly retreated to a "curricular zone of safety" (p. 272).

Rovegno (1995) examined a student teacher's decisions about task content and task progressions across an elementary and high school sport unit, and how he justified the decisions he made.
Through field observations and interviews, Rovegno found that the student teacher's PCK consisted of explaining the task, demonstrating and then allowing the children to play games. As she put it:

First tell about the biomechanically efficient body position and second play games (p. 292).

In all of the studies described above, Rovegno used qualitative techniques. Two to twelve subjects were used in the studies and most of these subjects were preservice teachers. Field notes and interviewing were the most common methods employed. Videotape and personal journals were other sources of data. In terms of the accumulated knowledge base in PCK, it would appear that it is still in a growing phase, a view expressed by Carter (1990).

While Shulman and Rovegno may have acknowledged the importance of PCK, their views about how or where it came to exist seems at odds. Rovegno (1994) relied on Mark’s descriptive relationship between CK, PCK, and Pedagogical knowledge as “three connected neighborhoods with distinct central identities yet blurred identities where they are connected” (Marks, 1990, p. 269). Thus, by implication Rovegno describes PCK as inseparable from CK, both co-exist relationally and situationally, and it is only through experiences that novice teachers learn to refine, develop, and differentiate those knowledges.

Sources of Teacher Knowledge

In this review of the sources of teacher knowledge, I drew on Ball & McDiarmid's (1990) review on the subject. Ball and McDiarmid (1990) observed that
teachers subject matter preparation takes place in the college or university through courses. However, "Elementary teachers take half or more of their courses in the liberal arts" (p.439), and not in colleges of education. They noted that secondary teachers take as few as four to five teacher preparation courses in addition to student teaching.

Teacher socialization research has also pointed to the fact teachers spend at least 13 years in school prior to entering college. During this period they have taken courses. This experience shapes student subject matter understanding long before formal education and learning to teach takes place (Feiman-Nemser, 1983).

As noted by Ball and Mc Diarmid (1990) another source through which teachers learn their content is through student questions, a particular textbook activity, or through an intense discussion. Through these activities teachers come to understand an idea, theme or problem for the first time. How this occurs is subject to further study. They caution that what students (teachers) learn may not only be examined from the course syllabi or curricular goals and objectives but can also be gleaned from other outcomes such as their dispositions, knowledge about the subject, and substantive knowledge of the subject.

Substantive knowledge of the subject was defined as knowledge of the ideas, facts, and theories of a subject. They emphasized that no knowledge of subject matter can exclude substantive knowledge. Substantive knowledge is the "very stuff of a subject" (p.440). Subject matter knowledge was defined as the knowledge that includes host of understandings about the subject. Even if such understandings are not explicitly stated as goals, students develop ideas about the subjects they study. Often in studying a
subject, students develop ideas that are not in tune with the ways their professors and other scholars think about their subject. Student beliefs about the nature of their subject influences their substantive understandings.

Another source of knowledge of their subject comes from the dispositions students develop toward their subject. They may acquire dislikes and likes, for example, of certain sports and games, and may pursue study of some activities to the exclusion of others. Students may develop conceptions of themselves as being good in some subjects and not in others. Such disposition towards subject matter are often overlooked in studies about subject matter.

An important source of subject matter knowledge comes from teaching it. As teachers interact with the subject matter they come to develop understandings and knowledge not normally found in textbooks.

In physical education, Rovegno's (1989) investigation of the PCK of a preservice teacher uncovered four sources associated with the development of PCK: a) field experience, b) liberal arts subject matter courses, c) non-field based content specific methods courses, and d) courses on the psychology of learning theory.

Schempp (1993), in his examination of how a high school physical education teacher constructed his knowledge necessary to meet the demands of his job, described the sources and processes used in making pedagogical decisions. Using life-history and ethnographic techniques of data collection, he found that the teacher relied on four knowledge sources: community, school, profession, and biography. The teacher who was the subject of the study realized that the community considered sport more important
than physical education and these were the messages he passed on to his students. He also found that school administrators were more concerned with discipline and management than student learning. While the teacher drew knowledge from several professional sources, the impact of these professional sources got lost on him. What was significant about this study was that, the teacher considered his personal initiative and professional experience as the largest sources in the construction of his professional knowledge. Schempp concluded that the messages the teacher received indicated that subject matter was not important.

Implications of Research

The different views of PCK might take us down different roads in how we prepare preservice teachers to develop their PCK, and how we might go about our research efforts. For one thing, we could begin to study PCK from the perspectives of the teacher-scholar, from the scholar, or from the teacher. The dimensions might affect the contexts within which the study of PCK takes place. For example, when a university professor investigates PCK the knowledge and information might not filter down easily to the elementary school teacher who sometimes relies on information from research to improve teaching methods. Another implication results from Rovegno's (1994) proposal of a "curricular zone of safety". In most educational contexts there is some curricular zone of safety but if teachers get boxed in by this it becomes problematic. It will become necessary for teacher educators to prepare teachers to deal with problems in teaching different levels of students. Teacher educators must be prepared to provide the experiences and strategies that will prepare preservice students for their jobs.
Summary

This review of literature has described the content and pedagogical content knowledge research paradigms which placed Shulman's work in general education and Rovegno's work in physical education as the theoretical framework. Generally, the developing theoretical framework emphasizes that if teaching aims at improving children's learning then teachers must have a sophisticated understanding of the subject matter they teach. At the heart of teaching is the notion that teachers must know how to represent the subject matter in ways that children can understand. Knowledge of subject matter influences the way the teacher teaches. Teachers who know more about their subject matter are more likely to represent it in interesting and innovative ways, and thus they will be more effective. Knowledge of subject matter content is important if the teacher is to be able to evaluate teaching methods, teaching aids, and other mediums of instruction. In assembling their knowledge in colleges or universities, teachers may also have developed misunderstanding of the subject matter and this needs to be rectified if teachers are to teach effectively. Shulman's model focuses on providing the means to understanding the development of pedagogical content knowledge, and thus to an understanding of some aspects of teacher growth.

In physical education, the development of PCK is important to preservice teachers. When preservice teachers have strong PCK they feel confident and excited about teaching, but when it is weak, they have problems when they teach children. Preservice teachers do not have adequate content knowledge in physical education.
Acquiring PCK can be problematic. Little is known about the content and pedagogical content knowledge of expert or experienced teachers.
The investigation examined the influence of physical education teachers' content knowledge and pedagogical content knowledge on student success in learning the cartwheel. The study utilized both quantitative and naturalistic inquiry techniques. This chapter describes the rationale for the methodology to the study of content and pedagogical content knowledge, and provides details related to subjects, research settings, data collection, data analysis, and data trustworthiness.

**The Rationale of the Methodology**

Patton (1990) argued that one important way to strengthen a study is to utilize a combination of methodologies in the study of the same phenomena or programs (p. 187). This is referred to as triangulation and can mean the use of both quantitative and qualitative methods. The logic of triangulation according to Denzin, 1978 (in Patton, 1990) is based on the premise that no single method ever adequately solves the problem of rival causal factors....Because each method reveals different aspects of empirical reality, multiple methods of observations must be employed. This is termed triangulation. I now offer as a final methodological rule the principle that multiple methods should be used in every investigation (p. 28).
Triangulation in this study involved utilization of naturalistic and quantitative techniques. The term naturalistic inquiry is often used synonymously with the term qualitative research. Mullen (1995) has indicated that qualitative research does not designate a specific approach. Locke (1989) defined naturalistic inquiry as the "systematic, empirical strategy for answering questions about people in a bounded social context" (p.2). According to Peshkin (1988) naturalistic inquirers "share a commitment to understanding the complexity of the phenomenon of interest to them" (p. 416).

Naturalistic inquiry is well suited to:

a) generating hypotheses, b) discovering potentially important variables, patterns and relationships, c) gaining increased understanding of the meanings of the events to participants and, in general, d) examining the less obvious and apparently more ambiguous aspects of life in schools (Earls, p. 40).

Strauss and Corbin (1990) also stressed that the nature of the research problem may demand the use of naturalistic approaches to solve it. According to Strauss and Corbin (1990):

Qualitative methods can be used to uncover and understand what lies behind any phenomenon about which little is yet known. It can be used to gain novelty and fresh slants on things about which quite a bit is already known. Also, qualitative methods can give the intricate details of a phenomenon that are difficult to convey with quantitative methods (p. 19).

Multi-case replication design is a method common to both qualitative and quantitative methodologies. Bogdan and Biklen (1982) have indicated that when two or more subjects, settings, or data sets are studied researchers are doing multi-case studies. The underlying logic for multi-case designs is based on replication. Multi-case design is common to qualitative methodology (Patton, 1990) and to quantitative methodology,
particularly behavioral research (Cooper, Heward, & Heron, 1987) where the multiple baseline design across subjects, settings, or behaviors has become a standard design. Advocates of both paradigms would agree with Cooper, Heward, and Heron's (1987) contention that:

The evidence from the multiple baseline cases is often considered more compelling and the overall study is therefore regarded as more robust (p. 52).

This study focused on cross-case analysis using the multiple cases as basic data sources. The research questions were posed in cross-case language to emphasize the analysis among the various individual cases as the primary focus. Multi-case models have been used in a number of physical education studies recently (Dyson, 1994; Lund, 1990; Rauschenbach, 1992; Romar, 1995; Tsangaridou, 1993).

**Sampling Design**

A purposive sampling technique was used to collect data. According to Patton (1990), the purpose of purposeful sampling lies in sampling information-rich cases for in-depth study. Due to ethical considerations (the requirement that subjects be voluntary) and practical considerations (time, cost, and logistical support) many studies of this type use purposive sampling. The problem this creates for generalization of the study is selection bias. This sampling technique has strengths in identifying important data sources, but has a major weakness in establishing generalized outcomes. While a generalized outcome is eventually important, research on pedagogical content knowledge in physical education is sufficiently young that the primary purpose of this study of
analyzing specific connections among content knowledge, pedagogical content knowledge, and learner behavior among a purposeful sample of experienced teachers was considered to be an initial step.

**Subjects**

The subjects for the study consisted of volunteer, experienced elementary physical education teachers from Franklin County and their students. The teacher sample in this study (n=7) consisted of a subgroup of teachers selected purposively from those volunteering based on teaching experience and reputation as effective teachers. Those solicited were limited to suburban teachers because access to the main nearby urban district could not be achieved within the study's time parameters.

Experienced teachers were solicited because Dodds (1994) had concluded that pedagogical content knowledge is a function of experience in teaching and that novice teachers were less likely to demonstrate it. Elementary physical education specialists were chosen because of the skill to be studied (cartwheel) and the desire to observe the skill being taught to young, novice learners on the assumption that pedagogical content knowledge was crucially important to teaching effectiveness in such a context.

The student sample (n=4) for each site was two more-skilled and two less-skilled students, one boy and one girl in each category. The small sample was used to eliminate managerial and organizational concerns so as to focus exclusively on teaching the cartwheel. Students were selected purposively from teachers' classes based on teachers' recommendations. Teachers' ratings of children's abilities have been found to be accurate (Weiss & Horn, 1990). Previous research (Dunbar & O'Sullivan, 1986;
Siedentop & O’Sullivan, 1993; Son, 1989) has shown that students of different levels often have quite different instructional experiences. Lund (1990) selected students from a teacher compiled list of high and low achievers that differed markedly in their response patterns, as a strategy to exploit the variability between high and low ability students. Lund (1990) did find that this strategy allowed her to observe and analyze variability in student response patterns. This study employed the same strategy.

Entree

A list was compiled from a directory of teachers in Franklin county and the assistance of the faculty member responsible for elementary methods classes at the Ohio State University. The investigator was already known to some of the teachers in his role as university supervisor. Teachers were contacted through a letter inviting them to participate in the study. The letter explained the nature and purposes of the study and their expected involvement. Confidentiality and anonymity were guaranteed for the participants concerning the collection of data and report of the findings. According to Erikson (1986), these procedures minimize risks (social, physical or psychological) for the subjects and address the ethical issues of paradigmatic research.

Teachers were provided one credit hour of independent study for participation in the study. They received a complete debriefing after the study. Formal written permission to conduct the study was sought and approved from the Human Subjects Review Committee at The Ohio State University and School Districts where the subjects work. A meeting was arranged with each participant in their school before data collection began. The purpose of this meeting was to explain in detail procedures for
data collection and to deal with any concerns the subjects might have about data
collection. Data collection began two weeks before teachers went on summer holidays.
The last data was collected a day before public schools closed for the summer holidays of
1996.

Setting

Sites for the study were suburban, public schools in central Ohio. Each site
represented a case in the multi-case study. No special facilities were required. Teachers
were allowed to choose the time when they would complete two 15-30 minute lessons
with the four students. No specialized equipment other than floor mats were required for
this study. Each school had wholly adequate physical education facilities and equipment.

Conduct of the Study

The selection of methods for this investigation were guided by the research
questions. The major research questions drive the conduct of a study (Earls, 1986).
Multiple data collection methods were utilized. The following methodologies were
utilized:

1. Demographic sheet

2. Investigating the content knowledge of teachers

   A) Written Survey

   B) Interviews
3. Investigating the pedagogical content knowledge of teachers
   
   A) Interviews

   B) Field notes

   C) Videotape analysis of teaching

4. Investigating student responses

   A) Observation of practical sessions

   B) Group focus interviews

**Demographic Sheet:**

Teachers completed a demographic sheet that provided information about their race, gender, school location, and teaching experience. Other information from the sheet included age, type of education, major area of study, gymnastics experience, current status in gymnastics participation or teaching, amount of time spent in teaching and coaching, and any information that assisted in understanding their development as gymnastics teachers.

**Written Survey**

Teachers were surveyed in written form to elicit information about their knowledge of the cartwheel. The survey consisted of questions related to the critical and technical elements of the cartwheel, identifying the errors in a side cartwheel performance, and describing in sequence the skill components of the cartwheel.

**Interviews**

Interview transcripts served as one of the data sources for the teachers and students in this study. The interviews were semi-structured; that is, they contained the
same basic set of questions, but at the same time were open enough to allow the researcher to pursue unique lines of inquiry when the need arose in order to establish teachers knowledge about content and pedagogical content knowledge. Interviews were conducted on an individual basis in teachers' schools and audio recorded. Interviews with teachers were conducted during their planning or conference periods or after school. Teacher interview protocols contained questions designed to elicit information about the critical and technical elements of the cartwheel and the relationship between these and student responses.

**Teacher Interview Protocol**

The protocol for the teacher interview consisted of a series of questions presented to the teachers about content and pedagogical content knowledge. Specifically, questions were designed to elicit information about 1) what experiences they had performing and/or teaching the cartwheel, 2) what they perceived to be the source of their knowledge about teaching the cartwheel, 3) what their basic strategy was in teaching the cartwheel to young novice learners of varying skills, and 4) what they saw as the main learner problems and how they overcame them.

**Student Interview Protocol**

A group focus debriefing interview session was held at the end of the two lessons. The protocol for the student interview contained questions about their understanding of the cartwheel and their reactions to teacher instruction. Specifically, students were asked what their teacher told them that helped them to learn the cartwheel, how they would
differentiate between a good cartwheel and a bad one, and what they thought of doing right when they performed the cartwheel.

**Videotape Analysis**

Each participant was videotaped teaching two lessons of 15 to 30 minutes duration to the same group of four students. Each lesson was videotaped with a wide angle lens and camera. The general purpose of this videotaping was to produce a permanent product to be used for quantitative data analysis. More specifically, the videos were used to code teachers instructional actions and to analyze student responses relative to teacher presentation of tasks to see how those responses changed over the course of the two lessons.

**Observation Instrument for Videotape Analysis**

The modified form of the Task Structure Observation Instrument (TSOI) (Marks, 1988) was utilized for collecting data for the analysis of task presentation. This observation system was designed for coding with a permanent product, the videotape. The focus was on how the teacher presented tasks to students and how these students responded to those tasks.

The observer recorded events on the coding sheets as they occurred in videotaped lesson. A chronograph which ran continuously throughout the lesson, provided the means for recording time data and was used by the observer for coding of the videotape.

In the attempt to observe and describe teachers pedagogical content knowledge, a training manual (see Appendix F) was designed to train an independent observer. The manual's focus was on:
a) Teacher's description of tasks
b) Student response to specific tasks
c) Teachers' response (feedback)

These three major segments comprised the observation system. The system produced a record of instructional tasks and how these tasks progressed within and across lessons. Managerial tasks were not the focus of this observation system.

Field Notes

According to Bogdan and Biklen (1990), field notes are the written account of what the researcher sees, hears, experiences, and thinks in the course of collecting and reflecting on data. All lessons were observed and field notes related to the lesson’s activities and events pertinent to the nature of the study were taken. After each lesson observed, as recommended by Bogdan and Biklen (1990), the notes were expanded, typed, and reviewed before the next observation. Bogdan and Biklen (1990) suggested that notes should be detailed and descriptive but should not rest on assumptions that the researcher made about the setting.

Data Analysis

The data analysis procedures used in this study were considered with the research questions in mind. Data from teacher interviews, teacher survey of content knowledge, teaching strategies, and teacher perspectives data were used to answer the first question. Information from coded videotapes was used to answer question two. Information from videotapes and interviews with students were used to answer the third question. Cross-case and cross-interview analysis was used for grouping answers from the different
subjects to common questions in the interviews (Patton, 1990). A process of inductive and comparative pattern analysis was used to permit patterns and categories to emerge from the data (Guba, 1978).

