Effect of Knowledge on Teachers' Interactive Thinking and Children's Overhand Throwing Performance.

Edward Walkwitz

Louisiana State University and Agricultural & Mechanical College

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Effect of knowledge on teachers' interactive thinking and childrens' overhand throwing performance

Walkwitz, Edward, Ph.D.
The Louisiana State University and Agricultural and Mechanical Col., 1989

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Effect of Knowledge on Teachers' Interactive Thinking and Childrens' Overhand Throwing Performance

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy in The School of Health, Physical Education Recreation and Dance

by Edward Walkwitz
B. S., Springfield College, 1972
M. S., University of Montana, 1974

August, 1989
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DEDICATION

My father and mother, Edmond and Julie, taught me through example the values of hard work and persistence. This writing and the accompanying Ph.D. degree would not have been possible without these values, and their ongoing support and confidence in me.
FOREWORD

This writing follows the guidelines recommended by the American Psychological Association. The body of the dissertation is written in a format that is appropriate for submission to a refereed professional journal. Supporting information in the form of tables, instruments, procedures, documents, references, and an extended review of literature are presented in the appendices.
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Abstract

This study examined the effects of knowledge of subject matter (overhand throwing) and of throwing-specific instructional strategies on teachers' interactive thinking. The impact of these two categories of teacher knowledge on lesson objectives, the quality of skill practice, and kindergartners' overhand throwing development over a unit of instruction were also explored. Eight kindergarten classroom teachers who possessed high generic teaching skill competence taught a six-week overhand throwing unit to the children (N=150) in their intact classes. Prior to the unit, four of the teachers were exposed to a training program that increased their knowledge of overhand throwing. Four teachers (comparison group) did not experience this knowledge training. During the throwing unit, stimulated recall interviews were conducted. The interviews were audiotaped, transcribed, and coded to evaluate teacher thoughts, decisions, concerns, information sources, awarenesses, and lesson objectives. In order to determine the quality of throwing practice, the student practice trials were videotaped and analyzed for frequency of opposite foot stepping. The students were pretested and posttested on an overhand throwing test that included a throw for distance, and a developmental stage assessment (foot, pelvic-spine, and arm actions).

The results indicated that teachers' knowledge of subject matter and of content-specific instructional strategies play very important roles during throwing instruction. The knowledge that
was acquired during the training sessions influenced the teachers' lesson objectives and interactive thinking. This resulted in higher quality decisions. Sound professional decision-making combined with instructional procedures and strategies which focused on specific developmental body actions enabled the knowledgeable teachers to conduct lessons where the students were engaged in a high number of correct practice trials, which in turn facilitated overhand throwing development/performance. Conversely, the knowledge deficient teachers demonstrated lesson objectives and interactive thoughts/decisions that lacked an awareness of overhand throwing developmental concepts. This resulted in poorer quality practice trials and decreased the likelihood of overhand throwing development/performance gains. The overall results support the view that formal physical education instruction in public school settings under the direction of knowledgeable teachers does make a difference.
A number of studies have investigated the impact of instruction on the development of overhand throwing among young children (Dusenberry, 1952; Flinchum, 1971; Glassow, Halverson, & Rarick, 1965; Halverson & Robertson, 1978; Halverson, Robertson, Safrit, & Roberts, 1977; Hanson, 1961). The measures that were used to detect developmental changes in these investigations (pre vs post instruction) included the velocity or force of the throw, the distance that the ball was thrown, and/or analyses of filmed body component actions. Findings from this line of research provide some support to the view that formal instruction can accelerate the development of overhand throwing as evidenced by increased stepping with the opposite foot (Dusenberry, 1952; Glassow et al., 1965), a longer stride with the stepping foot (Glassow et al., 1965), greater overall body rotation (Dusenberry, 1952; Glassow et al., 1965), improved trunk action (Halverson & Robertson, 1978), increased range of spinal rotation (Halverson & Robertson, 1978), the appearance of forearm lag (Halverson & Robertson, 1978), and an improvement in throwing distance (Hanson, 1961). However, the latter finding is not always observed because radical change in throwing form sometimes results in a temporary decrease in distance that an object is thrown (Dusenberry, 1952). The velocities of thrown balls seem to be unaffected by overhand throwing instruction (Glassow et al., 1965; Halverson et al., 1977; Hanson, 1961).

Taken together, these findings provide some useful information regarding the potential contribution of instruction on overhand
throwing development, but have limited practical application to public school settings for a number of reasons. First, much of the data were collected from child care centers, nursery schools, church sponsored activity centers, and from special physical education programs, rather than regular public school classes. Second, when public school children were used as subjects they were assigned to experimental groups, thus the natural composition of each class unit was changed. Third, the subject matter was frequently taught by investigators in the experiment, or by personnel and volunteers at the agencies cited above, rather than by public school teachers. Fourth, the investigators who were called upon to instruct may have had a high degree of technical knowledge about the overhand throw, or had access to this information. In contrast, elementary school classroom teachers who are responsible for physical education instruction may not possess such a high degree of this domain-specific knowledge, and may not have access to this technical information. Finally, since the primary focus of these studies was on accelerating overhand throw development rather than understanding teaching, systematic observation and/or videotape analysis techniques were not employed to describe what transpired during the lessons. Thus the findings provided little information about the processes of teaching. There is a need to integrate these research procedures.

A recent research approach which has increased our understanding of the teaching processes is based on the assumption that what a teacher does in a classroom to affect student behavior
and achievement is influenced and even determined by his/her thinking (Clark & Peterson, 1986). This approach is known as the teacher cognition and decision-making research paradigm. Various forms of teacher self-reports of their mental activities are recorded and analyzed to determine preactive (before the lesson), interactive (during the lesson), and postactive (after the lesson) thoughts. A limited number of studies have described the interactive thoughts and decisions of physical education teachers during instruction in laboratory (DiCicco, Housner, & Sherman, 1981; Housner & Griffey, 1985; Taheri, 1982) or public school settings (Howell, 1987). In each of these studies, the lessons were videotaped. Upon completion of a lesson, the teacher viewed selected segments of the videotape to "stimulate-recall" of thought processes relevant to that phase of the class. The teachers' comments were then recorded, transcribed, and content analyzed to provide a description of interactive thoughts and decisions. Taken together, these studies indicated that expert physical education teachers focused most of their attention on student performance (Housner & Griffey, 1985; Howell, 1987), and made interactive decisions in response to these performance cues (Housner & Griffey, 1985). Conversely, preservice physical education teachers focused most of their attention on cues related to student interest, and made most interactive decisions in reaction to these cues (Housner & Griffey, 1985).

Research on the thought processes that underlie teachers' actions in the classrooms/gymnasium has increased our understanding
of pedagogical expertise. However, this line of research has been
criticized by a number of scholars (Leinhardt & Smith, 1985;
Peterson, 1988; Shulman, 1986) because it has ignored the
importance of teachers' subject matter knowledge during
instruction. It has focused almost exclusively on the cognitions
associated with the generic teaching skills and processes needed to
organize a lesson and to manage student behavior, at the expense of
the domain specific content that was taught. Similar criticisms
have been directed toward studies organized under the
process-product research paradigm.