**Analysis of the Research Questions**

1.0 What do teachers know about the cartwheel and how to teach it, and how did they come to that knowledge?

Responses from teachers regarding the sub-questions were grouped to answer this question.

1.1 What experiences have teachers had performing and/or teaching the cartwheel?

Information about teachers' experience teaching or performing the cartwheel were drawn from the interview data. The demographic data provided by teachers provided the first means to determine teachers' teaching and performing experiences. Data from the interviews and demographic data were then used to begin to sort teachers into groups.

1.2 What do teachers perceive to be the sources of their knowledge about teaching the cartwheel?

Information about their sources of knowledge about teaching the cartwheel were drawn from the interview data. The first step in analyzing the interview transcripts involved reducing the data from each interview to a set of statements relevant to each participant's perceptions. Categories that emerged from the data were compiled. For comparative purposes the total number of activities from the list of categories were tabulated for each teacher.
1.3 What do teachers know about the critical and technical elements of the cartwheel?

Teachers' content knowledge was analyzed for the technical and critical elements. A pre-established framework was used for analyzing these areas.

The Critical Elements of the Skill: The cartwheel represents a skill that can be broken into identifiable components, for example, initial stance; hurdle step; hand-foot placement; flight, and landing, which are important to successful execution. These components were established from information gathered from the literature, and after a panel of four expert teacher-coaches or coaches provided common points of reference for evaluating teachers content knowledge about the critical elements. The experts were selected from two different universities. The head mens' gymnastics coach and a professor emeritus with extensive gymnastics coaching and teaching experience formed the poll from one university. At the second university the womens' gymnastics head coach and the gymnastics teacher who was also the head of the university circus team comprised the second team of experts. In addition, the cartwheel represents a skill with a desired level of complexity in that it is difficult enough to pose reasonable demands on the subjects knowledge structures, but reasonably familiar to all subjects. Overall content knowledge accuracy scores, accuracy scores as a function of the number of components included in responses were computed.

Sequencing of the Skill: Pre-established frameworks for analysis of teachers content knowledge about the cartwheel were developed from expert opinion and from the literature. Four gymnastics teacher-coaches or coaches formed a panel of experts.
Experts were provided a copy of the responses of each teacher and asked to comment on the sequence and strategies teachers described they used to teach the cartwheel. The experts were asked to provide what they considered to be the correct sequence of the cartwheel. A common order of sequences were developed from expert responses and used as categories for judging teacher responses. The number and order of sequence elements included in teacher responses were tabulated and used to judge teacher knowledge about the sequence of the cartwheel.

Identifying Errors in the Cartwheel: Teachers were presented with a pictorial sequence of a cartwheel performance, and asked to identify errors during any stage of the performance. Five errors in the sequence of ten figures, which the expert pool identified were used to analyze teacher responses. Teachers were scored on errors identified correctly and components misidentified as errors.

1.4 What were the teachers basic strategy in teaching the cartwheel to young, novice learners of varying skill levels?

The categories that were used to judge teachers knowledge of pedagogical strategies were determined by the patterns that emerged from interview data. Teachers were asked to speak to the strategies they used in teaching the cartwheel, what they emphasized and reasons for what they emphasized. A descriptive analysis was made of the patterns that emerged from the interview data about the strategies teachers used to teach the cartwheel and teacher responses were grouped under common themes. Throughout data analysis, the data from teaching observations and from interviews were searched for contradictory evidence.
1.5 **What do teachers see as the main learner problems and how do they overcome them?**

Categories that emerged from the interview data were used to provide a descriptive analysis of what teachers regarded as the main learner problems. Questions such as: “What are the main learner problems?” “In what order of importance relative to learning the skill successfully are these problems?” “In what order of more or less frequency do they occur?” were analyzed and described. Data were organized into units and were categorized according to similarities that emerged.

2.0 **How do teachers present cartwheel tasks and provide feedback to more and less skilled novice children?**

An analysis of this question was made from the sub-questions.

2.1 **What are the progressions of tasks children are asked to do and how are those tasks presented?**

Data coded from the videotapes were used to answer this question. The analyses focused on what tasks were presented and the order of presentation. The analysis examined how the tasks were presented (e.g., through word pictures, demonstrations, metaphors, catch-phrases, etc).

The second part of the analysis examined what skill related interactions teachers had during their lessons in relation to the task progression and based on what students were doing.
The tasks were analyzed for the order in which they were presented and for the similarities and differences in (a) tasks presented and (b) order of tasks across cases.

A description of the type of task and the percentage of total time for the lesson was reduced for presentation in tables. Tables were organized by student ability level to focus on the distribution of time and tasks by student ability level.

2.2 What types of feedback and prompts do teachers provide to learner responses?

The primary purpose of this analysis was to examine the type of feedback (congruent, corrective, general) the teacher provided in response to immediate practice success of the low and high skilled students for the different tasks. Tasks were used as the unit of analysis and so all data were preserved by tasks.

A two step process was used to code instructional tasks, teacher feedback and prompts and student responses. In the first step, each change in task emphasis was recorded. In the second step, the researcher coded the practice trials (appropriate or inappropriate; successful or unsuccessful) of each student during each task for each response. Student response were coded appropriate if they were performed according to the teachers stated task. For example, if the teacher asked the student to take a hurdle step before placing the left hand down, a hurdle step before the placement of the hand would meet this criterion. Points at which the teacher provided corrective, congruent or specific feedback were coded. This process provided a record of each students motor skill responses to each instructional task before and after feedback in each lesson. The
data gathered was summarized in tables. From the summarized data, frequencies and percentages of teacher behavior in each cell were determined.

3.0 How do more or less skilled children respond to these learning opportunities and what do they understand about how to do the cartwheel?

Since learners' performance during instruction was the criterion for determining the relationship between teachers content knowledge, pedagogical content knowledge, and student response the measure of their performance was of interest. The purpose of the study was to determine how teachers pedagogical content knowledge was transformed into student learning of a skill.

3.1 What are their patterns of success and errors?

Patterns of success or non-success component

All student responses to instructional tasks were observed. Student activity time, opportunities to respond, and congruence of the response to stated tasks were organized for presentation in tables. Each student's response was judged qualitatively for congruency and topography. Response congruency is how congruent the response was in relation to the stated task. Response topography was divided into successful and unsuccessful.

Student response were coded as successful when the students' response to the teachers stated task was judged by observers to have met the quality criterion of the activity. It was coded as unsuccessful when the outcome of the response was judged not to be of sufficient quality according to the criterion stated in the task.
3.2 After the lessons, what is their basic understanding of how to do the cartwheel?

For the student understanding component, data that emerged from the student interviews were assessed for their understanding of how to do the cartwheel. The children were asked to respond to what the teacher told them that made them learn the cartwheel, what they thought of doing best when performing the cartwheel, and how they might differentiate between a good cartwheel and a bad one. The transcribed interview notes were read and reread and the answers from the children to common questions were grouped into topics. Responses were also analyzed for contradictions from what the teachers emphasized in their lessons. Variations in the responses of the children for the content-richer, content-medium, and content-poorer groups of teachers were grouped for common patterns of their understanding and for comparative analysis. The categories that emerged from the data were used to analyze student understanding.

Trustworthiness

Trustworthiness is the step the researcher utilizes to convince other readers that the findings are valid for the context (Lincoln & Guba, 1985). This study utilized three strategies: Triangulation, peer debriefs, and inter-observer reliability checks.

Triangulation

According to Patton (1990) one important way to strengthen a study design is through triangulation. He identified four basic types of triangulations: (1) data triangulation which is the use of a variety of data sources in the study, (2) investigator triangulation - the use of several different researchers or evaluators, (3) theory
triangulation - the use of multiple perspectives to interpret a single set of data and (4) methodological triangulation - the use of multiple methods to study a single problem or program. In this study, data and methodological triangulation were used to strengthen the design of the study. Different methods were used to overcome any biases of other methods. Findings from one data source were compared and contrasted with other sources.

Peer Debriefing

Peer debriefing is the process whereby the researcher invites other people to comment on the findings and interpretations (Lincoln & Guba, 1985; Patton, 1990). Experienced physical education and qualitative research professors served as the primary sources of peer debriefing. The head of the advisory committee for this study read the raw data, the early analysis and interpretations, and the final analysis. Reactions, comments and any probing questions were used to make revisions for the methodological and analytic interpretations.

Inter-Observer Agreement

To check the reliability of the quantitative data, inter-observer agreement measures were made. Data collected through the modified form of the Task Structure Observation System was checked by a Graduate Teaching Assistant in the Physical Education Teacher Education section of the School of Health, Physical Education and Recreation of the Ohio State University. The observer was familiar with observation systems and coding procedures for various instruments.
Training for the observer followed a sequential format. The observer was given a manual with the definition of the categories and instructions on how the system worked. The researcher met with the observer to discuss the observation system and to deal with any problems or questions. The researcher and the observer then practiced by watching and coding a videotape together. Then, two lessons for four of the seven teachers were randomly selected and coded independently and reliability measures calculated.

Summary

For this study, seven elementary school physical education specialist teachers served as subjects. A total of 16 lessons were observed for all teachers. The lessons were taught during recess, after-class, or arranged. Qualitative and systematic observation strategies were utilized to describe and analyze the data from the transcribed interviews and the videotaped lessons. Data collection were from field notes, interviews, and videotapes. Finally data were carefully analyzed to collect information about teacher content and pedagogical content knowledge structures in elementary physical education classes.
CHAPTER 4

RESULTS

This chapter presents the results from a cross-case analysis of the data from seven cases. The chapter is divided into four sections. The first section presents the inter-observer agreement results. The following three sections present the analysis for the three research questions.

Section 1 - Inter-observer Agreement (IOA)

Inter-observer agreement, the percentage of agreement between two observers, was measured to provide an estimate of the systematic observations of the teachers and students during the instructional lessons. Four teachers were randomly selected and both lessons for each of these teachers were observed and coded independently by two observers. The IOA was calculated for each behavior category in the ten category observation system. Specifically, the categories were, number of tasks, feedback directed towards correcting performance errors, supportive feedback, feedback to restate tasks, informing, refining, extending and application tasks, number of student opportunities to respond (OTR), the success of student responses, and the degree to which student responses were technically appropriate.
An observer was trained by the researcher using protocols described in a coding manual (see appendix F). Category behavior definitions were discussed. A video tape of one of the lessons was observed and coded independently by both observers. Results were discussed and problems in interpretation and application of category definitions were resolved. The newly trained observer then coded selected lesson video tapes and results were compared to researcher coding of the same tapes. Results indicated that not all categories achieved the 80% agreement criterion established. The two observers again discussed the differences in the two records and the application of category definition in the problem areas. Both observers independently coded the tapes a second time. The IOA scores for the second coding ranged from 80 - 85% on all categories. The data from this second coding were analyzed to answer the research questions.

Section Two - Research Question 1:

1.0 What do teachers know about the cartwheel and how to teach it, and how did they come to that knowledge?

Data related to teacher knowledge about the cartwheel, their perceptions on how they acquired that knowledge, their descriptions of their approaches to teaching the cartwheel, and how they developed those approaches are reported in the sub-questions.
1.1 What experiences have teachers had performing and/or teaching the cartwheel?

Findings about teacher experiences are presented under performance experience and teaching experience.

**Performance Experience**

Teacher characteristics are shown in Table 1. The average age for teachers was 38 years old, while the mean number of years of teaching experience was 13.4. Each participant was a certificated teacher and held a bachelor's degree in physical education. Two teachers had earned master's degrees. Five teachers reported they had no competitive experience on either high school or collegiate teams. Three teachers had performed at the high school or college level. Benjamin and Liz competed on their high school teams, while Julie competed on her college team. In high school and college competition, Julie remembered that she had difficulty doing the cartwheel on the balance beam, due to the fear of falling off. As she put it,

> When I had a beam routine I had difficulty because back then, that was a really something if you could do a cartwheel on the beam and I don't think I ever perfected it that I actually put it in my routine. It was difficult on the beam. On the floor it wasn't quite so bad. You didn't have so far to fall off, but on the beam it was scary.

Julie and Benjamin had coaching experience in gymnastics. Two teachers, Benjamin and Liz, had taken courses from the United States Gymnastics Federation.
<table>
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<th>Subjects</th>
<th>Sex</th>
<th>Age</th>
<th>Years of Teaching</th>
<th>High/College Gymnastics Experience</th>
<th>Highest Degree Earned</th>
<th>Gymnastic Coaching Experience</th>
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<td>38</td>
<td>13.4</td>
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</tbody>
</table>

Table 1: General Characteristics of Elementary Physical Education Teachers
**Teaching Experiences**

Regarding their experiences teaching the cartwheel, some teachers found that the students considered the skill a gendered skill. Larry said that when he was able to get a boy to do the cartwheel, other boys would say that "well, this isn't a girl type of thing to do." Such comments made him aware that the boys did not consider the cartwheel a skill to be taken seriously. Liz, observed that,

A lot of the girls practice it outside of school and they get it real quick, and when I start with the boys, I mean they get really proud of themselves if they, I mean.. but typically I would say that girls have more exposure to cartwheels and are more apt to do them quicker and the boys I think don't get as much experience in doing them.

Some teachers thought that there was great unpredictability in the performance of students from moment to moment. According to Cassady,

Its amazing though the number of children who will have it one minute and not the next. They may do a complete pattern for you one second and then turn around and show me again and they don't have it or show me and its completely wrong.

Liz expressed similar views.

Some kids it takes them awhile to be able to...just skipping one day they can do it if they are ready, their brain is ready.

Benjamin noted that the children will not focus on one aspect of the skill unless they felt he was watching.

If they don't feel that's something I am looking at that present time; if they think that right now he is looking for hand and foot placement they will just forget that they have to keep their arms and legs straight. If they think I am looking for arms and legs straight they will keep them straight. but not necessarily land their cues.
However, Benjamin said that when he focused on adapting materials, and simplifying progressions based on the child's skill and ability, he has been successful in teaching the students.

Summary

On the basis of these data, one could begin to sort the sample of teachers into two groups, one that had competitive performance and coaching experience and the second group of teachers who had neither performance nor coaching experience. Teachers with more coaching and personal performance traits described experiences that suggested greater content knowledge about the difficulty of the skill, while teachers with no such experience could only describe the type of programs that influenced their content knowledge. The findings in this sub-question reported aspects of performance and teaching experience salient to teachers content knowledge.

The two identified groups were able to describe two important issues. The issues were related to student's perceptions of the cartwheel as a skill for girls, and the unpredictability of students' performances.

1.2. What do teachers perceive to be their sources of knowledge about teaching the cartwheel?

The practice of a profession requires not only an initial period of education and orientation, but the continual accumulation of new knowledge to meet challenging situations (Schon, 1983). The following data describe the sources teachers reported for their knowledge about the cartwheel. Two main sources influenced teachers content knowledge: a) professional experience and, b) biography.
Several sources of knowledge were traced from teachers pedagogical practice. All teachers perceived their sources of knowledge to derive from the courses they took in college or the university, even though valued differently, and also from experience teaching students or coaching. For example, Benjamin, said that

The knowledge to teach the cartwheel actually came about through my contact with coaching or you know, like the Special Olympics or with my students at school and my base. My knowledge came from the USGF.

Similarly, Liz observed that

I think a lot of it comes through experience when you are watching the children trying to do something and you are trying to help them, I think that you learn.

Five teachers said they gained additional knowledge through books and manuals. Three teachers reported that they either talked to peers or learned from audio-visual aids such as TV. Another three teachers had participated in high school or college while two of the teachers had gone further to take courses with the United States Gymnastics Federation (USGF).

The teachers taken as a whole, did not provide evidence of serious continuing professional development for the improvement of teaching gymnastics. Liz, had pursued further development in a limited way, partially due to her interest in gymnastics. Benjamin was the only teacher who showed consistent professional development. The teachers with the least amount of initial experience seemed least likely to pursue further knowledge development in gymnastics.
Benjamin's and Liz's training from the United States Gymnastics Federation increased the likelihood that they would find new ways of teaching the skill. Indeed, Benjamin perceived his knowledge came:

mostly from USGF which is the United States Gymnastics Federation. I have seen most of the materials they put out. I have also seen their ten levels system approach when it first came out which is the same system they are following now to form part of the culture to follow for training their athletes for competition.

While Liz may have taken a course from the USGF, she indicated that this was a safety course and there is no evidence of a relationship between knowledge of safety in gymnastics and content knowledge of the cartwheel.

Other teachers, on the other hand, used their personal resources or personal interest to trigger their professional knowledge. In Julie's own words:

Probably, the most significant source was when, just when I participated in gymnastics as ...at the university and high school as a competitor so I would say from coaches and from actually teaching, because I taught gymnastics in college.

Bernard, on the other hand, had little experience to begin with and showed a nearly casual approach to further developing his knowledge base. He reported he gained knowledge:

from what you've seen on TV and then by what I got from my bachelors degree and class on gymnastics

Leslie had very little experience performing the cartwheel. In recollecting if she had difficulty with the skill, she said:

I just didn't have any formal experience myself where anyone ever said do this and watch me do it. I don't know what it looks like, but I have messed around with the kids enough in the gym that I have tried it myself. So that's where all my experience comes from, that room.
She added that:

I am not a gymnast. It really.. even as a kid and in high school I didn't have any gymnastics before I went to the university. I had zero gymnastics so that is not a really really strong area.

Larry's knowledge was particularly derived from following a daughter who participated in gymnastics. He got his knowledge:

from having my daughter being involved in like Universal Gymnast and Midwest Gymnast and going and watching her and watching the teaching progressions they are using.

As mentioned earlier, while all teachers had college education in gymnastics, most teachers believed their undergraduate training had little significant influence on their ability to teach the subject-matter as they traced their sources of knowledge to factors other than their programs. Only two teachers, Larry and Leslie, thought their undergraduate program was an important source of knowledge for teaching gymnastics. As one of the teachers reporting their undergraduate programs had the least influence on their ability to teach the cartwheel, Liz observed that:

I think in my program in college, that there wasn't really a lot of emphasis on the cartwheel.

On the other hand, Larry who thought his college class developed his knowledge base said:

In my gymnastics unit that I do, I give kids width of skills similar to the class that I had in Ohio State. I really liked that.
Leslie also said that:

Undergraduate, I did get a lot of experience then, just, I mean that's where I learned it, was student teaching basically, I say. OSU at the gymnastics class we did a lot of different things and I can remember working more specifically on cartwheels because we were doing gymnastics unit as I was teaching. That helped, made a tremendous difference.

Summary

In summary, not only were teacher's initial training and teaching experiences perceived as sources of their knowledge, colleagues, books and manuals, and other non-traditional sources were also used to increase teachers' opinions regarding the teaching of the skill and to refine particular courses of action. These teachers had to assimilate the various messages funneled to them through the various sources, sometimes without proper guidance.

The primary contributor to most teachers' content knowledge was their interaction with their students over the years. Teachers seemed unconcerned about their knowledge of the cartwheel or lack thereof, showing confidence that their experience had increased their understanding of the cartwheel components. Teachers who reported that they had no experience with the cartwheel were the same teachers who thought their undergraduate training helped their understanding of the cartwheel. On the other hand, teachers whose sources of knowledge went beyond their undergraduate training, suggested that college courses were not important sources of knowledge for them. Benjamin was the "outlier" in terms of his extensive experience as a performer, coach, teacher, and his professional development.
1.3. **What do they know about the critical and technical elements of the cartwheel?**

Teachers' content knowledge of the critical and technical elements of the cartwheel was determined through a written assessment. Results from those assessments were compared against preestablished responses from an expert pool. The data were analyzed for evidence of the degree of content knowledge with respect to three important kinds of knowledge related to successful teaching of the cartwheel. These were the critical technical elements of skilled performance of the cartwheel, the sequence of the skilled movements to perform the cartwheel, and the capacity to identify major errors in cartwheel performance. The written assessment was comprised of these three portions. Teacher responses were then compared against those established by the expert pool.

**Critical Elements**

Table 2 shows the results of teachers' knowledge of the critical elements. Five of the teachers were similar in identifying three or four critical elements, while two teachers could not identify a single critical element. The elements not identified by most teachers were the hurdle step leading into the cartwheel and the finish element. The teachers sorted into two groups on the basis of this assessment. The higher performing group contained all the teachers who had performance and/or coaching experience, but also included Bernard and Cassady.

Several teachers answered in ways that showed a lack of understanding of the critical skill elements. Larry, for example, recorded confidence and lateral flexibility as critical elements of the skill. This is not to suggest that confidence and lateral flexibility
are unimportant from a physical or pedagogical perspective, rather that they are not technical elements of skills. Lateral flexibility is more a physical fitness attribute rather than a physical performance component of the skill of cartwheel. Confidence is also a psychological state rather than a physical performance component. This finding suggests that some teachers lacked thorough understanding of the critical elements of a skill they typically taught in their programs, and perhaps even a lack of understanding of the concept of a critical skill element.
<table>
<thead>
<tr>
<th>Participants</th>
<th>Hand-hand Placement in straight line</th>
<th>Hand-foot foot</th>
<th>Critical Elements</th>
<th>*Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Bernard</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Cassady</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Julie</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>Larry</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leslie</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Liz</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>3</td>
</tr>
</tbody>
</table>

Key

+ Knowledge element identified correctly
0 Knowledge element misidentified or misunderstood
* Total number of critical elements identified correctly

Table 2: Teacher Knowledge Related to the Critical Elements of the Cartwheel
Sequencing of the Skill

Figure 1 shows teacher knowledge of the sequence of the skill. Data from the teacher survey showed that Liz, Julie, and Benjamin correctly identified the sequence of movements salient to successful performance of the cartwheel. Others tended to focus on the technical aspects of the skill, describing the advantageous limb positions and the movements involved from start to finish. Some teachers focused on body awareness concepts rather than on the limb positions throughout the entire movement. For example, Larry described the sequence of the skill as:

- Learning to support own weight with straight arms,
- Learning techniques to get hands down, legs-up
- Moving in a straight line (lateral bend, hand and foot position
  smooth weight transfer along support points)

Cassady's description of the sequence was stated as:

- Lunge step, shoulder width from foot- 1st hand, shoulder width, 2nd hand
- Corresponding hand-foot placement
- Body support
- Limbs straight
- Body awareness/orientation for finish.

Liz was not able to make a distinction between the critical elements and sequencing of the skill. In her own words:

Cartwheel is a travelling skill on hands and feet. It involves travelling in an inverted position and taking weight on hands and feet. A cartwheel should be done sideways in a straight line. Ears should be next to elbow-helps keep body straight not arched.

The data suggest that most teachers either misunderstood or did not understand the concept of sequencing or that their knowledge of the movement sequence for the cartwheel was inadequate. Benjamin, again, was a notable exception.
<table>
<thead>
<tr>
<th>Participant</th>
<th>A</th>
<th>A-B-C</th>
<th>Correct Sequence</th>
<th>C-D</th>
<th>D-E-F-G</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Bernard</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cassady</td>
<td>+</td>
<td>+</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Julie</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Larry</td>
<td>0</td>
<td>+</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leslie</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Liz</td>
<td>0</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Key**

A  Start is from sideways stance with hands overhead, body straight.

A-B-C  From stand to side-scale, rotation through hip joint until lead hand contacts the floor. Body is straight, with lead hand close as possible to support foot.

C-D  As body weight is transferred onto lead arm, lead leg begins to rotate about the hip joint, and legs become straddled.

D-E-F-G  This part is a mirror of A-B-C. Lead leg is close to support hand.

G  Finish is same as start. Hands frame face.

+  Sequence element identified correctly

0  Sequence element misidentified or absent

Figure 1: Teacher Descriptions of the Cartwheel Sequence.
Identifying Errors in the Cartwheel

A pictorial sequence (see Appendix E) of a cartwheel performance was presented to teachers and they were asked to identify the errors in the sequence. For purposes of analysis, the upper level was numbered 1-5 and coded as U1 (represents picture 1 in the sequence, left to right) U2, U3 to U5. Similarly, the lower level was coded as L1 (representing the first picture in the sequence left to right), L2, L3 to L5.

Experts' analyses of the picture suggested the following errors were present: (1) Starting position the arms of the performer were not up over the head and the lead foot should be lifted just before the beginning of the skill (U1). (2) The first and second hand down should be in line with the direction of the skill, the lead leg of the performer should be straight, and the performer should be in side scale (U2 and U3). (3) The handstand phase, the head of the performer should be tucked in and feet in direction of skill (U4, U5). (4) As the hands leave the mat in recovery, arms do not frame face and the performer should be in a side scale (L3 and L4). (5) In the final phase the arms should have been over the head and close to the ears and last foot down should be in line with direction of the skill (L5). Teachers were scored on their ability to identify the five errors in the picture. Table 3 shows teacher knowledge of incorrect skills exhibited by a performer. Column one shows the number of errors correctly identified (hits). Column two shows the number of errors that were present but were not identified (misses), and column three shows the number of elements misidentified by teachers as errors, but in fact were not errors.
There was clear evidence between groups of teachers that there was some relationship between experience and analytical ability to identify errors in a performance. Benjamin, Julie, Bernard, Cassady, and Liz as one group of teachers, were able to identify correctly 3 to 5 errors in the performance presented to them. Leslie and Larry, as a second group, consistently exhibited less knowledge based upon the responses from the survey.

<table>
<thead>
<tr>
<th>Teacher</th>
<th># correctly identified &quot;Hits&quot;</th>
<th># unidentified &quot;Misses&quot;</th>
<th>Elements misidentified as errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Julie</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Bernard</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Cassady</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Liz</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Larry</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Leslie</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3: Teacher Scores for Error Identification

Summary

There were clear differences between groups of teachers on their content knowledge about the critical and technical elements of the cartwheel. On the basis of amount and type of gymnastics experience, and knowledge of the critical elements,
sequencing of the cartwheel skill, and error identification, teachers were partitioned into three groups for further analysis. The three groups were called "content-richer", "content-medium", and "content-poorer". The content-richer group (Benjamin, Julie) was the gymnastics teachers with more extensive experience in performing, teaching and coaching, and demonstrable greater knowledge in the critical and technical elements. The content-medium group (Bernard, Cassady, and Liz) is the teachers with mostly teaching experience and a moderate knowledge in the critical and the technical elements of the cartwheel. The content-poorer group (Larry and Leslie) is the gymnastics teachers with no performing or coaching experience other than training received in their undergraduate program, with little knowledge in the critical and technical elements of the cartwheel.

1.4. What is teachers basic strategy in teaching the cartwheel to young, novice learners of varying skill levels?

Teaching Strategies

Data from interviews were analyzed for teachers descriptions of the strategies they use to teach the cartwheel. Expert opinions were sought on whether the strategies described by the teachers represented appropriate progressions for teaching the cartwheel to novice children, and if not what they thought would be considered appropriate strategy. Experts also commented on anything in the teachers' description that represented a misunderstanding of the content of the skill and how to teach it. Patterns that emerged from respondents are discussed under task presentation, organization, instructional style, and evaluation.
Task Presentation

Table 4 shows the teachers' descriptions from the interview data of the teaching sequence for the cartwheel to young novice children of the three groups. Analysis of teacher responses to the interview questions indicated that, teachers described between two to five strategies for teaching the skill. There were no clear differences between groups of teachers on the number of teaching strategies employed in teaching the cartwheel. Classes started with an explanation and demonstration of the skill. This was followed by lead up exercises that focused on weight bearing activities. When teachers were secure in the knowledge that students could bear their body weight, the cartwheel was introduced. Comparison of what teachers described as their strategy for teaching the cartwheel was made with the strategies they actually used to teach the cartwheel. There was evidence to suggest that there was a congruence between what teachers described as their strategies and what strategies they adopted in teaching the skill. For example; Bernard, a content-medium teacher, described his strategy as:

Do some activity to build their confidence, so they see if they can put up their body weight on their hands. Then do like a progression, starting with weight on their hands and do the first part. But, to build up where the first cartwheels are not going all the way over, we doing like half-cartwheels.

On the other hand, Julie, a content-richer teacher, described her strategy as:

First, I start with a sort of direct approach with the whole class go through this little progression for being able to hold themselves in an inverted position and then I sort of break it up into a station kind of thing where they sort of work at what level they are at, to either at a wall practicing their handstand or they are going to the mat and do their cartwheel so it sort of starts with a direct whole class approach and then it sorts of breaks down to more individualized approach, and I always start with a demonstration of the skill.
<table>
<thead>
<tr>
<th>Strategies</th>
<th>Content-Richer</th>
<th>Content-Medium</th>
<th>Content-Poorer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ben</td>
<td>Julie</td>
<td>Liz</td>
</tr>
<tr>
<td>1. Watch videotape</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Explain and demonstrate skill</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. Warm up/Stretching</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>4. Provide weight bearing activities</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5. Lead-ups</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6. Cartwheel</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Total No. of Strategies | 3  | 4  | 5  | 4  | 2  | 4  | 3  |

**Key**

+ Sequential order of the strategy as described by the teacher
0 Not part of the description of the strategy teacher provided

Table 4: Teacher Description of the Cartwheel Strategies
Teaching Aids

There was not a significant difference between the teaching aids content-richer, content-medium, and content-poorer teachers described they used. Teachers said they used folded mats to create safe landing floors for the children. Benjamin was the only teacher who described the use of audio-visual aids (video). Modeling, visual cues such as tape on the floor of the gym or mats, and spotting was an important part of the aids used by all groups to help students. Larry, Liz, Julie, Cassady, and Leslie also described modeling and spotting, but it was only Liz who indicated she used hoola-hoops as teaching aids.

Teaching Cues

Content-richer and content-poorer teachers described similar cues used to help children learn the cartwheel. All groups of teachers indicated they used the "1-2-3-4" rhythm or "hand-hand-foot-foot" cues to aid children. The content-medium teachers focused on mental imagery as important cues. Bernard intimated that the cues he used included asking the children to visualize gymnastics they had seen on the TV and "picture of the arms being like spokes in a wheel". Bernard also said he used pictures taken from books. Cassady described the "lunge" and "hand-foot pattern" as cues he used.

Teaching Style

Teachers' descriptions of their style was determined from interviews and from lesson presentation and a judgment made in terms of student process and outcomes. Two instructional formats were identified from teachers descriptions: The command style and
task style. Content-richer teachers described using the task approach to teaching skills. Julie described her style as a "direct" individualized approach. Benjamin also said he used an individualized approach. What teachers described as their style was compared with the style they used in teaching the skill. It was found that Benjamin, Julie, and Leslie used the task styles, while the other teachers used the command style. Liz used a combination style of command and task styles.

Some teachers presented tasks using whole method or whole-part-whole method approach to teaching the skill. Bernard and Leslie's approach were one in which they would model the skill, put students through weight bearing activities, and then let them try the cartwheel. Liz, Larry, and Cassady used only a slightly different approach. They would put students through lead-up or weight bearing activities such as the mule-kick or donkey kicks, explain to children the mechanical or hand-foot patterns of the cartwheel, and then asked the students to perform the cartwheel as they provided feedback. Experts from two different universities described Leslie's approach to teaching as a "somewhat unstructured approach". Leslie apparently, has very little knowledge of the cartwheel and/or progressions of tumbling. They understand a few basic principles of gymnastics, but not exactly how and what to do teach it correctly.

Cassady was similarly described as a teacher who "doesn't understand progressions needed to teach." Bernard was described as someone who "does not totally understand the importance of progression", and "helping children understand the principles involved" .
Liz's approach was described as a "disjointed approach". Another comment was that she should:

realize that a cartwheel is a good kinesthetic motor balance skill. It should not be underestimated in the very young for teaching kinesthetic awareness.

Organization

Two organizational patterns were used. Benjamin and Julie, the content-richer teachers, and Leslie and Larry, the content-poorer teachers, had the students in stations each with their own mats. Cassady, Liz, and Bernard, the content-medium teachers, lined up mats in a sequence and students had to perform one after the other. Liz, started her lessons with a guided discovery approach, and once children understood the nature of the tasks, they were put at opposite ends of the mats to work individually while she supervised and provided feedback. These organizational patterns were related to opportunities for students to respond to tasks. This finding can be explained in terms of teacher pedagogical knowledge. This knowledge consists of creating the best conditions for students to practice tasks. Students whose teachers used stations had the highest OTR. The teachers whose students had fewer opportunities to respond, had fewer opportunities to use their content knowledge to facilitate the acquisition of skill by their students.

Evaluation

Benjamin was the only teacher with a built-in formal evaluation system in his lessons. He felt that it was important for students to pass each lead up before moving on to the next lead up. Decisions about when to test was made by the student. The student
practiced and if he or she felt competent enough to test they tested, and then they had to color it in on a chart which he had prepared for each student. Testing was not for grade purposes but only to determine mastery of each level of competence.

**Summary**

Teacher description of strategies they utilize to teach the cartwheel did not show significant differences between content-richer, content-medium, and content-poorer teachers. All groups focused on explaining, demonstrations, and use of audio-visual cues as strategies for task presentation. In terms of organization, content-richer and content-poorer teachers used an individualized approach or format while the content-medium teachers used a whole class approach with students lining up to take turns.

### 1.5. What do teachers see as the main learner problems and how do they overcome them?

**Learner Problems**

Table 5 shows teachers' knowledge about problems learners encounter in learning the cartwheel. The content-richer group in the study had a different sense of learner problems from the content-poorer and content-medium teachers. When the content-poorer and content-medium teachers talked about learner problems they focused on the fears of the children and children's lack of conceptual understanding of the cartwheel movements rather than technical aspects which take into account children's fears and therefore present ways of introducing the skill that minimize those fears.
### Table 5: Teachers' Knowledge about Learner Problems

<table>
<thead>
<tr>
<th>Learner Problems</th>
<th>Content-Richer</th>
<th>Content-Medium</th>
<th>Content-Poorer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ben</td>
<td>Julie</td>
<td>Liz</td>
</tr>
<tr>
<td>1. Fear</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>2. Children lack of</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>conceptual understanding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Technical Elements</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Key**

+ Indicates that the teacher focused on those aspects of learner problems.
Helping Children Overcome Difficulties

In addition to arranging the conditions for learning, specialists need to be able to recognize what it is that the students in the class might have difficulty with, how they might conceptualize and understand content, and then provide the best suitable means to help children learn.