In response to these criticisms, a number of investigators
have begun to examine the role of professional knowledge in
classroom teaching (Fennema, Carpenter & Peterson, in press;
Leinhardt & Smith, 1985; Peterson, 1988; Roehler, Duffy,
Herrmann, Conley, & Johnson, 1988; Shulman, 1986, 1988; Wilson,
Shulman, & Richert, 1987). This research has shown that classroom
teachers draw upon many components of knowledge as they conduct
lessons (Shulman, 1988; Wilson et al., 1987). Teachers' subject
matter knowledge (Leinhardt & Smith, 1985; Shulman, 1988) and
pedagogical content knowledge (Shulman, 1988; Carpenter, Fennema,
Peterson, Chiang, & Loef, in press; Fennema et al., in press) play
extremely important roles during classroom instruction. Despite
these advances, the role of teacher knowledge generally has not
been studied in the context of physical education instruction.

Expert-novice research outside the field of teaching has
conceptualized subject matter knowledge (declarative knowledge) as
a growing semantic network consisting of organized nodes and links (Chi, Glaser, & Rees, 1982). Nodes represent concepts, while links symbolize associations between concepts. If this framework is applied to instruction, one might speculate that a teacher who is an expert of subject matter has access to more and better organized domain specific content that can be incorporated in a lesson. Leinhardt and Smith (1985) argued that, "subject matter knowledge supports lesson structure and acts as a resource in the selection of examples, formulation of explanations, and demonstrations" (p. 247). Furthermore, these authors contended that subject matter knowledge constrains lesson structure and influences how a lesson is instructed.

Other evidence obtained from research on knowledge structure development of sport performers suggests that there is a connection between content knowledge, thinking, and decision-making (French & Thomas, 1987; McPherson, 1987). Findings from these studies revealed that experts with high levels of declarative knowledge tended to make higher quality decisions as they played basketball and tennis, respectively. If these findings are applicable to the context of teaching, this may explain why the expert physical education teachers in the Housner and Griffey (1985) study made most interactive decisions in response to student performance cues. Similarly, the inexperienced teachers in the same investigation may have focused on student interest cues because of limited knowledge in the content that was taught.

While these studies indicate that subject matter knowledge
plays an important role in classroom instruction, other research findings suggest that it is pedagogical content knowledge that most clearly distinguishes the content specialist from the expert classroom pedagogue (Shulman, 1987, 1988), or the novice classroom teacher from the skillful veteran (Gudmundsdottir & Shulman, 1987). Pedagogical content knowledge is a special understanding of content and pedagogy that enables teachers to transform their comprehension of content into representations, explanations, demonstrations, illustrations, and actions that can be easily understood by students of diverse ability levels. It emerges and develops as teachers experiment and struggle with ways to present subject matter to their students during instruction (Shulman, 1988). Minimally, pedagogical content knowledge consists of at least five understandings: "knowledge of alternative frameworks for thinking about teaching a particular subject; knowledge of student understanding and misconceptions of a subject; knowledge of curriculum; knowledge of particular content; and knowledge of topic-specific pedagogical strategies" (Shulman, 1988, p. 19).

In sum, evidence obtained from recent research on classroom teaching and expert-novice studies outside the field of education indicate that pedagogical content knowledge and subject matter knowledge perform vital roles during the preactive and interactive phases of instruction. Since physical education researchers have not focused on the role of teacher knowledge in their research paradigms, the relationship between these variables in the context of physical education instruction is not known. There is a need to
study the effects of subject matter knowledge and pedagogical content knowledge on the thoughts and decisions that determine teachers' pedagogical actions during physical education instruction.

The purpose of this study was to investigate the effects of subject matter knowledge and pedagogical content knowledge on the interactive thinking and decision-making of elementary school classroom teachers as they instructed a six-week unit of overhand throwing to kindergarten children. Additionally, this study explored the effects of these two categories of teacher knowledge on lesson objectives, the quality of practice, and the development of kindergarten children's overhand throwing during a unit of instruction. In this study, pedagogical content knowledge was defined as the understanding of content-specific instructional strategies that facilitate the learning/development of overhand throwing among young children.

Method

Subjects

Teachers. Elementary school principals and district supervisors in the Baton Rouge, Louisiana area were asked to nominate expert female kindergarten teachers who had a minimum of five years of professional experience. Volunteer subjects were sought from the nominated teachers. Each volunteer completed a questionnaire that assessed her physical education training and experience in overhand throwing. The responses to the questionnaire revealed that all of the teachers had no experience in overhand throwing. Two trained
observers used the Teacher Assessment and Development System-Meritorious Teacher Performance (MTP Form) (Performance Assessment Systems, Inc., 1984) to identify eight volunteer teachers who had well-managed classes and who could demonstrate relatively high generic teaching skill competence during a classroom academic lesson. The TADS-MTP Form is an instrument that assesses 82 teaching skills that are organized under four broad categories: knowledge of subject matter, techniques of instruction, classroom management, and teacher-student relationships. The TADS (MTP Form) has been shown to be a valid and reliable instrument for differentiating meritorious teachers nominated by professional colleagues from a random sample of teachers (Ellett and Capie, 1985). Since the five teaching skills organized within the knowledge of subject matter category are content-specific rather than generic in nature, they were excluded from the analysis. A score of 65 or better on the remaining 77 item instrument was set as a criterion ranking for generic teaching skill expertise.

Prior to the generic teaching skill assessments, both observers completed a 40-hour university course and a three-hour review session, both of which focused on the TADS-MTP scoring procedures. After completing the scoring procedure training, both observers visited a teacher on the same occasion to assess her teaching during a period of classroom academic instruction. Three teachers were observed and assessed in this fashion. After each lesson, interobserver agreement checks were conducted. The degree of interobserver agreement was calculated by dividing the number of
agreements by the sum of agreements and disagreements, and then multiplying the resulting fraction by 100. Since an overall agreement of 85% was achieved for each of the broad categories (techniques of instruction, classroom management, teacher-student relationships) during the three lessons, the other five teachers were assessed by one of the trained observers.

These procedures continued until eight teachers with no overhand throwing experience and high generic teaching competence (65 or higher on the shortened version of the TADS-MTP) were identified. One volunteer teacher was eliminated from the study because of a low TADS-MTP generic teaching skill assessment score, while another subject was excluded because she had less than five years of professional experience. The TADS-MTP scores (shortened version) for the eight teachers participating in the study ranged from 68 to 74 (M=71.38). Four of the teachers were randomly assigned to an experimental (knowledge trained) group. The other four teachers represented the comparison (not knowledge trained) group. Informed consent was obtained from the eight teachers.

The relatively small number of teachers that were studied was desirable because it enabled the researcher to conduct very intense interviews and to analyze the data of individual subjects in detail. The use of small groups of subjects is common in the teacher cognition and knowledge assessment literature. Detailed qualitative descriptions of teacher thoughts, decisions, and underlying knowledge concepts are needed in order to reveal patterns which emerge from the data.
Students. The children enrolled in the eight teachers' intact kindergarten classes made up the student subject pool. The children taught by the experimental and comparison teachers represented the experimental and comparison students, respectively. Parental permission forms were received for all of the students.

General Procedures

Generally, the eight teachers instructed a six-week overhand throwing unit to their intact kindergarten classes. Prior to the unit all of the teachers were provided with identical supplies and equipment. These included beanbags, dead tennis balls, and newspaper balls (one of each for each child in their classes), two rubber playground balls, and two 4 x 3 foot cartoon targets. They could use any other supplies and equipment to instruct the lessons. Three of the five weekly lessons focused on the development of overhand throwing. To preserve a balanced curriculum, the teachers instructed activities other than throwing on the other two days. Lesson plans were monitored to ensure that the teachers followed this weekly schedule.