Five basic techniques were used by teachers to help students overcome the problems they encountered learning the cartwheel. Table 6 shows teacher techniques for helping children. Noticeable differences between groups of teachers were found in the category "equipment modification". While teachers in the content-richer group thought it was necessary to modify equipment when the need arose, the content-medium and the content-poorer teachers failed to mention this.

Three teachers said that they modify equipment. Larry described a trapezoid vaulting box, which comes in sections. Based on the students' ability, he modifies the height of the box to accommodate the child's needs. Although Bernard did not mention using a box, in his lessons he used a box to give children a feel of being in the air.

Benjamin in describing how he modifies equipment said that

If they are having trouble with hand foot placements I might try different size mats. I might try ..maybe give them better cues than the hand foot cues, because the hand foot cues I use now I didn't use to use.

Visual cues teachers described they use included hand foot cues and taped lines on the mat to help students get the concept of moving in a straight line. Liz, in her lessons, used hoola-hoops to assist students in hand foot placements. Bernard used hot spots for hand foot placements.
Lead up activities generally aimed at getting students to be able to bear their own weight on their hands. Such lead-ups included wall-walks, mulekicks, the caterpillar, or the handstand. This was a recurring theme with all the teachers. For example, Leslie said that

I teach the mulekick, handstand and if the child is doing pretty good on the mulekick...then I will start working on the handstand, getting their weight on their hand, getting their legs straight up in the air.

Therefore, there were more similarities in the techniques teachers used in helping children to overcome learning difficulties than there were differences.

All teachers said they spot the children to get them to feel what it is like to be inverted, and use lead up activities as progressions. Field notes did show that teachers spotted children during lessons, especially when the children were in inverted positions.

Summary

Teachers in the content-richer group focused on technical aspects of the cartwheel when describing learner problems, while teachers in the content-poorer or content-medium group focused on the fears of students. All groups of teachers described similar techniques for helping students overcome learning difficulties. All teachers said they use spotting and lead-ups that build into the cartwheel showing knowledge of the need for safety and progressions respectively. While teachers said they used spotting and lead-ups it was not clear whether spotting was used to teach the techniques or to help children overcome their fears. It was clear that various techniques were used to deal with technical problems.
### Table 6: Techniques for helping children overcome learning difficulties

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Spotting</th>
<th>Lead Ups</th>
<th>Visual Cues</th>
<th>Task Modification</th>
<th>Equipment Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Julie</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Liz</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Bernard</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Cassady</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Larry</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Leslie</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

**Key**

+ Indicates teacher described he/she used the technique

0 Description of the technique is absent

Table 6: Techniques for helping children overcome learning difficulties
Section Summary

The data allowed for sorting teachers into content-richer, content-medium, and content-poorer groups. Benjamin and Julie comprised the content-richer group; Cassady, Bernard, and Liz made up the content-medium group, and Larry and Leslie made up the content-poorer group. Within the content-richer group, Benjamin was clearly in a league of his own in terms of experience and knowledge. On the other end of the spectrum were Leslie and Larry who had little understanding of the concepts of the cartwheel, and the rest of the teachers in a zone between Benjamin and the content-poorer teachers. At minimum, the findings suggest that teachers who exhibited the most correct knowledge about the cartwheel differed in linking the relationships between the various components of the cartwheel and how to teach it from the teachers who exhibited the least knowledge. In conclusion, teachers as a group failed to demonstrate clearly that they were adequately prepared in content knowledge of the cartwheel.
Section 3 - Research Question 2

2.0. How do teachers present cartwheel tasks and provide feedback to more or less skilled novice children.

Task presentation and feedback to learners was discussed under two main broad categories, (1) Task presentation and task progression and, (2) Skill related interactions.

2.1. What are the progressions of tasks children are asked to do and how are these tasks presented?

Task Presentation

Teacher task presentation was analyzed and discussed under four categories: (1) Teacher use of time, (2) Task Type, (3) Communication of Tasks, and (4) Selection and Organization of Learning Cues

Use of Time:

How much time the teacher provided for practice instruction was of interest because the learning experiences that teachers have designed and the time devoted to practice is important in increasing student knowledge (Siedentop, 1992). Teacher time was divided into management, instruction, and practice time. Management time was the time spent in tasks other than instruction. Instructional time referred to time during lessons when the teachers primary focus was on transmitting knowledge related to the content of the cartwheel. Practice time referred to the time during lessons when students had the opportunity to practice. Table 7 contains the results of the analysis of participants use of time. Lessons lasted from a low of 10:56 minutes to a high of 30:00 minutes. Time provided to students for practicing tasks ranged from 55.3% to 97.3% of
total time. Teachers spent as little as no time in transmitting knowledge to students about what to do and how to do it to as much as 35.2% of total time. Some of the variation in management time was due to frequent breaks given the students, time devoted to warm up and students waiting or transitioning from one part of the work area to another. Management time ranged from 0.0% to 17.0%.

The teachers' groups cannot be fully differentiated on the basis of time utilization data. The time data were fairly standard with minor differences among teacher groups. Initial lessons had more instructional time, with the second lessons having a higher percentage of practice time. The two content-richer teachers did have the highest percentage of practice time in their second lessons, but the two content-poorer also did quite well by that standard. This suggests that these teachers were more similar than different in their pedagogical knowledge.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Lesson</th>
<th>Management Time</th>
<th>Instructional Time</th>
<th>Practice Time</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Julie</td>
<td>1</td>
<td>12.9</td>
<td>14.7</td>
<td>73</td>
<td>19:25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.8</td>
<td>5.4</td>
<td>92.7</td>
<td>16:05</td>
</tr>
<tr>
<td>Benjamin</td>
<td>1</td>
<td>6.0</td>
<td>25.7</td>
<td>68.3</td>
<td>29:00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.7</td>
<td>0.0</td>
<td>97.3</td>
<td>30:00</td>
</tr>
<tr>
<td>Liz (Boys)</td>
<td>1</td>
<td>4.2</td>
<td>20.7</td>
<td>75.1</td>
<td>16:30</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>9.3</td>
<td>17.4</td>
<td>73.3</td>
<td>14:20</td>
</tr>
<tr>
<td>Liz (Girls)</td>
<td>1</td>
<td>17.0</td>
<td>18.7</td>
<td>65.2</td>
<td>19:20</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12.0</td>
<td>28.2</td>
<td>60.4</td>
<td>22:50</td>
</tr>
<tr>
<td>Bernard</td>
<td>1</td>
<td>11.2</td>
<td>33.5</td>
<td>55.3</td>
<td>19:15</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3.5</td>
<td>16.7</td>
<td>82.6</td>
<td>24:00</td>
</tr>
<tr>
<td>Cassady</td>
<td>1</td>
<td>1.0</td>
<td>35.2</td>
<td>63.8</td>
<td>29:00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.0</td>
<td>21.8</td>
<td>78.2</td>
<td>25:34</td>
</tr>
<tr>
<td>Larry</td>
<td>1</td>
<td>4.8</td>
<td>23.6</td>
<td>72.6</td>
<td>16:00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.0</td>
<td>7.9</td>
<td>87.0</td>
<td>10:56</td>
</tr>
<tr>
<td>Leslie</td>
<td>1</td>
<td>4.2</td>
<td>17.6</td>
<td>78.1</td>
<td>14:16</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.5</td>
<td>9.5</td>
<td>89.0</td>
<td>16:05</td>
</tr>
</tbody>
</table>

Table 7: Time distribution during lessons
Task Type and Frequency

Table 8 shows the types and frequency of tasks students engaged in during instruction. Tasks were coded for frequency using categories from the Rink (1985) system: informing, extending, refining, and applying. The number of tasks ranged from 6 in Benjamin's classes to 24 in Liz's classes. Teachers used 23 informing tasks, 37 refining tasks, 44 extending tasks, and 3 applying tasks in 16 lessons. For each practice task, time measurements were recorded to reflect the duration of time spent for each task type. Four teachers (Julie, Leslie, Liz, and Benjamin) spent more time extending tasks, and three teachers (Liz, Bernard, and Cassady) spent more time refining tasks. Proportionately, teachers used refining tasks a greater percentage of time (Mean=41.7%) to increase the quality of student responses. Extending tasks were used 34.6% of the time and informing tasks 21.1%. Liz was the only teacher who used applying tasks.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Practice Tasks</th>
<th>Frequency</th>
<th>Percent of Practice Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin**</td>
<td>Informing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Julie</td>
<td>Informing</td>
<td>5</td>
<td>40.8</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>3</td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>5</td>
<td>49.1</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bernard</td>
<td>Informing</td>
<td>6</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>10</td>
<td>35.9</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Liz - Boys</td>
<td>Informing</td>
<td>2</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>4</td>
<td>58.1</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>4</td>
<td>19.8</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>1</td>
<td>5.7</td>
</tr>
<tr>
<td>Liz - Girls</td>
<td>Informing</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>8</td>
<td>72.2</td>
</tr>
<tr>
<td></td>
<td>Extend</td>
<td>11</td>
<td>12.2</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td>Cassady</td>
<td>Informing</td>
<td>3</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>8</td>
<td>60.5</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>6</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(To be continued)

Table 8: Frequency and Duration for Practice Tasks
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Task Type</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larry</td>
<td>Informing</td>
<td>3</td>
<td>24.4</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>2</td>
<td>33.1</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>4</td>
<td>42.5</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leslie</td>
<td>Informing</td>
<td>4</td>
<td>26.9</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>1</td>
<td>22.3</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>3</td>
<td>50.8</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Group Mean (n=7)</td>
<td>Informing</td>
<td>3.4</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>Refining</td>
<td>4.6</td>
<td>41.7</td>
</tr>
<tr>
<td></td>
<td>Extending</td>
<td>5.5</td>
<td>34.6</td>
</tr>
<tr>
<td></td>
<td>Applying</td>
<td>0.3</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**Benjamin -** Benjamin's instructional format was one in which all the tasks were presented in a video tape. Following the videotape, no further instructions were provided. Students initiated tasks.
Task Communication

Table 9 shows how tasks were communicated to students. In task presentation, teachers used verbal presentations 100% of the time. Four teachers gave demonstrations while three teachers did not use any demonstrations. Liz used demonstrations in the boys lessons 72.7% of the time. Two teachers, Cassady and Liz did not employ student demonstrations in their lesson, preferring to demonstrate all activities themselves. Larry used the highest number of student demonstrations, 33.3%. Field notes revealed that in one situation, during Leslie's presentation the student started practice before the teacher completed task presentation.

For each task, Julie provided a cue or cues while Liz provided the least number of cues 58.3%. The mean number of cues provided by teachers was 84.2. Teachers presented lessons with teaching aids 42.7% of the time. Cassady was the only teacher who did not use any aids.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Tasks #</th>
<th>Teacher Demo %</th>
<th>Student Demo %</th>
<th>Teach Cues %</th>
<th>Aids %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>0</td>
<td>16.6</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>53.8</td>
<td>30.7</td>
<td>100</td>
<td>61.5</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>21.7</td>
<td>8.7</td>
<td>78.3</td>
<td>34.8</td>
</tr>
<tr>
<td>Liz (Boys)</td>
<td>11</td>
<td>72.7</td>
<td>0</td>
<td>72.7</td>
<td>18.2</td>
</tr>
<tr>
<td>Liz (Girls)</td>
<td>24</td>
<td>37.5</td>
<td>0</td>
<td>58.3</td>
<td>44.4</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>58.8</td>
<td>0</td>
<td>88.2</td>
<td>0</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>0</td>
<td>33.3</td>
<td>88.9</td>
<td>33.3</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>0</td>
<td>12.5</td>
<td>87.5</td>
<td>50</td>
</tr>
<tr>
<td>Mean</td>
<td>30.6</td>
<td>12.7</td>
<td>84.2</td>
<td>42.7</td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Task Communication
Selection and Organization of Learning Cues

Teachers selection and organization of learning cues were analyzed for appropriateness and accuracy of the cues. Table 10 presents the results for accuracy and appropriateness of cues. The appropriateness of cues was determined by the number of cues presented per instructional task. The literature has suggested that three or less cues presented meets the criterion for appropriate number of cues (Rink & Werner, 1989). More than three or no new learning cues related to the task was considered inappropriate. The percentage of cues teachers presented to students ranged from 62.5% to 100%. Three teachers presented less than 80% of appropriate cues. Two teachers presented cues appropriately 100% of the time.

The cues were also analyzed for technical correctness in terms of its relation to critical elements for the task. Accuracy was globally defined to mean that the information in the cues was technically correct. If the information in the cue was technically incorrect or if no cues were presented, then the cue was inaccurate. The results show a 72.7% to 100% range in the accuracy of cues.

Differences were found between content-high, content-medium, and content-low teachers. Content high teachers provided cues that were not only consistent, but also technically correct. Among the content-medium and content-low teachers there was little difference. An outlier was Leslie, a content-poorer teacher whose cue accuracy was comparable to the content-high teachers. Leslie's cue accuracy could only be explained in terms of her knowledge of a few cues and a repetition of the cues for tasks presented.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Tasks</th>
<th>Appropriateness %</th>
<th>Cues</th>
<th>Accuracy %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>78.3</td>
<td>82.6</td>
<td></td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>88.9</td>
<td>88.9</td>
<td></td>
</tr>
<tr>
<td>Liz (Boys)</td>
<td>11</td>
<td>63.6</td>
<td>72.7</td>
<td></td>
</tr>
<tr>
<td>Liz (Girls)</td>
<td>24</td>
<td>66.6</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>88.2</td>
<td>88.2</td>
<td></td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>88.9</td>
<td>88.9</td>
<td></td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>62.5</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Appropriateness and Accuracy of Cues
**Task Progressions**

The content development for teachers is presented in Figure 2. Teachers developed student performance through the use of informing, refining, and extending tasks in most single skill sequences. There were clear patterns between the content-richer and the content-poorer in terms of the development of tasks presented to the children. One pattern that emerged from the data was Benjamin's task development. Alexander's (1982) description of the contingency developed task system suggested that instructional tasks begin as stated tasks that the teacher describes verbally. As students respond to the tasks, the teacher in turn responds to their efforts and the actual tasks develop. In Benjamin's class tasks were teacher initiated and student initiated. Benjamin initiated tasks through video instruction, and then students had to initiate practice tasks following the presentation. Students did not get further instruction from the teacher during practice. Students charted their progress through progress task cards.

A second pattern was seen in the classes of Liz. She taught the boys and the girls in separate lessons. From the data, it was found that Liz presented twice as many tasks to girls as to boys, a ratio of approximately two to one. Field notes indicated that Liz had different expectations for the boys and girls and may have taught the lessons based on those expectations. Specifically, Liz had made a comment in her interview that:

> Typically I would say that girls have more exposure to cartwheels and are more apt to do them quicker and the boys I think do not get as much experience in doing them, so I don't really focus a lot on the cartwheel.

A third pattern was seen in the way some of the content-poorer teachers developed content. Typically, their lessons started with weight bearing activities such as
mulekicks followed by handstand, and then the cartwheel was introduced. Teachers had explained in the interviews that their strategy was to get students to take weight on their hands before becoming inverted. This pattern seems consistent with expert opinion that suggests the handstand should be taught as a skill before the cartwheel. However, these tasks were often presented as informing tasks without much attention paid to refining these tasks. Field notes show that teachers used these skills as weight bearing activities, without a real regard to their important link as necessary skills to know, before the cartwheel can be learned. No competency was required of the students in these activities before the cartwheel was introduced to them, so the activities were used as transitions to the cartwheel.
<table>
<thead>
<tr>
<th>Content-Richer Teachers</th>
<th>Content-Medium</th>
<th>Content Poorer Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ben</td>
<td>Julie</td>
<td>**Liz</td>
</tr>
<tr>
<td>Inform</td>
<td>Inform</td>
<td>Inform</td>
</tr>
<tr>
<td>Refine</td>
<td>Extend</td>
<td>Inform</td>
</tr>
<tr>
<td>Extend</td>
<td>Inform</td>
<td>Extend</td>
</tr>
<tr>
<td>Extend</td>
<td>Extend</td>
<td>Extend</td>
</tr>
<tr>
<td>Extend</td>
<td>Inform</td>
<td>Extend</td>
</tr>
<tr>
<td>Extend</td>
<td>Extend</td>
<td>Extend</td>
</tr>
<tr>
<td>Refine</td>
<td>Extend</td>
<td>Extend</td>
</tr>
<tr>
<td>Extend</td>
<td>Apply</td>
<td>Extend</td>
</tr>
</tbody>
</table>

Figure 2: Content Development and Skill Progressions for Teachers

(To be continued)
Figure 2 (continued)

<table>
<thead>
<tr>
<th>Content-Richer Teachers</th>
<th>Content-Medium</th>
<th>Content-Poorer Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ben</td>
<td>Julie</td>
<td>**Liz</td>
</tr>
<tr>
<td>Refine</td>
<td>Refine</td>
<td>Refine</td>
</tr>
<tr>
<td>Apply</td>
<td>Extend</td>
<td></td>
</tr>
<tr>
<td>Refine</td>
<td>Refine</td>
<td></td>
</tr>
<tr>
<td>Extend</td>
<td>Rrfine</td>
<td></td>
</tr>
<tr>
<td>Extend</td>
<td>Extend</td>
<td></td>
</tr>
<tr>
<td>Apply</td>
<td>Extend</td>
<td></td>
</tr>
<tr>
<td>Extend</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key
** Data represent content development for boys lessons.
*** Data represents content development in girls lessons
----- Broken lines are used to show differences between Lessons 1 and 2.
Presentation of Task Cues

Table 11 shows the presentation of task cues to students. Cues were described as technical, production, or metaphorical. Technical cues were described as directed at the critical elements of the task. Production cues were cues that focused on effort or quality of the task. Metaphorical cues were cues that described the use of images. Teacher presentation of technical cues ranged from 63.6 to 100%. Metaphorical cues were least frequently used. Three teachers used metaphorical cues, and the range was 3.5 to 4.5% of all cues. Production cues ranged from none to 36.4% of all cues.

Teachers started their lessons with a description of the activities for the lessons, while the children were seated. The children were then put through lead up activities. Teachers employed extending or refining tasks to move the children through their learning experiences.

Tasks were described verbally and some teachers either asked a student to demonstrate the task or the teacher demonstrated the task. Teachers focused on providing teaching cues to instructional tasks and sometimes prompted students. Field notes showed that teachers used prompts after the initial task to initiate practice. While the children worked on the activities, individual feedback was provided, or the teacher would spot where appropriate. Conditions in the classes varied very little. Students either worked on mats lined up or on individual mats arranged to allow easy access and clear view of each student. In some teachers classes, children performed the handstand against the wall either with teacher spotting or alone.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Total # of tasks</th>
<th>Technical cues</th>
<th>Production cues</th>
<th>Metaphorical cues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>83.3</td>
<td>16.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>100</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Liz (Boys)</td>
<td>11</td>
<td>100</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Liz (Girls)</td>
<td>24</td>
<td>79.3</td>
<td>17.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>85.7</td>
<td>10.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>87.5</td>
<td>12.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>63.6</td>
<td>36.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>90.9</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table 11: Teacher task presentation of cues
Summary

Teachers in the study provided high practice time in an attempt to bring about learning of the cartwheel skills which one might expect given the highly favorable conditions of the lessons. Teachers developed content through the use of refining tasks to improve the quality of student responses. In communicating tasks, verbal presentations were the most common mode. Tasks were also presented through teacher and student demonstrations, cues, and teaching aids. Teachers were careful in providing the right number of cues for each task and in keeping the information in the cues technically correct. Three types of cues were found to be used by teachers, technical, production, and metaphorical. While teachers in their interviews indicated that they used metaphorical cues, in actual teaching, they were found to use this minimally. In conclusion, the data for cues cannot be differentiated by teacher group.

2.2 What types of feedback and prompts do teachers provide to learner responses?

The types of teacher feedback and prompts in response to immediate practice success of students for the different tasks are presented in Tables 12 and 13. Results indicated that the highest percentage of interaction for teachers low skilled students was prompting, with a range of 1.1 to 3.0 prompts per minute, with a mean of 2.1. Similar results were found for the high skilled learners of teachers. Prompting was the highest percentage for high skilled students with a range of 1.4 to 2.3 prompts per minute, and a mean of 1.9 prompts per minute.
Supportive feedback was the next highest for both groups of learners. With the low skilled, feedback directed at supporting their efforts ranged from 0.7 statements per minute to 1.8 with a mean of 1.2, and for the high skilled it ranged from 0.7 to 1.7 feedback statements per minute. These findings indicate that teacher feedback was not usually aimed at restating tasks. The results also indicate that teachers often use supportive feedback rather than corrective.

Summary

Six of the seven teachers provided more total feedback to their low-skilled students than to their high-skilled students. The distribution among the types of feedback given was highly similar for the higher and lower-skilled students. It was not possible to differentiate among the three teacher groups on the basis of these data. This suggests that teacher interactions during practice time is more a function of pedagogical knowledge than content knowledge.
<table>
<thead>
<tr>
<th>Duration</th>
<th>49:00</th>
<th>25:00</th>
<th>38:00</th>
<th>30:00</th>
<th>49:00</th>
<th>25:00</th>
<th>25:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
<td>T4</td>
<td>T5</td>
<td>T6</td>
<td>T7</td>
</tr>
<tr>
<td></td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
<td>Freq. % Rate</td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP</td>
<td>22</td>
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<td>0.4</td>
<td>42</td>
<td>28.9</td>
<td>1.4</td>
<td></td>
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<tr>
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<td>17.2</td>
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</tr>
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<td>RT</td>
<td>5</td>
<td>3.5</td>
<td>0.1</td>
<td>10</td>
<td>6.9</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>67</td>
<td>47.5</td>
<td>1.4</td>
<td>68</td>
<td>46.9</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>141</td>
<td>100</td>
<td>2.9</td>
<td>145</td>
<td>100</td>
<td>4.1</td>
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</tr>
</tbody>
</table>

**Key:**
- T1-Benjamin
- T2-Julie
- T3-Cassady
- T4-Bernard
- T5-Liz
- T6-Larry
- T7-Leslie
- DP-Feedback directed at correcting errors
- SP-Supportive feedback
- RT-Feedback aimed at restating task
- PP-Prompts

Table 12: Feedback and Prompts Analysis during Practice Time - High Skilled
<table>
<thead>
<tr>
<th>Duration</th>
<th>49:00</th>
<th>29:00</th>
<th>38:00</th>
<th>30:00</th>
<th>49:00</th>
<th>25:00</th>
<th>25:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
<td>T4</td>
<td>T5</td>
<td>T6</td>
<td>T7</td>
</tr>
<tr>
<td></td>
<td>Freq.</td>
<td>%</td>
<td>Rate</td>
<td>Freq.</td>
<td>%</td>
<td>Rate</td>
<td>Freq.</td>
</tr>
<tr>
<td>Feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>5.8</td>
<td>0.3</td>
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<td>0.1</td>
<td>3</td>
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<td>SP</td>
<td>66</td>
<td>29.5</td>
<td>1.3</td>
<td>20</td>
<td>18.5</td>
<td>0.7</td>
<td>25</td>
</tr>
<tr>
<td>PP</td>
<td>104</td>
<td>46.4</td>
<td>2.1</td>
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<td>2.1</td>
<td>42</td>
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<tr>
<td>Total</td>
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<td>100</td>
<td>4.5</td>
<td>108</td>
<td>100</td>
<td>3.7</td>
<td>86</td>
</tr>
</tbody>
</table>

Key
- T1-Benjamin
- T2-Julie
- T3-Cassady
- T4-Bernard
- T5-Liz
- T6-Larry
- T7-Leslie

- DP - Feedback directed at correcting performance errors
- RT - Feedback directed at restating tasks
- SP - Supportive feedback
- PP - Prompts

Table 13: Feedback and Prompts Analysis - Low Skilled
Section Summary

Teachers as a group seemed stronger in pedagogical knowledge than in content knowledge. Teachers used good pedagogical skills to present tasks and knew that it was important to sequence tasks for student learning.

Section 4 - Research Question 3

3.0. How do more or less skilled children respond to the learning opportunities and what do they understand about how to do the cartwheel?

Children's responses to learning opportunities were collected by coding each child's response opportunities (OTRs) and then qualitatively judging whether the responses were technically appropriate given the learning task and successful within the context of the task description.

3.1. What are students patterns of success and errors?

Student response to learning opportunities are analyzed for total OTRs, appropriateness and success, and by skill level and gender. The results are reported in Tables 14 to 17.

Total OTRs ranged from 0.5 per minute of instructional time to 5.2 per minute of instructional time. In Benjamin's class, there was a relatively high OTR rate compared to other teachers. Field notes showed that Benjamin's students' responses were continuous and the inclusion of an evaluative system may have influenced students' attempts to stay on task. Each student had to check off a task completion card for each lead up before they could move on to the next task.
Each OTR was also analyzed for appropriateness or inappropriateness, and success. Success was judged globally within the context of how the task was described and what was emphasized in the task description. Success rates ranged from 27% to 100%.

Students' responses during instructional practice tasks were also analyzed according to skill level and gender. The data for the low skilled males showed a range of 0.7 to 6.3 OTR's per minute; 0.8 to 5.7 for low skilled females, 0.7 to 5.5 for high skilled males, and 1.0 to 6.2 for high skilled females. The data for all categories of students showed similarity. Field notes suggest that in those classes where students were organized into station work for individual practice (Benjamin, Leslie, and Julie's classes), OTR's were higher than in classes where the students had to line up and perform one after the other (Cassady, Larry, and Bernard's classes). For example, in Benjamin, Leslie and Julie's lessons, mean OTR rates were 5.9, 3.6, and 4.4 respectively. In the lessons of Cassady, Larry, and Bernard, mean OTR rates were 0.8, 1.4, and 2.0 respectively.

Success rate for low skilled males and females were also compared, and the data were similar for both groups. Percentage of successful responses to practice opportunities for low skilled males ranged from 42% to 88.7%, while for the low skilled females it ranged from 32.2% to 87.9%. With regard to the high skilled males and females, success rates ranged from 32.1% to 94.4% and 27% to 100% respectively, showing differences in success rates for high skilled and low skilled.

Another pattern in the data concerns the successes and errors of low skilled and high skilled performers. For all teachers, their high skilled students responded more
successfully than the low skilled students. An interesting pattern was observed for Leslie. While her students consistently were unsuccessful, her high skilled male student had a 94.4% rate. An explanation might be that, the student's success was due more to his ability than instruction from the teacher, since the teacher seemed unable to improve students skill in the cartwheel. While the students of the content-poorer and content-medium teachers, for example, Cassady and Leslie, with the least CK had the highest unsuccessful rates of responding, the children of Julie, a content-richer teacher, were also unsuccessful half the time. At minimum this suggest that there is a more complex relationship operating to explain the student results.

Content-richer teachers' low skilled female students showed high OTR's per minute and high success rates. There was a positive relationship between practice opportunities and success rates for these students. Content-medium teachers, even though they had students responding appropriately, their students were less successful, even though Larry's students responded successfully 80% of the time.

With regard to low skilled boys, a surprising find was found in Bernard's classes. His student was the most successful, 88%. Even though success rates of low skilled students for all groups of teachers were low content-low teachers scored much lower compared to content-richer teachers for example, less than 55% for content-poorer teachers and between 50%-75% for content-high teachers. The difference between content-high and content-medium teachers was not clear.
High skilled male students for all groups of teachers, responded appropriately to tasks. However, in comparison to the content-high teachers whose students were on the average 88.9% successful, the students of the content-medium and content-low teachers were on the average 73.3% and 63.3% successful.

Content-high teachers high skilled female students had on the average, higher OTR's per minute, 4.4 and also had high success rates, 90.3%. Content low teachers on the other hand had students who had fewer OTR's per minute, 2.7 and low success rates, 40.3%. Among content-medium teachers, OTR rates per minute averaged 2.8 and success rates of 78.8%.

Benjamin again appeared to be an outlier. His students had the best combination of high OTR's, very high percentage of appropriate responses, and high success rates.
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Total tasks</th>
<th>Practice Time</th>
<th>Total OTRs</th>
<th>OTRS /min</th>
<th>Success %</th>
<th>Appropriate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>48:59</td>
<td>266</td>
<td>5.4</td>
<td>87.9</td>
<td>100</td>
</tr>
<tr>
<td>Julie*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>30:28</td>
<td>57</td>
<td>1.9</td>
<td>61.4</td>
<td>92.9</td>
</tr>
<tr>
<td>Liz</td>
<td>24</td>
<td>26:24</td>
<td>131</td>
<td>5.0</td>
<td>68.7</td>
<td>100</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>38:29</td>
<td>31</td>
<td>0.8</td>
<td>32.3</td>
<td>96.8</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>25:28</td>
<td>143</td>
<td>5.7</td>
<td>32.2</td>
<td>86.7</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>25:32</td>
<td>35</td>
<td>1.3</td>
<td>85.7</td>
<td>100</td>
</tr>
</tbody>
</table>

* The student did not participate in the lesson

Table 14: Low skilled Female Response to Practice Tasks
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Total Tasks</th>
<th>Total Time</th>
<th>Total OTRs</th>
<th>OTRs /min.</th>
<th>Success %</th>
<th>Appropriate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>48:59</td>
<td>309</td>
<td>6.3</td>
<td>75.7</td>
<td>94.5</td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>29:05</td>
<td>116</td>
<td>4.0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>30:28</td>
<td>53</td>
<td>1.8</td>
<td>88.7</td>
<td>96.2</td>
</tr>
<tr>
<td>Liz</td>
<td>11</td>
<td>22:53</td>
<td>88</td>
<td>3.8</td>
<td>42</td>
<td>100</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>38:29</td>
<td>25</td>
<td>0.7</td>
<td>44</td>
<td>100</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>25:28</td>
<td>76</td>
<td>3.0</td>
<td>53.9</td>
<td>93.4</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>25:32</td>
<td>40</td>
<td>1.6</td>
<td>75</td>
<td>97.5</td>
</tr>
</tbody>
</table>

Table 15: Low Skilled Male Response to Practice Tasks
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Total tasks</th>
<th>Practice Time</th>
<th>Total OTRs</th>
<th>OTR's /min.</th>
<th>Success %</th>
<th>Appro. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
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<td>270</td>
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<td>91.1</td>
<td>100</td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>29:05</td>
<td>120</td>
<td>4.1</td>
<td>86.7</td>
<td>100</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>30:28</td>
<td>67</td>
<td>2.2</td>
<td>64.2</td>
<td>86.6</td>
</tr>
<tr>
<td>Liz</td>
<td>11</td>
<td>22:53</td>
<td>90</td>
<td>3.9</td>
<td>62.2</td>
<td>100</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>38:29</td>
<td>28</td>
<td>0.7</td>
<td>32.1</td>
<td>100</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>25:28</td>
<td>107</td>
<td>4.3</td>
<td>94.4</td>
<td>100</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>25:32</td>
<td>33</td>
<td>1.3</td>
<td>93.9</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 16: High Skilled Male Response to Practice tasks
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Tasks Freq.</th>
<th>Practice Time</th>
<th>Total OTRs</th>
<th>OTRs /min</th>
<th>Success %</th>
<th>Appropriate. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>6</td>
<td>48:59</td>
<td>305</td>
<td>6.2</td>
<td>93.8</td>
<td>100</td>
</tr>
<tr>
<td>Julie</td>
<td>13</td>
<td>29:05</td>
<td>75</td>
<td>2.6</td>
<td>86.7</td>
<td>100</td>
</tr>
<tr>
<td>Bernard</td>
<td>23</td>
<td>30:28</td>
<td>66</td>
<td>2.2</td>
<td>69.7</td>
<td>92.4</td>
</tr>
<tr>
<td>Liz</td>
<td>24</td>
<td>26:24</td>
<td>126</td>
<td>4.8</td>
<td>66.7</td>
<td>100</td>
</tr>
<tr>
<td>Cassady</td>
<td>17</td>
<td>38:29</td>
<td>37</td>
<td>1.0</td>
<td>27.0</td>
<td>94.5</td>
</tr>
<tr>
<td>Leslie</td>
<td>8</td>
<td>25:28</td>
<td>110</td>
<td>4.4</td>
<td>53.6</td>
<td>100</td>
</tr>
<tr>
<td>Larry</td>
<td>9</td>
<td>25:32</td>
<td>35</td>
<td>1.3</td>
<td>100</td>
<td>91.4</td>
</tr>
</tbody>
</table>

Table 17: High skilled Female Response to Practice Tasks
Summary

The data for student responses can be compared with elementary school data reported by Jones (1989) in which student success rate was 78% to 82% of the time for two classes. Nearly all pedagogical research suggests that successful student responding is the strongest indicator of learning, and that a higher percentage of successful responses is an important goal (Rosenshine & Stevens, 1986; Silverman, 1985, 1990, 1991; Werner & Rink, 1989). If success is measured by this criteria, then in this study, there was a wide range of success for the children. A conclusion to be drawn from these data is that there is a relationship between teaching strategy and student response. What is unclear is whether utilizing a more efficacious teaching strategy is primarily a function of content knowledge or primarily a function of pedagogical knowledge. The data from this study suggest that it may be more a function of pedagogical knowledge, since the data did not clearly correlate with the groups formed on the basis of content knowledge. However, Benjamin's combination of strong pedagogical knowledge and content knowledge brought about student success.

3.2. After the lessons, what are students understanding of how to do the cartwheel?

Information about students' understanding of the cartwheel lessons were collected through small group interviews. Categories of student understanding are represented in Figure 3. The children of all the teachers described the verbal cues given them as most important in their learning of the cartwheel. The children of three teachers mentioned spotting and manual guidance as helping them to learn the cartwheel. Analysis of
children's response on the basis of the grouping of teachers did not show any marked differences.

When the children of the content-poorer teachers talked about their cartwheel experiences, they focused on their former experiences and their abilities and on cues given them by their teachers. Larry's children focused on their earlier experiences. One of the children in Benjamin's class said that he (Benjamin),

kept my hands out and adjust them and it helped keep them straight.