Teacher Training

Before the unit started, each of the teachers participated in three training sessions totaling four hours. The major focus of the training sessions differed for the experimental and comparison teachers. The four experimental teachers were exposed to information/instruction designed to develop their knowledge of subject matter and of content-specific strategies to teach overhand throwing. The subject matter knowledge training emphasized the
facts, concepts, and current research literature related to overhand throwing form and development. A videotape training package was employed to develop teacher expertise in identifying the stages of overhand throwing. The instructional strategies stressed techniques to encourage children to step with the opposite foot, rotate the body, whip the arm, and to lag the forearm. Additionally, the experimental teachers were introduced to techniques to maximize student engagement time, and were provided with a written booklet of individual and group throwing and catching activities (including games) that were xeroxed from a number of elementary school physical education methods books.

The four comparison teachers were introduced to the same engagement time techniques that were presented to the experimental group and were provided the booklet consisting of xeroxed pages from elementary physical education books. The latter materials were provided to ensure that all of the teachers had equal access to elementary physical education books that are typically available to public school classroom teachers. They were not provided with any information about throwing form and development, nor overhand throwing specific instructional strategies. Considerable time was spent emphasizing the need for maximizing time in student practice.

Teacher Knowledge Assessments

The experimental and comparison teachers were administered overhand throwing knowledge assessments prior to and after the throwing unit. As a check for knowledge training retention, the experimental teachers also took part in an additional assessment at
the halfway point of the unit.

For the beginning of the unit knowledge assessment, the eight teachers were shown six immature throwers on videotape and asked: "Do you have any thoughts about this child as a thrower?" and, "If you observed him/her in your physical education class what statements would you make to him/her, if any?". The statements were audiotaped, transcribed, and later content analyzed and coded by two trained independent coders with extensive baseball experience. An overall knowledge score for each teacher was obtained by counting the number of references the teacher made to immature throwing actions, developmental stages, and instructional procedures that facilitate overhand throwing development. Intercoder agreement for identifying the knowledge concepts that were revealed by the teachers exceeded 95 percent. The disagreements were later discussed and jointly resolved by the two coders.

The middle of the unit knowledge assessment employed the same procedures as the initial assessment except the teachers viewed and analyzed three rather than six immature videotaped throwers. The end of the unit knowledge assessment was identical to the one administered at the beginning of the unit except that two additional questions were asked: "Think about some of the children in your class who in your opinion are good/mature throwers. Can you describe what makes their overhand throws efficient?" and; "Think about some of the children in your class who in your opinion are extremely immature throwers. Can you describe what makes their overhand throws not as efficient?". Teacher statements that made specific reference
to developmental foot, pelvic-spine, and/or arm actions represented
evidence of teacher knowledge of overhand throwing. Again,
intercoder agreement exceeded 95 percent on both parts of the end of
the unit knowledge assessment, and disagreements were resolved by
discussion.

Class Filming and Stimulated Recall Interview Procedures

During the unit, the teachers were videotaped on three occasions
as they presented overhand throwing lessons. Each teacher was filmed
once every two weeks. After completing a filmed lesson, the teacher
participated in a stimulated recall interview. All of the interviews
were conducted within 4 hours of the throwing lessons.

Each subject was shown the lesson and was instructed to stop the
tape at any point she recalled thoughts or decisions. Additionally,
the researcher stopped the tape: 1) when the teacher shifted
activities in which the pupils were engaged, 2) when the teacher
provided individual assistance to a student who was practicing
throwing activities and, 3) when a critical incident occurred that
affected the flow of the lesson. Each time the tape was stopped a
series of pre-planned probe questions were asked. The questions
were: 1) "What were you thinking at that point?", 2) "What were you
noticing?", 3) "Was there anything else you thought of doing at that
point but decided against?" and, 4) "What was it?". The teachers' responses were audiotaped and transcribed verbatim. At the end of
the interview session, each teacher was asked one additional
question: "What were your primary objectives in this lesson?".

An adaptation of the instrument of teacher thinking developed in
the South Bay Study (McNair, & Joyce, 1979; Morine-Dershimer, 1979) and later used by Lee, Walkwitz, & Carter (1989) and Nelson (1988) was employed to code the teacher thoughts and decisions. The classification system was revised so that the overhand throwing related concepts that were nested within each teacher's thoughts and decisions could be documented. Procedures used to revise the preliminary system included several steps. First, several transcriptions were analyzed separately by two researchers using the system. Results were shared and appropriate revisions were made. After several revisions, the major categories and subcategories were defined and rules for inclusion were established.

The instrument contains four major categories: decisions, concerns, information sources, and awareness. The first category defines teacher decisions according to whether they were made as a result of pupil behavior or lesson planning. Teacher concerns relate to pupil psychomotor skill learning (e.g., throwing form, accuracy, general performance), pupil behaviors (e.g., attitude/feelings, understanding of directions, conduct/attention), and procedural matters (e.g., instruction, organization, or management/discipline related). Information source refers to the cues that guide teacher thinking and decision-making. These are subclassified into observing skill performance (e.g., form, outcome/accuracy, general performance) or student behavior, and focusing on non-observational cues as they relate to skill performance or pupil behavior (verbal/auditory, teacher hunch/recall). The awareness category encompasses teacher consciousness of student interest/participation, personal feelings,
principles of teaching/classroom academics, and alternative instructional strategies.

Analysis of each protocol was done by segments and required several readings. First the entire transcription was read to get a general idea of the subject's thoughts. During the second reading, the researcher identified the overhand throwing knowledge concepts that were interspersed within the teacher thoughts. With the third reading, the researcher identified and categorized the teacher concerns, information sources, and awareness levels. Next, the decisions were identified and classified as pupil or plan related. Finally, the number of instructional procedures carried out in response to cues and/or concerns about overhand throwing developmental body components were recorded.

Prior to the actual analysis, interrater agreement was established. Two coders independently coded five interviews. Interrater agreement for all of the interviews was .86, and ranged from .85 to .88 for the four broad categories. Agreement for the 21 individual items ranged from .80 to 1.00. Total intrarater agreement for the codings was .98. Interrater agreement for identifying the four categories of knowledge concepts within the interactive thoughts was .98.

Quality of Practice Trials Assessment

Two trained coders who had previously established 90 percent intercoder agreement employed slow motion/stop action techniques to analyze a 3.5 minute segment from each half of the three lessons that were videotaped of each teacher for the stimulated recall interviews.
The number of practice trials that the children demonstrated opposite foot action (stage 3 or higher) were recorded. All other throwing trials were rated as either immature (stages 1 or 2), or as uncodable. The percentage of the codable throws that exhibited opposition was calculated for each of the eight teachers.

**Overhand Throwing Testing**

The overhand throwing test involved a beanbag throw for distance and a developmental stage assessment. The best throw out of three attempts was measured to the nearest half foot. With the stage assessment, each child was videotaped as he/she threw 10 used tennis balls against a wall 20 feet away. The child was told to "throw hard" and to "crash the wall" with the ball.

Stop action, normal speed, and slow motion analyses of the 10 throws were conducted by two independent coders who had extensive baseball experience. Ninety percent intercoder agreement was established during a thirty hour training program. Each of the three body components was rated on a five point scale using the developmental stage scoring instrument (Moser & Shutz, 1983) shown in Table 1. The overall score for each component was obtained by calculating a mean for the ratings across the 10 throws. Intercoder agreement checks were repeated each time the coders completed rating

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A class of approximately 20 throwers. Ninety percent agreement was maintained throughout the ratings.
Analysis of Data

The data collected from the teachers and students (e.g., lesson objectives, interactive thoughts and decisions, quality of practice trials, and throwing performance scores) were analyzed in order to describe the effects of teacher knowledge. The lesson objectives were content analyzed in order to identify the overhand throwing developmental concepts that the teachers cited in their instructional goals. The frequencies and percentages of interactive thoughts/decisions and overhand throwing concepts revealed by the experimental and comparison teachers during the stimulated recall interviews were contrasted and described. Similarly, comparisons were made in the quality of the practice trials and the overhand throwing performances that were demonstrated by the students enrolled in the knowledge trained and knowledge deficient teachers' classes.

Results and Discussion

The findings are presented and discussed in five sections. The sections deal with the acquisition and retention of teacher knowledge, lesson objectives, interactive thinking and decision making, the quality of practice trials, and student overhand throwing performance, respectively. Two additional sections summarize the results and discuss the implications of the findings for teacher education, teaching/learning, and future research.

Acquisition and Retention of Teacher Knowledge

Table 2 summarizes the beginning, middle, and end of the unit
knowledge assessment scores. The scores represent the number of immature developmental body actions, stages, and appropriate content-specific instructional strategies that the teachers identified as they analyzed the videotaped throwers. Taken together, the results indicated that the knowledge trained teachers possessed more subject matter knowledge and pedagogical content knowledge of overhand throwing than the four teachers in the comparison group. This knowledge superiority was maintained over the entire unit.

The supplemental two question knowledge assessment that was administered at the end of the unit further documented what the teachers knew about throwing. When asked to describe what makes an overhand throw efficient (mature) or inefficient (immature), all of the knowledge trained teachers cited the appearance or absence of opposite foot stepping, pelvic-spine rotation, and at least two of the following arm actions: a whiplike/forceful throw, cocking the arm back, lagging the forearm, and following through toward the target area. In contrast, the four teachers who were not knowledge trained never mentioned oppositional foot stepping nor pelvic-spine rotation, and only one of them was aware of the desirability of forceful and whiplike throwing, and cocking the arm back.

Lesson Objectives

The knowledge trained teachers stated lesson objectives that referred specifically to the development of opposite foot stepping,
body rotation, efficient arm action (cocked back, follow through), force production, and throwing accuracy. The following are typical of the objectives that were provided: "I was trying to get the kids to focus in on a target using the things we had gone over about the step-throw, the twisting, and the throwing hard" and; "I wanted the children to try to throw 40 balls apiece, take a good step as they threw, and to throw hard".

The teachers who were not knowledge trained provided objectives that emphasized general improvement in overhand throwing and accuracy in hitting targets. They never referred to specific developmental body actions, and only one of the twelve lesson objectives specified force production. The accompanying examples are representative of the objectives that were provided: "My objective was to have them overhand throw"; "The primary objective in this lesson was to give the children additional practice using beanbags and using the technique of the overhand throw". She did not describe the technique that was involved. To the four knowledge deficient teachers, overhand throwing technique generally meant an overhead arm action as opposed to an underhand or sidearm arm movement.

Interactive Thinking and Decision Making

Table 3 presents the frequencies and percentages of interactive thoughts and decisions that were produced by the high and low knowledge teacher groups. To control for differences in the length

Insert Table 3 about here
of the lessons, percentages were largely used in the analysis and discussion.

Similarities between the knowledge trained and comparison teachers were observed in the categories of thoughts related to concerns about student attitude/feelings, understanding directions, and pupil behavior/attention; to procedures dealing with organizing and managing students; to cues focusing on student behavior; and to awarenesses of student interest/participation, personal feelings, and classroom academic concepts (e.g., addition, spelling). Since these categories of thoughts were not directly related to the instruction of overhand throwing subject matter, these similarities were expected.

The most dominant differences between the two groups dealt with teacher concerns about student overhand throwing performance (categories 3 through 5), and the cues that the teachers focused on as they observed throws (categories 12 through 14). The knowledge trained teachers frequently expressed concerns about and focused on observational cues related to overhand throwing form (categories 3 and 12, respectively). They did this by referring to the absence or appearance of opposite foot stepping, body rotation, and a whiplike arm action. The following are typical examples: "She wasn't twisting, she wasn't throwing hard, she was just pushing the beanbag right in front of her" and; "She was throwing with the feet planted together and she wasn't stepping". Similar cues were attended to during the observation of throwing performances that the teachers judged as desirable (category 12). The statements of the knowledge
trained teachers reflected a familiarity with the developmental body actions that determine mature/efficient overhand throwing: "She was rotating, pulling her arm back, and throwing hard" and; "He stepped out and he actually had a follow through". The knowledgeable teachers also demonstrated a moderate degree of concern for and skill observation interest in throwing accuracy (categories 4 and 13, respectively). However, these concerns and cues were often accompanied by an interest in developmental throwing form and/or throwing forcefully. The following are representative statements: "She stepped that time but she was still throwing it straight down" and; "She was snapping/throwing the ball down and just bending at the waist instead of rotating".

The knowledge deficient teachers were highly concerned with and frequently focused on observational cues related to throwing accuracy (categories 4 and 13), but without an accompanying emphasis on throwing forcefully. The following narrative was typical: "Some of them were throwing it a little wild especially the girls. It seemed like the girls were having a harder time hitting the target". Accuracy related cues were also emphasized during the observation of desirable throws: "He did a good job. He hit the target both times".

The low knowledge teachers rarely focused on specific cues or expressed concerns about the developmental body actions associated with mature/immature overhand throwing form. As shown in the following examples, they were cognizant of student throwing performance in a very general/vague manner (categories 5 and 14): "He threw it but didn't do it correctly"; "This child is throwing
sidearm instead of overhand"; "She's got her leg up in the air, she's all out of balance, her pivot point is off, and everything. She's like a ballerina dancer"; Todd was throwing with the left hand and he was a right handed child" and; "I like the way she extended her arm and threw it up like an arch".

Table 4 summarizes the overhand throwing knowledge concepts that were nested within the stimulated recall interview responses of the two groups of teachers. Among the knowledge trained teachers, 388 concepts were distributed within 259 (59.54%) of the 435 interview segments. The concepts encompassed all three of the developmental body action components, and included references to force production and to the stages of development. In contrast, the four knowledge deficient teachers elicited 17 concepts that were distributed across 15 (4.65%) of the 366 interview segments. Fifteen of these knowledge related facts were obtained from two of the teachers, and were largely limited to arm action and force production. Also, note that the knowledge trained teachers experienced 74 more questioning segments during their 12 stimulated recall interviews than the knowledge deficient teachers. Since they possessed greater knowledge of overhand throwing, they more frequently stopped the tape to make comments about skill performance.

Taken together, subject matter knowledge and pedagogical content
knowledge had a substantial impact on teacher thinking. In addition to influencing the types of skill related concerns that the teachers expressed and the observational cues that they focused on, knowledge affected the quality of their decisions (categories 1 and 2) and their learning related instructional strategies (category 9). A discussion of the latter three categories follows.

As shown in Table 3, both groups of teachers made more pupil related decisions (category 1) than plan related decisions (category 2). While the relative frequencies and percentages of these decision types were similar for the high and low knowledge teacher groups, distinct differences were observed in the knowledge ideas underlying the decisions. Of the 327 pupil related decisions that were made by the knowledgeable teachers, 206 (63%) of them were accompanied by overhand throwing knowledge concepts. Twenty-three (35.38%) of the 65 plan related decisions consisted of underlying facts. Among the knowledge deficient teachers, only 12 (5.28%) of the 265 pupil-related decisions were composed of overhand throwing developmental facts. None of their 76 plan related decisions consisted of knowledge concepts. Taken together, these findings suggest that knowledge of subject matter and pedagogical content knowledge increase the potential for sound professional decision making during the conduct of overhand throwing lessons. The knowledgeable teachers in this investigation based many of their decisions on their understandings of these knowledge types.