One of Larry's children who said she had some gymnastics experience said:

Well, I have been in gymnastics for a long time so what helped me do the cartwheel is first I do the handstand and I used to do the handstand against the wall when I was practicing and then I started turning in the handstand.

Since students were expected to be novices, the student was asked if her experiences included any knowledge about how to perform the cartwheel. This question was necessary to confirm that for the cartwheel skill all children were novices. She said she had no experience with the cartwheel, however. Another student thought that his previous experiences with other skills helped him.

Well, the kick and also when I was in karate some things that were like sort of the cartwheels. Once we did it in aerial and that's pretty much on that cartwheel without using your hands.

Another felt that

Well when I go diving and over there sometimes I do flips and it... that helps me get my arms support stronger when I do the cartwheel and so that I can do flips off the diving board.
The statement of children suggested they thought their former experiences helped them transfer motor ability skills from other sports to the learning of the cartwheel. The children were able to recognize that it required strength to do the cartwheel, and they necessarily developed the strength from engagement in other sports.

Leslie's children though focused on the technical cues provided them. One of the children described a good cartwheel as:

A good cartwheel is you can land on the line with their hand and feet and the bad one is you can't.

Their responses often suggested that the teacher told them to "keep your hands straight and locked there".

The children of content-richer teachers also emphasized technical cues the teacher provided. Julie's children said in response to teacher communication of what was important to know:

Child #1:
Really mine was to keep my toes out, become pigeon footed and keep doing it really straight so that I can do it really nice.

Child #2:
She helped me to understand how to put my legs straight so that the cartwheel looks better.

Child #3:
She taught me to kind of stick my feet onto the mat and keep my feet over my head and not down closer to the mat
Child #4

I think she taught me really good how to land because before I came into this class, I had no idea how to land on my feet and I always kept on sticking my foot in when I was just at the end and I will just go like this and curl up in a ball.

On the other hand Benjamin's children seemed to think that apart from the technical cues he provided his use of imagery seemed to impact them. In their own words one of them said:

He told me when I was on the floor to imagine myself doing a cartwheel on the floor on my head and that pretty much taught me.

Another child said that she was told to imagine that there were "Sharks in the water and I was trying to go over the water and that helped me".

When the content-medium teachers emphasized technical cues, their children also understood the cartwheel to represent these cues. The most powerful verbal cues given the children which they understood to aid their performance was the hand-hand-foot-foot cue. One of the children in Cassady's class described what the teacher told him that helped him.

Keep your feet up higher and out. That note to the...that's why I never learned the cartwheel because I didn't know how to do the lunge.

Cassady's children had a respect for his notions of what is worth immediate attention.

First learn body strength and keep my legs up higher and put my hands closer so I can fall out.
Another said that:

He told me you do the lunge and keep your feet higher and you go stand up on your hands.

When the children were asked to describe their understanding of a good cartwheel, one of the children was unable to clearly describe a good cartwheel.

Actually the handstand. I can do the handstand. I did the whole cartwheel, but she did the lunge and the hands and then you just follow with and then you do the cartwheel.

Liz, "would hold up our legs so that we get used to being upside down." The children of Liz described that their teacher "tried to help us with that cheese thing". However, one of the boys observed that "we didn't do better with the cheese" while another said that "I think it was probably the slant. It was easier to roll off".

The two teachers who used visual cues and which impacted the students learning were Benjamin and Liz.

**Summary**

Children's understanding of the cartwheel was based on what teachers emphasized to them during the lessons. Generally, there was a relationship between teacher knowledge of the cartwheel and childrens' understanding of how to do the cartwheel. Children understood the sequences of the cartwheel, hand-hand-foot-foot and their ability to bear body weight, and being able to do a handstand was important for learning the cartwheel.
### Figure 3: Categories of Student Understanding of the Cartwheel Tasks

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Technical Cues</th>
<th>Visual Cues</th>
<th>Spotting</th>
<th>Motor Ability</th>
<th>Imagery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Julie</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bernard</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Liz</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cassady</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Leslie</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Larry</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>
Section Summary

This section examined students patterns of successes and errors, and their understanding of the cartwheel following instruction. The data suggest that high skilled students were often more successful than their low skilled counterparts. The differences between boys and girls were less clear. There was a less clear relationship between teacher CK and student OTR. Children of content-richer teachers were generally more successful than children of either the content-medium or content-poorer teachers.

The relationship between practice and student success in learning the cartwheel and high success rates to appropriateness of tasks were less clear. The data suggested that more or less appropriateness of task practice did not have an effect on higher success rates.

A second pattern suggested a relationship between teacher knowledge of the cartwheel and student understanding of the cartwheel. Students whose teachers emphasized technical components of the cartwheel, had students who exhibited more content knowledge about those components.

Chapter Summary

The chapter reported the findings of three research questions that focused on examining the content and pedagogical content knowledge of seven teachers. The analysis of the data found three groups of teachers: content-richer, content-medium, and content-poorer. A relationship between teacher content knowledge and student knowledge was found from this grouping. Teachers with high content knowledge had
students who also were more successful in learning the cartwheel than teachers with less content knowledge. This relationship was, however, seen in the event that teachers provided the right environment and opportunities for learning the tasks as was seen in Benjamin's classes. The data suggested that teachers as a group were better prepared in pedagogical knowledge, than in content knowledge. The implications of this for teacher education are discussed in the following chapter.
CHAPTER 5
DISCUSSION AND CONCLUSIONS

This chapter presents a synthesis of the findings of this study and relates them to previous findings from research on content and pedagogical content knowledge in physical education. The chapter also presents conclusions of this study based on the analysis and discussion of results and the relationship between teacher content and pedagogical content knowledge to teaching performance. Future directions for research in this area are presented.

Discussion of the Findings

This study examined the content knowledge and teaching practices of seven experienced physical education specialists teachers. Part of the analysis of teaching focused on how tasks were presented and what feedback was utilized, two areas pedagogical content knowledge would be most clearly revealed. Each teacher taught two brief lessons (approximately 20 minutes each) to a small group of learners. The focus of the lessons was the cartwheel, and the learners were typically not familiar with this skill. The teaching context was purposefully simplified to eliminate factors that might be attributed to management and discipline, and therefore, to make more readily apparent the influence of content knowledge during the instructional episodes.
The section that follows presents a synthesis of the findings for each research question and relates them to previous research.

1.0 What do teachers know about the cartwheel and how to teach it, and how did they come to that knowledge?

Research indicates that teacher content knowledge influences "both what teachers teach and how they teach it." (Grossman, Wilson, & Shulman, 1989, p.26). Specifically, research in physical education indicates that experienced teachers have extensive knowledge of the subject they teach, compared to novice teachers (Ennis, Mueller, & Zhu, 1991; Rink, French, Lee, Solmon, & Lynn, 1994). Siedentop and Eldar (1994) also observed that experienced teachers have an ability to synthesize their knowledge of skill or concepts in meaningful ways to aid students to cope with tasks that less experienced teachers lack. This study, assessed the teachers content knowledge through a number of variables including their performance experience in the cartwheel, their sources of knowledge about the cartwheel, knowledge of the critical and technical elements of the skill, knowledge of learner problems, and teaching strategies. As results for the following sub-questions indicate, the teachers differed markedly in both experience in and knowledge about the cartwheel.

1.1. What experiences have teachers had performing or teaching the cartwheel?

Teachers background in this study, if measured by their gymnastics experience, amount of participation, and number of college units in gymnastics taken suggested
inadequate entering content knowledge about gymnastics in general and the cartwheel as a skill within gymnastics. Comments by most of these teachers could easily be interpreted to suggest that their gymnastics content knowledge was modest at best, yet the teachers, while recognizing a lack of gymnastics preparation in their formal training, seemed comfortable that the level of content knowledge they possessed was adequate for their teaching of the activity, a finding that replicates the research of Romar (1995).

Five teachers had indicated through their interviews they had little experience performing the skill. Teachers were assessed on their knowledge of critical elements of the cartwheel and their ability to detect common errors. Based on the interviews and assessments the sample was divided into three groups; a content-richer, content-medium, and content-poorer group. Benjamin and Julie, the two content-high teachers, and Liz, a content-medium teacher, were the only teachers to participate in gymnastics at any level.

It does appear that assessing both the experience of teachers in formal and informal professional development experiences and directly analyzing their knowledge through assessments of critical elements and common errors is a valid method for estimating differences in content knowledge. Earlier studies that tried to correlate number of college units and knowledge of subject matter were less fruitful, because the variables used to represent teacher content knowledge (number of college science courses, college GPA, number of academic credits) yielded little useful information (Grossman, 1991).

The gymnastics content knowledge these content-poorer teachers had constructed were "impractical" at best. If the amount and kind of content knowledge influences instruction (Bellamy, 1990) considering the relationship between teacher and student
content knowledge, teachers with more content knowledge were more likely to substantially develop conceptions of the best ways to teach the cartwheel than teachers who possessed less knowledge. The implication for teachers with weak knowledge about the cartwheel is that they would be less likely to present learning tasks in ways that help learners to advance quickly, less able to provide cues and prompts that allow learners to understand the dynamics of a skill, and less likely to detect important errors and provide relevant feedback to correct those errors.

The two content-poorer teachers were the only two to indicate that their gymnastics course as part of their initial teacher preparation was salient to their current content knowledge. Teachers who had performance or coaching backgrounds generally discounted their initial gymnastics course as a source of content knowledge. While some of the teachers may have had little experience performing the cartwheel, they were not particularly concerned about their ability to teach the cartwheel. Most of the teachers had taught the cartwheel in their gymnastics units over several years of teaching, and all teachers reported that they had learned a great deal about the cartwheel through their teaching experiences. This "comfort" level in teaching an activity for which they had limited experience is similar to what Romar (1995) found for middle school teachers in basketball and gymnastics.

The teachers' experience was that the cartwheel was a gendered skill. They reported that this affected somewhat how they taught the skill to boys and girls, not in any gender-biased manner but with a pedagogical sensitivity that their learners brought some biases to the learning of this skill as part of the physical education curriculum.
There was no consistent evidence in the teaching analysis of any gender bias in teaching. Liz, a content-medium teacher, chose to teach the boys and girls separately and provided more time and opportunity for girls to learn the skill, but this separate-class approach to her teaching confounds any effort to understand whether this suggests a pervasive gender bias in her teaching.

1.2. **What do teachers perceive to be their sources of knowledge about teaching the cartwheel?**

All teachers had a gymnastics course as part of their initial teacher preparation. Three teachers (Benjamin, Julie, and Liz) had competed in gymnastics. Two teachers (Benjamin and Julie) had coaching experience in gymnastics. An important source of knowledge for all the teachers, however, came from their daily interactions with students and the subject matter. Through these interactions over time, teachers believed that they came to acquire content knowledge about the cartwheel. Studies in physical education have shown that teachers entering knowledge come from several sources. Rovegno (1991) found that playing and coaching was more contributory to beginning knowledge for some student teachers than were their formal teacher education experiences. Schempp (1993) also found that teachers constructed their knowledge from four sources, community, school, profession, and biography. Similarly in this study, the primary sources of teacher knowledge came from their experiences from teaching the subject and their daily interactions from the students. Teachers described other sources of knowledge such as media, United States Gymnastics Federation courses, and experience with their own children. Only the two content-poorer teachers (Lesley and Larry)
reported that their undergraduate gymnastics course was influential in their teaching.

There was no evidence of systematic professional development in the content of
gymnastics or teaching gymnastics for most teachers in this sample. Benjamin was the
only teacher who underwent systematic professional development and he was clearly the
best teacher. Grossman (1991) noted that "as teachers prepare to teach new material and
teach the same material over time, they also acquire new knowledge" (p. 207). There is
no doubt that these teachers did acquire rudimentary knowledge of the cartwheel through
their teaching experiences. However, as the data analysis demonstrated, several of the
teachers had remarkably inadequate knowledge of this skill that they had taught
frequently for years.

1.3 What do teachers know about the critical and technical elements of
the cartwheel?

In order to present material, develop content appropriately, and help learners
improve their performance, the content knowledge of teachers must be made explicit.
Teacher content knowledge must include a knowledge about the critical elements of
skills, an ability to analyze skill movements to detect important errors, and knowledge of
how to sequence learning tasks to provide for optimal skill development. When teachers
in this study were asked to identify the critical elements, four teachers were able to
correctly identify three of five critical elements. One teacher correctly identified four,
while two teachers misidentified or misunderstood the question. Knowing the critical
elements in turn is related to the ability to detect errors in a movement. Without
knowledge of what elements are critical to skilled performance, teachers might not
identify their presence or absence and might instead identify movement elements that are not critical to skilled performance. Of five possible errors that were present in the assessment protocol, three teachers correctly identified three, one teacher identified two, one teacher identified one and two teachers could not identify any. The two content-richer teachers identified three and two respectively while neither of the content-poorer identified any errors correctly. O'Sullivan (1996) noted that:

Learning to teach also includes the ability of trainees to analyze human movement. It ties one's knowledge of content with knowledge of pedagogy and one's ability to detect errors with one's knowledge of the appropriate sequence of steps to help students improve their performance (p. 327).

Dodds (1994) also noted that "expert teachers of motor skills are qualitatively different from novices in their abilities to detect errors and appropriate aspects of performance" (p.157). Several of the teachers were moderately successful in identifying common errors, but the average number of "hits" for the entire sample was 1.7 out of 5.

Considering the fact that research has done a great deal to provide us knowledge about training teachers to identify errors (Barrette, Allison, & Bell, 1987; Gangstead & Beveridge, 1984; Pinheiro & Simon, 1992), it was evident that the knowledge of teachers was at best incomplete. Together with sequencing of skills, this kind of teacher knowledge when appropriately communicated by teachers can help students improve their skill acquisition.

The data allowed for the conclusion that the content-richer teachers were able to identify critical elements and common errors more successfully than the content-poorer teachers; indeed, their ability to do so was contributory to the categorizing of the
teachers into those groups. The clearest differences were between the two content-richer and the two content-poorer teachers, which suggests that the performance and coaching experiences of the former were mostly responsible for those differences.

1.4. What is their basic strategy in teaching the cartwheel to young, novice learners of varying skill levels?

The teachers in this study did not have difficulty describing their approaches to teaching this skill, unlike Graber's (1995) study, where student teachers had difficulty in describing pedagogically coherent strategies and relied primarily on "trial and error" methods. Teachers were able to describe between two to five strategies for teaching the cartwheel. They were very specific about their strategies.

Teachers were aware that children at their ages needed to be able to bear their weight, and subsequently provided activities appropriate to achieving that prerequisite goal as a part of their learning progressions. For some of the teachers another strategy for determining how to teach the subject was to try to link it to their own difficulty with the skill. Teachers indicated that even though their undergraduate programs did not provide them specific training for determining pedagogical strategies best suited to the teaching of the cartwheel, they had taught the cartwheel sufficiently to know how to combine subject matter with their repertoire of other pedagogical strategies.

Research in physical education indicates that differences exist between expert teachers and less expert teachers in their development of contingency plans that meet the demands of the environment of the class (Graham, French, & Woods, 1993; Griffey & Housner, 1991; Manross, Tan, Fincher, and Schempp, 1995; Solmon & Lee, 1991).
this study teachers had developed detailed instructional strategies. The differences in how these strategies were, however, executed and the student learning environment and experiences were different for content-richer and content-poorer teachers. Benjamin, a content-rich teacher, for example, used a strategy different from what other teachers used. His strategy involved showing a video about the learning progressions of the cartwheel to the learners prior to practice trials. This strategy was associated with higher OTR's and high success rates for his students. He was the only teacher who included a formal evaluation system in his approach to teaching. While there may not have been marked differences between what groups of teachers described were their strategies, Cassady (a content-medium teacher) was the only teacher who in representing the skill, did not use lead ups. He explained and demonstrated the cartwheel and then immediately students were expected to perform the complete cartwheel. Experts in gymnastics teaching, however, were critical of many of the strategies, especially those of the content-poorer teachers. These experts particularly commented that the strategies reflected lack of knowledge about the cartwheel. Because of teachers experience in teaching the cartwheel, they could outline a logical and detailed skill progression which began with simple to complex activities. This capacity may reflect not only their experiences in teaching this skill, but also their general pedagogical knowledge related to teaching sport skills. While general pedagogical knowledge was not assessed in this study, it is likely to interact with content knowledge, perhaps especially in their responses to this part of the interview. These teachers described many ways of presenting information to learners. Their knowledge of students performance levels
helped them develop a diversity of teaching strategies to help learners (Manross et al, 1995). As Grossman (1991) noted in her review of the literature on pedagogical content knowledge, teachers control what gets taught through their selection of instructional methods and strategies. She added that:

Teachers who knew their material well, they were more likely to use whole group instruction; they allowed for more student involvement in the learning process. When they were less familiar with the material, they more often selected student-centered activities such as group work. In instances of whole group instruction, however, when teachers knew the material well, they allowed for more student talk; in teaching topics they were less familiar with, they tended to dominate the discussions (p. 207).

The content-rich teachers in this study allowed for student individual work, while the content-poor teachers tended to use group work where they could control student activities. While whole group instruction allows for guided practice in the initial parts of a lesson before independent practice, the content-poorer teachers did not provide for this independent practice, suggesting as Grossman noted that these teachers were less familiar with the material, and thus preferred to control student performance.