A related analysis supports the decision making findings. While both teacher groups frequently expressed concern for learning related
instructional procedures (refer to category 9, Table 3), the knowledgeable teachers were 11 times more likely to implement teaching strategies that were directed toward specific developmental body actions. Seventy-six percent (238) of the 300 instructional procedure concerns that were revealed by the high knowledge teachers were accompanied by concerns and/or cues related to foot stepping, body rotation, and/or forceful/whipping arm action. The following are representative examples: "She was throwing with the left hand but stepping with the left foot, so I was showing her to step on the right foot"; "He wasn't getting the twisting motion, so I'm trying to get him to twist" and; "She was just tossing it, kind of pushing it, so...I actually took her hand and showed her how it felt to throw real hard. I was pushing her hand forward".

Comparatively, only 16 (6.90%) of the 232 instructional procedure concerns that were cited by the knowledge deficient teachers were initiated or accompanied by developmental body action concerns/cues. As revealed in direct quotes from the interview responses, this group of teachers had an extremely limited understanding of content specific strategies to facilitate overhand throwing development: "She was aiming too high so I was trying to tell her that she needed to aim her toss down a little lower"; "I saw one child who did not throw overhand (so I) was just reminding them that they had to throw overhand" and; "I noticed that he was throwing too hard. He always throws like he's trying to break the target. So I said that's too hard, you don't always have to throw that hard". The latter statement reflects a lack of knowledge of the desirability
of forceful throwing to facilitate overhand throwing development.

Quality of Practice Trials

Table 5 summarizes the quality of the practice trials of the experimental and control classes using frequency of opposite foot action as the criterion. Although both groups experienced a similar number of throws, a substantially higher percentage of the throws observed during the lessons taught by the knowledge trained teachers showed opposition when compared to the lessons instructed by the knowledge deficient teachers. This finding was consistent across the lessons conducted during the second, fourth, and sixth weeks of the unit. Each experimental group class averaged 8.06 opposite foot throws per minute, while each control group class averaged 3.06 oppositional throws/minute. Assuming that these rates were consistent across the 18 lesson throwing unit, it is estimated that the four classes headed by the knowledgeable teachers experienced approximately 2900 opposite foot throws, while the students taught by the four knowledge deficient teachers experienced approximately 1100 oppositional throws. The knowledgeable teachers were better able to structure the learning activities so that their pupils practiced higher quality throws.

Student Overhand Throwing Performance

In order to determine the effects of teacher knowledge on the overhand throwing development of the 75 boys and 75 girls over the
course of the unit, a 2 x 2 x 2 (knowledge status of the teacher groups x student gender x time of skill assessment) multivariate mixed model repeated measures MANOVA analysis (Schutz and Gessaroli, 1987) with time being the repeated factor was performed on the four throwing measures. Student gender was included in the analysis because research suggests that biological variables contribute to overhand throwing developmental differences between young boys and girls (Thomas & French, 1985). The Wilk's Criterion values obtained from the RM MANOVA analysis indicated significant main effects for teacher knowledge, $F(4,143)=4.71, p<.01$, student gender, $F(4,143)=36.44, p<.0001$, and time (pre vs post) of the skill assessment, $F(4,143)=24.69, p<.0001$. The interaction effects for knowledge x gender, $F(4,143)=2.95, p<.05$, time x knowledge, $F(4,143)=23.16, p<.0001$, time x gender, $F(4,143)=8.36, p<.0001$, and time x knowledge x gender, $F(4,143)=7.62, p<.0001$, were also significant. Post hoc univariate RM ANOVA analysis of the significant MMM RM MANOVA effects revealed a number of significant main effects and interactions (refer to Table 6). To facilitate the interpretation of the findings, the significant interactions were plotted and post-hoc Bonferroni analyses were employed. Figures 1, 2, 3, and 4 graphically illustrate the mean average pretest and posttest overhand throwing performance scores.
The boys demonstrated higher scores than the girls on all four of the pretest throwing performance measures. It is not known whether these initial differences were attributed to heredity, previous practice opportunities, environmental influences, or a combination of these and other factors.

The influence of teacher knowledge on distance throwing performance was not clear-cut (Figure 1). The girls that received instruction from the knowledgeable teachers achieved greater distance throwing performance gains than the girls who were taught by the comparison teachers. However, even with instruction the experimental girls did not throw as far as either of the two groups of boys. In contrast, the boys who were taught by the knowledge trained teachers did not improve any more than the comparison group of boys. The slopes of their distance throwing performance line plots were alike, and the between group differences on the pretests and the posttests stayed the same. One can only speculate whether the girls were better learners than the boys, or if the knowledge treatment had a greater effect on children who started the unit at lower performance levels.

For foot action (Figure 2), teacher knowledge had a positive impact on opposite foot stepping with the development being much more pronounced among the girls than the boys. The experimental boys improved the equivalent of a half a developmental stage from pretest
to posttest, while the girls showed a performance gain of nearly two stages. By the end of the six week unit, the boys and girls who were taught by the knowledgeable teachers exhibited similar foot maturity levels. In contrast, the knowledge deficient teachers did not produce any significant improvement in foot action.

The greater foot action performance gains demonstrated by the experimental girls when compared to the boys might suggest that they were better learners than their male counterparts. On the other hand, the performance gain differences were expected because a greater number of the girls were either stepping with the same foot (stage 2) or not stepping at all (stage 1) prior to the unit. It would seem that getting children to step with the opposite foot would be easier than instructing them to rotate the body in a differentiated fashion, or to whip the arm/lag the forearm in one action.

With the pelvic-spine component, the children taught by the knowledge trained teachers achieved significant improvement during the throwing unit (Figure 3). The gains tended to be greater for the girls than the boys. Again, the latter finding might be expected because the girls generally began the unit at a lower floor level. Since a greater number of the boys were rotating their bodies initially (stage 3 and higher), they were more prone to an upper limit ceiling effect when they were rated at the end of the throwing unit. The greater pelvic-spine learning demonstrated by the girls may also be partly related to the foot action performance changes described earlier. Block rotation (stage 4) and differentiated body
rotation (stage 5) cannot occur in the absence of opposite foot stepping. As a child begins to step with the opposite foot, he/she is in a better position where body rotation can occur. In many instances, once oppositional foot stepping is learned some degree of body rotation will occur automatically. Thus, it is reasonable to assume that part of the body rotation gains that were shown by the experimental girls were attributed to their development of opposite foot stepping.

As shown in Figure 4, the knowledgeable teachers were successful in encouraging children to develop more efficient arm actions. Comparatively, the children taught by the knowledge deficient teachers demonstrated no significant gains during the six week unit. These findings were consistent regardless of student gender. While the girls instructed by the knowledgeable teachers showed arm action development that was similar in magnitude to the boys, their average performance at the end of the unit did not surpass the levels demonstrated by either the experimental or control boys prior to the unit.