1.5. What do they see as the main learner problems and how do they overcome them?

Research has suggested that teacher knowledge about difficulties that their students may have trying to learn a skill is important content knowledge. In a review of science studies for instance, Grossman (1991) argued that knowledge of students misconceptions and the preconceptions they brought to the study of a topic, was an important component of pedagogical content knowledge. In this study, the two content-richer teachers, when asked about common learner problems, focused on technical issues
related to learning the cartwheel. Content-medium and content-poorer teachers, on the other hand, focused on the fears of students and lack of conceptual understanding of the cartwheel. When teachers were able to identify the problems, they were able to provide approaches to dealing with the problems. Teachers used spotting, lead-ups, demonstrations, hand-foot cues, and task modification techniques to deal with the problems. The data for this question suggested that content-richer teachers saw learner problems related to the technical elements of the skill itself, while the other teachers cited what were essentially prerequisite problems.

2.0. How do teachers present cartwheel tasks and provide feedback to more or less skilled, novice children?

Shulman (1987) in making the claim for the study of pedagogical content knowledge, argued that knowledge of subject matter, had to be supplemented with knowledge of students and learning. Teacher knowledge of content and instructional strategies and ways of representing that knowledge, aimed at getting students to learn the cartwheel, are discussed through an analysis of data related to the instructional task system, the only task system observed in this study. Research has revealed other task systems including the managerial and student-social task systems (Jones 1992; Marks 1988; Tinning, 1983; Tousignant, 1982). This study was designed to eliminate, as far as possible, the influence of the managerial and social task systems on the instructional system, so as to reveal more clearly the influence of content and pedagogical knowledge. In fact, there were few managerial or discipline problems observed during the instructional episodes.
Teachers used verbal explanations, demonstrations, and verbal and visual cues in presenting tasks to students. Through the use of lead-ups, step-by-step presentations were made. The process was used by all the teachers except for Cassady. The aim of having lead-ups was to help students master an awareness of what their bodies were capable of at each stage of the learning process before moving on to the next. The seven teachers used an active teaching approach which has been described by Siedentop (1991) as a framework characterized by time, opportunity to learn and content covered, meaningful tasks and clarity, active supervision, and good pacing and momentum. Even though, initial research into active teaching focused on large classrooms, the seven teachers in this study frequently displayed many of those characteristics. They all used refining and extending tasks, with some frequency, a finding not always seen in physical education teaching research (Rink, 1996). They interacted with the students with prompts, a finding in England's (1993) study, by providing feedback to learners and cued students on the critical elements of the skill. The feedback provided by teachers was dominantly supportive rather than technical, a finding consistent with findings in physical education (Toby, 1974; Yerg, 1978).

Graham (1988) and Graham, Hussey, Taylor, and Werner, (1993), in their study of task presentations suggested that effective task presentations should include explicit instructions, an emphasis on usefulness of the content presented, structuring new content, signalling student attention, summarizing and repeating information, checking for student understanding, creating a positive climate for learning, and holding students accountable. If these criteria are used to judge teacher task presentation, then the seven
teachers in this study had appropriate pedagogical knowledge. Indeed the data suggest that the teachers may have been more alike in their pedagogical knowledge, and that knowledge may have existed at a higher level, than their content knowledge of gymnastics in general and the cartwheel in particular.

Sharpe, Hawkins, and Wiegand (1989) and Southard and Higgins (1989) have suggested that teachers should try to demonstrate whenever possible, because it is helpful to children who are visual as opposed to auditory. In communicating tasks, 30.6% of the tasks included teacher demonstrations, 12.7% included student demonstrations, 84.2% were accompanied by teaching cues, and 42.7% of the tasks included teaching aids. It has been widely believed in physical education that teachers employ demonstrations, performed either by the teacher or student as a means of communicating tasks to students. However the literature has not supported this (Griffin, 1991; Jones, 1989; Werner & Rink, 1989). The teachers in this sample appeared to use more communication strategies typical in physical education. The widest mode of communication used by teachers is verbalization (Anderson & Barrette, 1978). In this study instructional tasks were often delivered through teacher verbalization, combined with student or teacher demonstration. The seven teachers often provided group instruction, describing and demonstrating and then dispersing the students to work. The use of few demonstrations by some teachers may be a function of their unwillingness to model the wrong skill for the children, even though, some of the teachers described their cartwheel as not being "great". As Gould and Roberts (1982) suggested, a model of a skill should be accurate and the gender of the one who demonstrates the skill should be
the same gender as the learner. Teachers often used manual guidance during practice tasks to direct student response to a more qualitative one. Once students began distributed practice, teachers tended to stand aside, observe, and provide feedback. Rosenshine and Stevens (1986) have suggested that when a new task is introduced (informing tasks) or when the conditions for task practice have been changed substantially (extending tasks), it is important that a period of guided practice occur after the teacher has communicated the task. Guided practice is a period of teacher led, whole group practice that functions to correct major errors in performance, reteach the skill, and provide sufficient practice so students can participate successfully in independent practice and produce high rates of successful repetitions.

Rosenshine and Stevens (1986) argued that in providing independent practice to students, it allowed the student to repeat the activity several times, and gave opportunity to integrate previously learned behavior into new behaviors and learning became automatic. The teachers in this study, showed pedagogical content knowledge by engaging the students in independent practice, helping them with their errors, and checking for student understanding. However, knowledge of these instructional skills in itself was not always related to student success, as shown in this study. What Rosenshine and Stevens (1986) were emphasizing was that teachers must provide successful practice so that overlearning can take place. Teachers in this study were not very successful in providing successful practice, with the exception of Benjamin whose students were very successful.
Learner responses were appropriate and successful, because teachers gave verbal directions in a way they knew students would respond successfully.

**Time Analysis**

Research shows that students who spend more time in good practice learn more. Initially the construct was that the amount of time a teacher allocates to practice brought about the learning of skills (Anderson, 1980; Metzler, DePaepe, & Reif, 1985). Later, research modified this construct to include the idea that students must not only be engaged, but must be engaged at a high success rate (Metzler, 1979, 1989; Silverman, 1985, 1991). This construct came to be called Academic Learning Time -Physical Education (ALT-PE). Time, however, is not as precise a metric as are frequency of successful responses, so that as research in teaching physical education matured, the concept of opportunity to respond (OTR) tended to provide a more valid measure than ALT-PE, even though the two tend to be strongly correlated (Dugas, 1983). Student OTR rates tend to be strongly dependent on how teachers organize their practice sessions (Siedentop, 1991).

In this study, the data indicated several patterns. First within lessons, amount of time allocated to practice was significantly lower in teachers first lessons than in their second lessons. This was to be expected as initial lessons focused more on communication of knowledge about the skill to be learned. Secondly, for all teachers, more time was spent in practice than in either management or instruction. Practice time ranged from 55.3% to 97.3%. For the content-poorer teachers, practice time ranged from 63.8% to 89.0%, from 55.3 to 87% for content-medium, and 68.3 to 97.3 for the
content-richer teachers. These differences do not appear to be significant, again indicating that the teachers were more alike in pedagogical knowledge than in content knowledge.

A third pattern was found in relation to amount of time spent in management. Even though four children were selected to eliminate managerial concerns for large classes, some of the teachers still spent a considerable amount of time in this category. Julie, a content-richer teacher spent between 1.8 and 12.9% of her time in management, while Liz, a content-medium teacher, spent between 4.2% to 17% of her time in this category. Their comparatively high management time could not be explained by lack of content knowledge. On the other hand, Leslie, a content-poorer teacher, spent 1.5 to 4.2% of her time in this category. Recall that Leslie in her interview had stated clearly that "I had zero gymnastics". These differences cannot be explained by difference in content knowledge; rather, it suggests that the differences might have been related to differences in pedagogical knowledge, but this cannot be fully determined because no independent measure of pedagogical knowledge was used in this study.

2.1 What were the progressions of tasks children are asked to do and how are those tasks presented?

Research has suggested that when teachers develop content, they do this through a series of related tasks. The major model for studying task development in physical education is Rink's (1993) model using informing, refining, extending, and applying tasks categories. In this study content was developed through informing, refining, and extending tasks. All teachers frequently used extending tasks. Extending
tasks gradually change the nature of the task to bring it towards a final point. Refining tasks were directed to improving the quality of student responses related to a task, rather than changing the task. Refining tasks were used on average by all teachers about 4.6 times, extending, 5.5, informing, 3.4, and applying 0.3 times in teachers two lessons. Previous research has shown that teachers do not use refining tasks frequently (Dyson, 1994; Jones, 1989; Lund, 1990, Son, 1989). Siedentop, Doutis, Tsangaridou, Ward, and Rauschenbach (1994), however, did find that teachers used high rates of refining tasks. Considering the evidence in the literature that refining tasks are related to skill development (French, Rink, Rickard, Mays, Lynn, & Werner, 1991; Masser, 1985, 1993; Rikard, 1991; Rink, French, Werner, Lynn, & Mays 1991), teachers in this study demonstrated good pedagogical knowledge. Applying tasks were used very infrequently and in fact, only Liz used applying tasks where students were required to combine the cartwheel in floor routines.

Teacher task progression was mainly influenced by student success. Quite often when the students response was unsuccessful, teachers responded by altering the task or refining the task, showing a dual-directional influence in the teaching-learning environment. Bernard, Cassady, and Larry quite often responded by extending the task. Benjamin and Julie, the content-richer teachers in the study responded by focusing on the critical elements or through guided practice. This again suggests that content-richer teachers are more focused on technical elements of the skill, while teachers with less content knowledge, rather than focus on the skill itself, tend to move to a different task.
2.2. **What types of feedback and prompts do teachers provide for their learners?**

An analysis of the data for teacher feedback for the seven teachers showed that teachers most frequently prompted students, provided supportive feedback, feedback directed at correcting the performance errors of students and then to restate tasks. Studies in physical education have shown that teachers are not very efficient at providing feedback to students. Studies by Dodds (1989) and Tobey (1974) have demonstrated that teachers provide a dis-proportionately higher rate of general positive feedback and corrective feedback when compared with specific feedback. Siedentop's (1991) summary of this research suggests that technical feedback is generally infrequent in physical education.

In this study, teacher feedback most frequently focused on supporting the efforts of students, but there were efforts to use technical feedback. Teachers high skilled student feedback directed at supporting student efforts averaged 1.2 per minute and 1.1 for the low skilled students. Feedback directed at correcting student performance errors averaged 0.7 for high skilled students and 0.8 for the low skilled. However, there was frequent interaction in the form of prompts, averaging 2.1 per minute between teachers and students. Little difference was found in the pattern of distribution of feedback to both low and high skilled students. This suggests that teachers were highly interactive (approximately 4 per minute) and that they had a reasonable balance between supportive and technical feedback.
This finding, however, must be considered in terms of the small size of the class and the reduced focus due to the virtual elimination of managerial issues. One would have thought that with such a small group of students, teachers would have observed several movement responses of each student to identify consistent errors and provide feedback, before moving on to the next student, an idea put forward by Rink (1996). At minimum, the findings suggest that if teacher feedback to a small group of students is approximately 4 per minute then, possibly in large classes some students do not get frequent feedback from the teacher, a claim made by Magill (1994).

An analysis of the differences between the groups of teachers suggested that during practice for the high skilled, content-richer teachers averaged 3.5 feedback statements per minute, content-medium 4.2, and content-poorer 4.1. When low skilled students were practicing tasks, teacher total feedback to students averaged 4.1 for content-richer teachers, 3.6 for the content-medium, and 5.2 for the content-poorer teachers. Once again, these findings suggest that teachers were more alike than different in pedagogical knowledge relative to amount and kind of feedback.

3.0. How do more or less skilled children respond to these learning opportunities and what do they understand about how to do the cartwheel?

Studies have shown that student learning is related to the amount of successful practice (Silverman, 1990; Siedentop, 1991). When students are distributed to practice a task in order to solidify their learning, they should according to Rosenshine and Stevens (1986), be 90% successful. This is a stringent criterion that is seldom met in the physical
education teaching research literature.

An initial evaluation of tasks is to see if students' responses are congruent with what teachers asked them to do (Son, 1989), what in this study is labelled as "response appropriateness." There was high degree of appropriateness of responses by all learners (the modal appropriateness was 100%). Previous research has identified four categories of student responding: engaged in the task, engaged in a modified way, waiting, or deviant (Tousignant, 1982). Students in this study engaged purposefully in the stated tasks all the time. In this study, similar to England's (1993) tennis tutorial settings, "competent bystanding" was not possible, likewise deviant behavior was not seen even though some of the teachers created lines at mats for students to take turns performing.

There was no significant differences in response opportunities related to either skill level or gender of student, a finding that is discrepant with much of the previous research in physical education (Siedentop, et al. 1994), particularly as it relates to skill level. There were however, some differences that are attributable to organizational practices. When students worked independently in a fully distributed practice format, they had higher OTR rates. When teachers grouped students at mats with the students taking turns performing, there were lower OTR rates. The students taught by Benjamin and Julie, the two content-richer teachers, had OTR rates that were significantly higher than for the other teachers. Thus, in this case, content knowledge did appear to be related to this finding.
3.1. What are their patterns of success and errors?

Research data about specific measures of practice that have looked at actual practice trials, and not time, and which attempts to examine success and appropriateness have shown that there is a positive relationship between practice and learning (Silverman, 1990; Werner & Rink, 1989). Other studies have looked at the relationship between appropriate practice and the content of the practice (Godbout, Brunelle, & Tousignant, 1983; Silverman, Devillier, & Ramirez 1991).

In this study, if one assumes that higher rates of successful practice are a valid measure of learning, then the content richer teachers had students who learned significantly more with the children of Benjamin being most successful. Students of content -richer teachers had significantly higher OTR rates with student success rates typically above 85%. This relationship is also seen between appropriateness of practice and success. Their students practiced appropriately 100% of the time and also had high success rates. Students of content-moderate and content-poor teachers had lower OTR rates, even though their success percentages were often acceptably high. Leslie, a content-poorer teacher, was the exception. Her students had fairly high OTR rates but tended to be less successful.

3.2. After the lessons, what is their understanding of how to do the cartwheel?

Studies have shown that elementary school students who are given the opportunity to talk about their own learning are able to describe their perceptions of their physical education programs (Dyson, 1995), and their own abilities (Lee, Carter, &
Xiang, 1995). In this study, when students were given the opportunity to talk about their understanding of the cartwheel, a relationship between their teachers pedagogical content knowledge and their understanding about what is critical in learning the cartwheel was found. Interview data suggested that students in this study learned what their teachers taught them about the cartwheel, and that children believed that the information and cues teachers provided were helpful in their learning. The children were able to explain the cues teachers emphasized to them. This apparent congruence between what teachers expected students to know and the knowledge students demonstrated is a reminder that teachers clearly represented to students what they felt students needed to know and students were able to recall these instructions and generally thought them to be helpful.

A slightly contrary finding came from the students taught by Liz, a content-medium teacher. The data from Liz's children provided evidence that what works well with students as designed by the teacher may not always be helpful to the student. Liz thought that using hoops and an inclined cheese mat would help the children. The children thought otherwise. One of the children said that "we didn't do better with that cheese...it was probably the slant. It was easier to roll off". Another child said that "the hoola hoops didn't help much, but it was fun to have". This suggests that students are able to distinguish between what is fun to do and what is helpful for learning.

In this study, the children of the content-richer teachers, Benjamin and Julie, did not only get good practice and learned the cartwheel, they were also able to articulate an understanding of the technical cues which children of the content-poorer teachers were not able to do. When Julie's children talked about what they learned they mentioned an
inverted position with legs straight in the air, a cartwheel along a straight line path, and landing as critical to a good cartwheel. This suggests that the children were able to make links between the various components of a cartwheel, knowledge which is important for children to know to perform successfully. On the other hand, the students of Larry, a content-poorer teacher, emphasized their own abilities and a transfer of learning in other sports to their learning the cartwheel, suggesting that Larry emphasized non-technical cues.

Without the interview with the children one would surmise that the children probably were vessels to be filled, but would not be able to tell what works best for them, but interview data shows this is not true. Students understood what was appropriate for them to know about the cartwheel. More importantly, the students in this study felt that they had learned the cartwheel.

Conclusions

The evidence in this study about teacher content knowledge shows an integration of content knowledge, knowledge of instructional processes, and student understanding of the cartwheel. Teachers differed markedly in both experience and knowledge about the cartwheel. Teachers with more content knowledge about the cartwheel also coached and/or have performed the cartwheel at a stage during their professional career. However, except for Benjamin there was no evidence of systematic professional development in the content of the cartwheel. Most teachers had remarkably inadequate knowledge of the critical and technical elements of the skill. Teachers who exhibited the most correct knowledge about the critical and technical elements of the cartwheel were
also most successful in identifying the technical problems students encounter, but the
difference between teachers with correct knowledge and those with incorrect knowledge
was more a function of the performance and coaching experiences of the former.
Teacher experience interacted with their pedagogical knowledge to the point where
teachers could outline detailed and logical teaching strategies for the cartwheel.

Teacher pedagogical content knowledge also focused on how students were
successful and came to learn the cartwheel. The most important requirement in the
learning of motor skills is the view that students be provided OTR, and they should be
given feedback on their performance. This requires content knowledge for sequencing
and presenting tasks, knowledge of student understanding, and ways of transforming the
knowledge for students to learn. The evidence in the study shows that teachers were
more alike than different in pedagogical knowledge. Teachers spent the greatest amount
of time in instruction in their first lessons compared to their second lessons, and focused
more time on practice than on managerial or instructional issues. Relative to the
importance of structuring time to allow for optimum participation, teachers displayed
good pedagogical knowledge.

There was a relationship between teacher presentation of tasks and student
success in learning the cartwheel. Teachers whose students showed the most
improvement in skill levels were also teachers who used student demonstrations,
teaching cues and teaching aids. Teachers who demonstrated the skills themselves, also
had students who were least successful in learning the skill. Teachers who focused their
cues on technical aspects of the skill were more successful teachers than teachers who
focused on production or metaphorical cues. Perhaps a combination of cues, rather than one particular type of cue might be most effective in communicating to students the critical elements of skills.

If the relationship between student learning of the cartwheel and instruction is examined as a function of teacher knowledge, the relationship is less clear. Teacher's whose students were most successful also provided the most OTR, and used the most strategies emphasizing the sequence of learning the skill. On the other hand, teachers whose students were not always successful also provided high OTR's. The relationship existed only with those activities that emphasized the cartwheel. Those who did not have much opportunity to practice the cartwheel showed less success. Providing OTR's can be a powerful tool for learning a skill. Because students of content-richer teachers were so successful, the findings in this study demonstrate that successful OTR's are powerful for promoting the acquisition of skills. Thus we can conclude that teachers who had the most opportunity to use their knowledge of the cartwheel, and their knowledge of effective teaching to facilitate student learning also had the students who were most successful. Teachers who were among those exhibiting good content knowledge, and who used sufficiently appropriate strategies to teach the cartwheel, had students who exhibited a change in skill levels. Teachers who did not spend time teaching the cartwheel, their students had few opportunities and thus they had few opportunities to use their knowledge to facilitate learning for the students.

Teacher pedagogical content knowledge examined from how their students came to understand the cartwheel content shows that student perceptions of the cartwheel were
very much like that of their teachers. In the single case of Liz, her students perceptions differed from her own. Liz visualized some teaching aids as essential for learning the cartwheel, but the students found the reverse.

The teachers in this study were better prepared in pedagogical knowledge but less so in their content knowledge.

Summary

There is evidence to suggest that teacher knowledge and student motor skill acquisition are related, but the patterns that emerge are best considered when we examine teachers' instructional activities. When teachers' pedagogical knowledge was strong, but they did not have the opportunity to show this knowledge, that is instructional activities were limited, their students also did not learn much, and were not very successful. On the other hand, if their knowledge was strong and they had opportunity to exhibit it, student response was more successful. If teacher content knowledge was not strong, and there were plenty of opportunities to exhibit, but they failed to exhibit that knowledge, student success was minimal. Benjamin combined strong pedagogical knowledge and content knowledge that brought about greater appropriate OTR's for his students and greater success.

Implications

Results from this study, as well as previous studies from content and pedagogical content knowledge in physical education has provided insights into the CK and PCK of teachers. If what teachers know is insufficient for their work as teachers; if teachers have to be concerned with helping students to understand or learn new skills, then what
teachers learn in their undergraduate programs must be taken seriously. If such things as sequencing of skill, knowledge of student problems, presentation of tasks, and critical elements are important, then teacher education programs must focus more on knowledge of specific subject matter. Physical education majors must be provided with explicit knowledge about the subjects they will teach.

Teacher education coursework must also deal with the students prior knowledge of the content. As this study has shown, an undergraduate major in physical education is not alone sufficient to ensure that the teacher has the explicit knowledge necessary for representing the cartwheel to children. Teacher education programs ought to include subject matter course work that is specific to teaching what is taught in schools and at the specific grade level. Teachers must also themselves be players and good players. Programs must match the gymnastics programs in colleges with the explicit content that teachers will cover in K-6 programs. Requiring teachers to take various foundational courses, while little attention is paid to the content they will teach is an injustice to teachers.

This study suggests that presentation of tasks and how content is developed must take into account teachers training. Teacher education programs must teach students to increase their subject matter knowledge through more emphasis on doing than telling. Through student teaching practices that emphasize the presentation of tasks through verbal statements, teacher and student demonstrations, and the use of different types of cues, teachers will develop a repertoire of in-depth knowledge of the subject matter of gymnastics.
This study also indicated that teachers primarily used informing, extending and refining tasks. The study showed that when refining tasks were used, the quality of student responding improved. Elementary physical education should emphasize the concept of refining tasks to improve the quality of student responding and therefore influence student learning.

Another important implication for this study is that the elementary school teacher should use step by step progressions in breaking down what may be considered simple tasks. Teachers must find many ways of designating practice.

Recommendations

Future research on teacher content knowledge could go in different directions. First, there will be a need to replicate the studies that have been conducted in this area. For example, this study could be replicated using full classes of students. Different grade levels, different content areas and different methods, will help inform us about where we should be headed. When studies are replicated, often results are confirmed and strengthened and a theory is developed.

Teacher pedagogical knowledge ought to be assessed. Research that examines teacher pedagogical content knowledge should not only examine teacher content knowledge but assess their pedagogical knowledge to provide clearer pictures of the interactions between content and pedagogy in the development of pedagogical content knowledge.

Future research could examine the effects of physical education teacher specific subject-matter knowledge on various teacher behaviors, such as feedback, prompts,
questioning, structuring of content, planning, and on teaching various gymnastics skills, especially educational gymnastics. Research should also examine the differences in teacher content and pedagogical content knowledge and the differences in students knowledge, thus exploring fully the relationship between teacher and student knowledge and instruction.

Future research should consider the possibility of investigating the effects of the policies and institutional structures that require teachers to teach content they are unfamiliar with. School reform efforts will be futile unless we can explore the potential for building specific expertise into teaching structures so that we can explore the potential for building subject matter expertise into school programs. Teachers cannot possibly know everything, and should be not be regarded as people who can teach everything.

Different methods for examining teacher content and pedagogical content knowledge should be used. The use of qualitative and quantitative methods, with emphasis on combining different methods, such as survey type techniques, single case studies, and systematic observation must be used, for example, questionnaires, document analysis, interviews. To discover what teachers know should go beyond merely asking teachers to describe their knowledge to observing them teach what they say they know to discover the links between knowing and practice.

In studies in education, researchers used a research based taxonomy of problem types and student's problem-solving techniques in their study of experienced teachers' pedagogical content knowledge. Research in physical education that attempts to study
teachers' knowledge of student understanding can build on this in particular content areas.
LIST OF REFERENCES


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APPENDIX A

LETTER OF INVITATION TO TEACHERS TO PARTICIPATE
26 February 1996

To: Franklin County Elementary PE Specialists

From: Daryl Siedentop and Mensah Kutame

Re: Invitation to participate in a research study

A major current focus of teaching is "pedagogical content knowledge" (PCK), which is how a teacher transforms knowledge of the content to represent it to learners in ways that facilitate learning. Physical educators are just beginning to investigate this important dimension of effective teaching.

Mensah Kutame wants to study PCK for his dissertation, but to do so we need teacher volunteers. What Mensah proposes to do is to study how elementary PE specialists teach the cartwheel to novice learners. For teachers, the study would involve the following;

1. Complete a one page demographic information sheet.

2. Complete a brief review of your knowledge of the technical elements of the cartwheel.

3. Complete an interview in which you and Mensah would explore your sources of knowledge about the cartwheel.

4. Conduct two 15 minute lessons to six selected novice learners teaching them the beginning elements of the cartwheel. We would videotape the lessons which could be done at a recess or any other time convenient to your school schedule.

5. Allow Mensah to do short, group debriefing with the six students after the second lesson.

Your anonymity in this study will be protected completely. Teachers will not be referred to by name, nor will data be analyzed or shown in ways that
reveal identities.

We would be happy to provide one credit hour of HPER 693 independent study credit for participation in this study. We would, of course, provide a complete debriefing to you after the study including the results.

Please write, call, or e-mail to me your willingness to participate. We can then make the appropriate contacts with your Principal and district to secure permissions.

Thank you for giving us your consideration for participation in this study.

Daryl Siedentop
Senior Associate Dean

Mensah Kutame
Doctoral Candidate
APPENDIX B

LETTER TO PARENTS
May 15, 1996

Dear Parent:

We are presently involved in the preparation of future teachers at the Ohio State University. We are interested in what experienced teachers know about the content they teach and how they teach it to novices. This information is valuable in preparing future teachers and can contribute to our knowledge of how to help preservice teachers to improve their teaching skills.

We would like permission for your child to participate in a study that will be conducted outside their regular class time. The study is titled "The relationship between teacher content and pedagogical content knowledge on student acquisition of a gymnastics skill". Your child was chosen to participate in this study because he or she is in a class in which the teacher agreed to participate. The lessons to be conducted outside class time is to make sure that your child does not miss regular class time. Possible risk factors from your child's participation are no greater than his or her normal physical education activities.

Your son or daughter will be identified on videotaped lessons, but at no time will his or her name, or the videotapes be made available to anyone but for the researchers in this study. Students will not be identified by name at anytime in any of the reports of this study. If you decide to allow your child to participate, you or your child are completely free to withdraw consent and discontinue your child's participation at any time.

As the results of this study are completed, a summary will be made available to the principal of the school where your child is a student, which will be made available to you upon your request. If you have any questions, please contact us at 292-1292 or 292-7231.

Please sign and return the attached form as soon as possible. Thank you very much.

Sincerely,

Daryl Siedentop
Senior Associate Dean

Mark Anthony Kutame
Ph.D. student
APPENDIX C

BIOGRAPHICAL DATA SHEET
Biographical Survey

Please complete this brief biographical questionnaire. All information will remain confidential. This information will only be used to describe the general characteristics and backgrounds of those who participate in the study in the final dissertation. Thank you.

Name:_______________________________________________________________

Age:_________________ Male/Female:_______

School:________________________________________________________________

Work Phone:______________ Home Phone:________________________

Highest Degree:________________________________________________________

College/ Major:________________________________________________________________

For how many years have you been teaching physical education?________

Did you compete in high school? Yes/No.

Did you compete in college? Yes/No.

Have you ever coached or are coaching gymnastics? Yes/No If yes, At what level?________

Do you regularly teach gymnastics units? Yes/No________

Is the cartwheel part of your gymnastics unit? Yes/No________

Please describe any other aspects of your background that would assist us in understanding your development as a gymnastics teacher. (USE BACK OF SHEET IF NEEDED)

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APPENDIX D

SURVEY QUESTIONS TO TEACHERS
Cartwheel Survey

(Use back of sheet or additional paper if needed)

1. Describe in sequence the skill components of the cartwheel.

2. List what you consider to be the important critical technical elements of the cartwheel.

3. Identify the errors (if any) in the cartwheel performance shown on the accompanying sheet.
APPENDIX E

PICTORIAL SEQUENCE OF A CARTWHEEL PERFORMANCE
Identify the errors performed in this Side Cartwheel.

a. ________________________________

b. ________________________________

c. ________________________________

d. ________________________________

e. ________________________________
APPENDIX F

MODIFIED TASK STRUCTURE OBSERVATION SYSTEM

CODING MANUAL
This observation system was designed for coding with a permanent product, the videotape. The focus was on the teacher and students, how the teacher presents tasks to each of low and high ability students selected based on their being novices, and how these students respond to those tasks. The observer records on the coding sheets the events as they occur. The lesson itself should be recorded from the videotape. A chronograph, which runs continuously throughout the lesson, provides the means for recording time data. The observer should use the chronograph during the coding of the videotape.

Categories
In the attempt to observe and describe task structures which exist and operate in the elementary physical education classes, this observation system was designed to focus on

a) the teacher's description of the task
b) the students' response to the specific tasks
c) the teacher's response (feedback) and consequence of the students' behavior

These three segments comprise the observation system. The system is designed for coding instructional tasks. Managerial tasks are not the focus of this system. The system was designed so that it could record maximal activity or practice times for the students.

INSTRUCTIONAL TASKS

When a task is defined as instructional, the observer must identify whether the task is (a) an informing task (IT), (b) a refining task (RT), (c) an extending task (ET) or applying task (AT). It is important to note that some tasks will have overlapping categories indicating the need for more than one coding option.

DEFINITIONS OF THE CODES

TASK: What the student must do to successfully meet the demands of the situation.

TASK DESCRIPTION: This relates to the subject matter activity of the lesson; the intended learning students are to acquire by participating in the instructional activities.
e.g. hands up, step into lunge position.

**PRACTICE TASK**: A unit of practice defined by the direction from the instructor followed by learner responses.

**INSTRUCTIONAL TASK CATEGORY**: Presentation, practice, or participation with the subject matter. Instructional tasks have a substantive function in relation to class content. In physical education, these tasks are primarily movement activities or the acquisition of knowledge in relation to the activity (i.e. rules and strategy), Rink, (1979).

**INFORMING (IT)**: Newly introduced practice tasks. Any spoken or unspoken behavior intended to communicate substantive information to the learner and without having an extending, refining or applying function (Rink, 1979).

**REFINING (RT)**: Tasks which emphasize the qualitative dimensions of tasks previously introduced. A teacher move that communicates a concern for the quality of student performance (Rink, 1993). E.g. Work on placing one hand before the other.

**EXTENDING (ET)**: Variation in the conditions under which a task is practiced. A teacher move that communicates a concern for changing the complexity or difficulty of student performance (Rink, 1993). An extending task sequences the learning experiences from simple to complex and is sometimes called progressions. E.g. from mule kick to handstand.

**APPLYING (AT)**: A task that is practiced under the conditions similar to competition. A teacher move that communicates a concern for moving the student focus from how to do the movement to how to use the movement (Rink, 1993). It is a task that provide students opportunities to apply their skills.

**STUDENT RESPONSES (OTR)**: A discrete unit of movement which can be measured by frequency count such as a baseball hit, a hockey pass, or a volleyball smash.

**INAPPROPRIATE TASK** (IA): The student performs a task other than what is stated or described by the teacher.

**SUCCESSFUL TASK** (S): Student performs the task as described by the teacher with all the critical elements of the skill present. The quality of efficiency defines the performance when the actions of the performer are mechanically correct for the performance and the situation.

**UNSUCCESSFUL** (U): The student appears not to be able to perform the task.

**FEEDBACK**: Teacher behavior in response to student actions.
DIRECTED AT PERFORMANCE ERROR (FP): Content of the feedback directed at correcting the errors of the students following a performance.

RESTATING TASKS (FR): Content of the statements teacher makes is directed at repeating the task due to student misunderstanding of what needs to be done.

SUPPORTIVE (FS): Teacher statements aimed at encouraging the student, or to provide information to the student about what he/she did in the previous performance. E.g. Good boy! Attaboy!

CODING PROCEDURES:

The observer starts the tape and for each task stated the observer write down the number of the tasks and a description of the task

For example:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handstand</td>
</tr>
</tbody>
</table>

The observer makes a determination if the task described was an informing (IT), refining (RT), extending (ET) or applying task (AT).

For example:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
<th>Task category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handstand</td>
<td>ET</td>
</tr>
</tbody>
</table>

The target students response to the stated task must then be observed and coded. The purpose is to record the number of actual opportunities to respond (OTR). One aspect of the observation instrument was to record for each student, their involvement in tasks, counting OTR's for each student. This measure was important because it preserved the sequence of trials for girls and boys and for ability levels, high and low. To record the OTR's, the task itself must be discrete. The target students response might be a) successful (S), or b) unsuccessful (U) and c) inappropriate or appropriate. The observer makes a determination and writes down the behavioral symbol.

For example:

<table>
<thead>
<tr>
<th>Task#</th>
<th>Task description</th>
<th>Task category</th>
<th>Student response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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The observer must then attend to the teachers response to student performance by recording whether the teachers response (feedback) was: a) directed at the performance errors (FP), b) restating the task (FR) or c) supporting the students performance (FS).

For example:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Task Description</th>
<th>Task category</th>
<th>Student Response</th>
<th>Feedback category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handstand</td>
<td>RT</td>
<td>U</td>
<td>IA</td>
</tr>
</tbody>
</table>

TIME MEASUREMENTS

An aspect to this observation system focuses on duration time measures. A chronograph which runs concurrently with lesson episodes provides the means for recording time data. The tape starts at 0000 seconds. The coding sheet provides space for recording the start and stop times for each episode. The first time measure records the time taken to describe an activity to students.

For example:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Time start</th>
<th>Time end</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0010</td>
<td>0024</td>
</tr>
</tbody>
</table>

The second time measure records each discrete response of the student to a task. Each time the student starts an activity the time is recorded and when the activity stops the time is recorded, thus producing a chronological record.

When the observer has completed recording, the lesson would have been recorded verbatim.

For example:

<table>
<thead>
<tr>
<th>Task #</th>
<th>Time start</th>
<th>Time end</th>
<th>Task Description</th>
<th>Task category</th>
<th>Student response</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0010</td>
<td>0024</td>
<td>Handstand</td>
<td>RT</td>
<td>U</td>
<td>IA</td>
</tr>
</tbody>
</table>