Summary

Taken together, teachers' knowledge of subject matter and of content-specific instructional strategies facilitated the development of the body actions that contribute to efficient/mature overhand throwing. While boys and girls of various ability levels benefited from the knowledgeable teachers' instruction, the most pronounced developmental gains were achieved by female students who possessed lower skill prior to the unit.
The findings from this study are in agreement with classroom research which reported that teachers' subject matter knowledge and pedagogical content knowledge play central roles during instruction (Carpenter et al., in press; Fennema et al., in press; Leinhardt and Smith, 1985; Shulman, 1988). The wisdom that was acquired during the training sessions influenced the teachers' lesson objectives, and impacted their thinking, decision-making, and pedagogical actions in a positive manner. This enabled them to make higher quality decisions. This parallels the findings of expert-novice studies outside the field of education which showed a relationship between declarative knowledge and expertise in decision making (French & Thomas, 1987; McPherson, 1987). Sound professional decision making combined with instructional procedures and strategies which focused on specific developmental body components (foot, pelvic-spine, and arm actions) enabled the knowledgeable teachers to conduct lessons where the students were engaged in a high number of correct practice trials, which in turn facilitated overhand throwing development/learning. While the knowledge deficient teachers also possessed excellent generic teaching skills and could manage children in a learning environment, their lack of knowledge failed to positively affect the quality of their lesson objectives, interactive thoughts/decisions, and pedagogical actions. This resulted in poorer quality practice trials and reduced the potential for overhand throwing development/learning.

The overall results support the view that formal physical education instruction in public school settings under the direction
of knowledgeable teachers does make a difference. While past research indicated that instruction can accelerate overhand throwing development in laboratory settings (Dusenberry, 1952; Glassow et al., 1965; Halverson & Roberton, 1978; Hanson, 1961), the present study demonstrated that similar gains can be achieved by competent physical education teachers in the public schools.

Implications

The findings of this investigation have implications for teacher education, teaching/learning, and future research. The implications are discussed under these three headings.

Teacher Education. The results of this study suggest that we may have to rethink how we prepare teachers of elementary school physical education. The comparison teachers all completed an elementary physical education methods course during their undergraduate teacher education training, and taught physical education to their regular classroom classes for several years. Despite this training and experience, they were not successful in teaching the overhand throwing skill. Their lack of knowledge of throwing, of motor development, and of throwing-specific teaching strategies resulted in ineffective instruction.

Perhaps the content of the methods courses that we provide to preservice teachers should be more than one-semester surveys of movement experiences, rhythmic activities, stunts/tumbling, games, and sports skills. The coursework could possibly put more emphasis on the development of in-depth understandings of content (e.g., throwing, catching, the basic locomotor and nonlocomotor movements),
and of content-specific strategies to teach skills. Prospective teachers might be introduced to the facts, concepts, and current research literature related to the development of specific skills. Perhaps they could be taught to recognize efficient/inefficient body actions, to identify the stages of development, to understand the learning problems and misconceptions that students commonly experience as they practice a skill, and to analyze videotapes of children performing skills. Finally, it might be beneficial if we exposed teachers to a variety of alternative approaches that are appropriate for instructing specific skills to children of different skill levels (feedback cues, strategies, explanations), and introduced them to the curricular materials that are available to implement these approaches.

Teaching and learning. Most of the current elementary physical education books and curriculum guides advocate exposing young children to a broad range of activities. The results of this study suggest that it takes much more practice than is normally provided in the public schools to facilitate significant overhand throwing development. If future research replicates this finding with throwing and other basic skills, curriculum planners may have to consider the merit of providing more intense instruction over a narrower range of movement activities.

The gender-related, overhand throwing performance differences that have been reported in the motor development literature were demonstrated on each of the four overhand throwing pretest measures. What was significant however was that these developmental differences
were not independent of instructional intervention. The girls who received instruction from the knowledgeable teachers caught up to the boys on the foot action posttest performance measure. They also closed the gap developmentally on the pelvic-spine component. The findings suggest that with the right type of instructional interventions, many of the so-called gender performance differences can be overcome, or perhaps significantly reduced.

**Future Research.** This investigation was significant because it empirically demonstrated a link between teacher knowledge, teacher thinking/instruction, quality of students' skill practice, and students' psychomotor skill development. These findings should encourage other investigators to pay closer attention to the subject matter competence of physical education teachers in their research designs.

A number of related topics are worthy of future empirical study. Specifically, we need to describe the influence of knowledge on lesson planning, skill feedback, and the use of demonstrations during instruction. We might further explore the impact of teacher knowledge on lesson objectives, and on the teacher thinking/decision making that occurs during the instruction of more complex skills. Case studies of individual teachers who possess high levels of subject matter competence in specific sports could be conducted in order to identify patterns of teacher behavior that are common across content areas. A similar case study approach could be employed to contrast knowledgeable and less knowledgeable teachers.

Further work is needed to determine the impact of teacher
knowledge on student psychomotor skill learning. These studies should include a true control group of children. This will enable the researcher to compare the performances of the experimental and comparison groups with students who receive no instruction (no treatment). In this way, the investigator can determine how much change occurred beyond normal growth and development. There is also a need to investigate the differential impact of knowledge-based instruction on children of different developmental/skill levels. Another possible research focus would involve interviewing students at the end of the instructional unit to determine if they acquired knowledge understandings from their teachers, regardless of whether or not they demonstrated psychomotor skill gains.
References


Table 1

Overhand Throwing Developmental Stage Scoring Instrument

<table>
<thead>
<tr>
<th>Score</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feet parallel and unmoving during throw.</td>
</tr>
<tr>
<td>2</td>
<td>Ipsilateral pattern - same foot forward as throwing arm.</td>
</tr>
<tr>
<td>3</td>
<td>Proper foot placement - foot opposite to throwing arm is placed forward (one foot length minimum).</td>
</tr>
<tr>
<td>4</td>
<td>Slight forward step with proper foot to give added force to the throw (one foot length minimum).</td>
</tr>
<tr>
<td>5</td>
<td>Strides well forward with proper foot allowing for full rotation of the hips and providing for full weight transfer.</td>
</tr>
</tbody>
</table>

Body rotation

<table>
<thead>
<tr>
<th>Score</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No trunk action.</td>
</tr>
<tr>
<td>2</td>
<td>Trunk flexion - the trunk action accompanies the forward thrust of the arm by flexing at the hips.</td>
</tr>
<tr>
<td>3</td>
<td>Spinal rotation with little or no pelvic rotation - the upper spine twists away (45 degrees or more) while the feet and pelvis remain essentially fixed; facing line of flight.</td>
</tr>
<tr>
<td>4</td>
<td>Block rotation - spine and pelvis both rotate away from the line of flight (90 degrees rotation), then simultaneously begin forward rotation.</td>
</tr>
</tbody>
</table>
Table 1 cont'd

<table>
<thead>
<tr>
<th>Score</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No evidence of overarm throwing pattern.</td>
</tr>
<tr>
<td>2</td>
<td>Slight retraction of arm with the throwing hand initiating forward movement from a position even with or very slightly behind the ear, elbow well flexed.</td>
</tr>
<tr>
<td>3</td>
<td>Preparatory phase shows evidence of greater retraction of throwing arm (e.g., &quot;wind-up&quot; evident where ball is cocked well behind the body, rather than close to the head. Ball is &quot;pushed&quot; toward target area as a result of horizontally adducting the arm until the elbow is approximately in front of the shoulder before the forearm is extended.</td>
</tr>
<tr>
<td>4</td>
<td>Forearm flung forward in &quot;whipping&quot; rather than &quot;pushing&quot; fashion; forearm close to full extension at time of release.</td>
</tr>
<tr>
<td>5</td>
<td>As in 4 above, with the addition of &quot;forearm lag&quot;; forearm and ball appear to lag (e.g., to remain almost stationary behind the body as the shoulders move toward front facing).</td>
</tr>
</tbody>
</table>
### Table 2
**Beginning, Middle, and End of the Unit Overhand Throwing Knowledge Scores for the Knowledge Trained and Comparison Teacher Groups**

<table>
<thead>
<tr>
<th>Teacher group and time of assessment</th>
<th>Knowledge Trained</th>
<th>Knowledge Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beginning</td>
<td>Beginning</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature stages</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td>Instructional strategies</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Total score</td>
<td>48</td>
<td>8</td>
</tr>
<tr>
<td>(Maximum possible)</td>
<td>153</td>
<td>14</td>
</tr>
<tr>
<td>Actions</td>
<td>157</td>
<td>9</td>
</tr>
<tr>
<td>(216)</td>
<td>(216)</td>
<td>(216)</td>
</tr>
</tbody>
</table>

*Note: The middle of the unit knowledge assessment involved the analysis of three rather than six videotaped throwers.*
Table 3
Frequencies and Percentages of Interactive Thoughts for the Knowledgeable and Knowledge Deficient Teachers

<table>
<thead>
<tr>
<th>Categories of thoughts</th>
<th>Knowledgeable Teachers</th>
<th>Knowledge Deficient Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td><strong>Decisions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*1) Pupil-related</td>
<td>327</td>
<td>83.4</td>
</tr>
<tr>
<td>*2) Plan-related</td>
<td>65</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>392</td>
<td>20.7</td>
</tr>
<tr>
<td><strong>Concerns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*3) Pup learn-skill(form)</td>
<td>213</td>
<td>25.5</td>
</tr>
<tr>
<td>*4) Pup learn-skill (outc/acc)</td>
<td>103</td>
<td>12.3</td>
</tr>
<tr>
<td>*5) Pup learn-skill (general)</td>
<td>19</td>
<td>2.3</td>
</tr>
<tr>
<td>6) Pup attit/mood/feelings</td>
<td>53</td>
<td>6.3</td>
</tr>
<tr>
<td>7) Pup unders direction/rout</td>
<td>9</td>
<td>1.1</td>
</tr>
<tr>
<td>8) Pup behav/atten/partic</td>
<td>39</td>
<td>4.7</td>
</tr>
<tr>
<td>*9) Proced-instruct(learning)</td>
<td>300</td>
<td>35.9</td>
</tr>
<tr>
<td>10) Proced-organiz/equip/facil</td>
<td>73</td>
<td>8.7</td>
</tr>
<tr>
<td>11) Proced-management</td>
<td>27</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>836</td>
<td>44.1</td>
</tr>
</tbody>
</table>

*Represent differences which are discussed in the narrative.
<table>
<thead>
<tr>
<th>Information Source</th>
<th>n</th>
<th>%</th>
<th>(Sub%)</th>
<th>n</th>
<th>%</th>
<th>(Sub%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*(12) Observ-skill perf (form)</td>
<td>217</td>
<td>38.2</td>
<td>14</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*(13) Observ-skill perf (accur)</td>
<td>122</td>
<td>21.5</td>
<td>177</td>
<td>42.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*(14) Observ-skill perf (gen)</td>
<td>27</td>
<td>4.8</td>
<td>78</td>
<td>18.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15) Other sources-skill perf</td>
<td>84</td>
<td>14.8</td>
<td>42</td>
<td>10.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(16) Observ-non skill learning</td>
<td>88</td>
<td>15.5</td>
<td>94</td>
<td>20.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17) Other sources-non skill</td>
<td>30</td>
<td>5.3</td>
<td>20</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>568</td>
<td>30.0</td>
<td>415</td>
<td>29.3</td>
<td></td>
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<table>
<thead>
<tr>
<th>Awareness</th>
<th>n</th>
<th>%</th>
<th></th>
<th>n</th>
<th>%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(18) Stud interest/partic</td>
<td>39</td>
<td>39.8</td>
<td></td>
<td>28</td>
<td>33.7</td>
<td></td>
</tr>
<tr>
<td>(19) Teacher feelings</td>
<td>35</td>
<td>35.7</td>
<td></td>
<td>29</td>
<td>34.9</td>
<td></td>
</tr>
<tr>
<td>(20) Prin of teach/academics</td>
<td>11</td>
<td>11.2</td>
<td></td>
<td>12</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>(21) Alternatives</td>
<td>13</td>
<td>13.3</td>
<td></td>
<td>14</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>98</td>
<td>5.2</td>
<td></td>
<td>83</td>
<td>5.9</td>
<td></td>
</tr>
</tbody>
</table>

*Represent differences which are discussed in the narrative.
<table>
<thead>
<tr>
<th>Actions/Knowledge Concepts</th>
<th>High Knowledge Teachers</th>
<th>Knowledge Deficient Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg/foot action</td>
<td>144</td>
<td>0</td>
</tr>
<tr>
<td>(opposite foot stepping)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelvic/spine action</td>
<td>54</td>
<td>2</td>
</tr>
<tr>
<td>(differentiated rotation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm shoulder action</td>
<td>74</td>
<td>9</td>
</tr>
<tr>
<td>(cocked back, whiplike, lag,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and follow-through)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force production</td>
<td>90</td>
<td>6</td>
</tr>
<tr>
<td>(throws hard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous concepts</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>(identification of stages, content specific drills, and other research findings)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>388</td>
<td>17</td>
</tr>
</tbody>
</table>
Table 5

Number and Percentage of Practice Trials Exhibiting Opposite Foot Action During the Lessons Taught by the Knowledgeable and Knowledge Deficient Teachers

<table>
<thead>
<tr>
<th>Lesson A</th>
<th>Lesson B</th>
<th>Lesson C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Opposite foot</td>
<td>244</td>
<td>83.56</td>
<td>212</td>
</tr>
<tr>
<td>No opposite foot</td>
<td>48</td>
<td>16.44</td>
<td>38</td>
</tr>
</tbody>
</table>

Knowledge Deficient Teachers' Classes

| Opposite foot | 65     | 32.18    | 122   | 33.52 | 72    | 39.13 | 259   | 34.53 |
| No opposite foot | 137   | 67.82    | 242   | 66.48 | 112   | 60.87 | 491   | 65.47 |

Total throws | 292 | 250 | 279 | 821 |

*This figure does not include 56 underhand throws which were not coded.
Table 6

Significant Main Effects and Interactions for the Post Hoc Univariate RM ANOVA Analyses of the Student Throwing Performance Measures

<table>
<thead>
<tr>
<th>Effects</th>
<th>Overhand Throwing Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance</td>
</tr>
<tr>
<td>Group</td>
<td>$F(1,146)=8.33, \ p&lt;.05$</td>
</tr>
<tr>
<td></td>
<td>Foot-action</td>
</tr>
<tr>
<td>Gender</td>
<td>$F(1,146)=8.85, \ n.s.$</td>
</tr>
<tr>
<td>Gr x Gen</td>
<td>n.s.</td>
</tr>
<tr>
<td>Time</td>
<td>$F(1,146)=26.77, \ p&lt;.01$</td>
</tr>
<tr>
<td>Time x Grp</td>
<td>$F(1,146)=8.10, \ p&lt;.05$</td>
</tr>
<tr>
<td>Time x Gen</td>
<td>$F(1,146)=7.03, \ p&lt;.05$</td>
</tr>
<tr>
<td>Time x Grp x Gen</td>
<td>$F(1,146)=23.92, \ p&lt;.01$</td>
</tr>
</tbody>
</table>
Figure Caption

Figure 1. Beginning of the unit and end of the unit distance throwing performance measures.
TIME OF ASSESSMENT

Note: Numbers within the parentheses represent the means and standard deviations, respectively.
Figure Caption

Figure 2. Beginning of the unit and end of the unit mean developmental foot action ratings.
FOOT DEVELOPMENTAL RATINGS

KDB=knowledge deficient boys
KDG=knowledge deficient girls
KTB=knowledge trained boys
KTG=knowledge trained girls

Pretest Posttest

TIME OF ASSESSMENT

Note: Numbers within the parentheses represent the means and standard deviations, respectively.
Figure Caption

Figure 3. Beginning of the unit and end of the unit mean developmental pelvic-spine ratings.
TIME OF ASSESSMENT

Note: Numbers within the parentheses represent the means and standard deviations, respectively.
Figure Caption

Figure 4. Beginning of the unit and end of the unit mean developmental arm action ratings.
KDB = knowledge deficient boys
KDG = knowledge deficient girls
KTB = knowledge trained boys
KTG = knowledge trained girls

TIME OF ASSESSMENT

Note: Numbers within the parentheses represent the means and standard deviations, respectively.
APPENDIX A

Extended Review of Literature
At the 1985 annual meeting of the American Educational Research Association in Chicago, Shulman (1986a) declared in his presidential address that the role of subject matter knowledge was being ignored in research on teaching. A review of the studies and articles presented in the most recent Handbook of Research on Teaching (Wittrock, 1986) supports his claim that subject matter knowledge was the "missing (research) paradigm". Five major paradigms organized the bulk of research on classroom instruction at that time: process-product, academic learning time, pupil cognition/mediation of teaching, classroom ecology, and teacher cognition/decision-making (Shulman, 1986b). While these research approaches have collectively increased our understanding of teaching in the classroom, they have limited practical application to education practice because they treated "teaching more or less generically, or at least as if the content of instruction were relatively unimportant" (Shulman, 1986a, p.6).

Historically, investigators who have studied physical education teaching have adapted and used the paradigms that were originally developed for classroom research. Two of the most productive paradigms that have been used in the context of physical education are the process-product (Carlisle, 1982; DeKnop, 1986; Dugas, 1984; Graham, Soares & Harrington, 1983; Oliver, 1979; Phillips & Carlisle, 1983; Pieron, 1982; Rink, Werner, Hohn, Ward & Timmermans, 1986; Silverman, 1985; Silverman, Tyson and Morford, 1988; Taylor, 1976; Yerg, 1977, 1981; Yerg and Twardy, 1982) and the teacher cognition/decision-making (DiCicco, Housner & Sherman,

A modest number of process-product studies have reported that what teachers do during physical education instruction (process) was related to student psychomotor skill achievement (product) in volleyball (Carlisle, 1982; Oliver, 1979; Phillips and Carlisle, 1983; Silverman, 1988; Taylor, 1976), archery (Dugas, 1984), tennis (Deknop, 1986), gymnastics (Pieron, 1982), and aquatics (Silverman, 1985). Teacher-student process variables which were found to be related to achievement gains in specific sport skills included providing task-specific feedback (Oliver, 1979; Phillips and Carlisle, 1983; Pieron, 1982; Silverman et al., 1988), analyzing student needs (Carlisle, 1982; Phillips & Carlisle, 1983), individualizing instruction (Taylor, 1976), demonstrating skills (Silverman, 1988; Taylor, 1976), explaining content (Silverman, 1988), increasing student engagement time in appropriate subject matter (Carlisle, 1982; Deknop, 1986; Phillips and Carlisle, 1983; Pieron, 1982; Silverman, 1988), providing more criterion practice trials (Dugas, 1984), flexible and appropriate instruction (Phillips and Carlisle, 1983) and a composite of behaviors described as information and play processes (Oliver, 1979).

These findings must be interpreted with caution because the reported relationships between specific process variables and student achievement were not always consistent across the various studies, or even from skill to skill within an instructional unit.
These inconsistencies may be partially explained by practice sessions that were sometimes too short for learning to take place, inappropriate statistical analyses, difficulties in measuring psychomotor outcomes, questionable methodology, limited resources available for large-scale studies, and a lack of concern for teacher knowledge differences.

A major criticism of process-product research was that it dealt exclusively with observable teacher and student behaviors and pupil achievement without regard to the thinking and decision-making that underlie teachers' actions (Clark and Peterson, 1986). Clark and Peterson argued that since there was a reciprocal relationship between these variables, the process of teaching could not be fully understood unless teachers' thoughts/decisions were studied in relation to their pedagogical actions and the observable effects of these actions on student behavior and learning.

A limited number of studies have described the thought processes of teachers as they planned for (Housner and Griffey, 1985; Howell, 1987; Taheri, 1982) and taught (DiCicco, Housner and Sherman, 1981; Housner and Griffey, 1985; Howell, 1987) physical education lessons. The content/skills taught in these studies ranged from basketball dribbling (Housner and Griffey, 1985; Howell, 1987), soccer dribbling (Housner and Griffey, 1985), the inverted balance (DiCicco et al, 1981), and fitness concepts (Taheri, 1982). Taken together, the findings revealed that, when planning lessons for small groups (n=4) of elementary school
children, experienced teachers made substantially more content adaptation and instructional strategy decisions than inexperienced teachers (Housner and Griffey, 1985). For the most part, the latter group of planning decisions dealt with strategies to promote skill learning (assessing performance, providing feedback, focusing student attention to key features of a skill, demonstrating skills) and managing activities during instruction. When planning lessons for intact, elementary school physical education classes, expert teachers planned for activities (content). Learning objectives were not the focal point of experts’ lesson planning, although some were hidden in general activity planning statements (Howell, 1987).

During instruction, expert/experienced physical education teachers focused most of their attention on student performance (Housner & Griffey, 1985; Howell, 1987), and made interactive decisions in response to performance cues (Housner and Griffey, 1985). In contrast, inexperienced teachers focused most of their attention on cues related to student interest (Housner & Griffey, 1985) and made most interactive decisions in reaction to these cues (Housner and Griffey, 1985). Other research indicated that expert and novice teachers tended to maintain rather than alter their routines during interactive instruction (DiCicco et al, 1981). This tendency was more prevalent among the experts.

In sum, the findings from research on physical education teaching indicate that physical education teachers are reflective, thoughtful professionals whose pedagogical actions can have an impact on student learning and achievement. A major limitation of
this research was the lack of concern the investigators showed for teachers' subject matter knowledge. None of the teacher cognition/decision-making studies assessed teacher knowledge of content. Of the process-product studies that mentioned teacher knowledge as a variable of interest (Carlisle, 1982; Oliver, 1979; Phillips & Carlisle, 1983; Yerg, 1977, 1981), none of the authors reported what the teachers knew about the subject matter, how this knowledge influenced their thinking and decision-making, nor how the teachers transformed their understanding of content into instruction that could be comprehended by students of different backgrounds and skill levels. Typically, teacher knowledge was vaguely defined as a numerical score derived from a written test on rules and playing strategies, or from a skills test. Taken together, the current status of research on physical education instruction mirrors the pre-1985 classroom teacher behavior studies which ignored the central role of subject matter in teaching.

Since Shulman made his "missing paradigm" declaration at the 1985 annual meeting of the American Educational Research Association, a number of scholars have investigated the role of teacher knowledge during classroom instruction using a variety of approaches. Substantial research has come from Stanford University's Knowledge Growth in Teaching Project (Shulman, 1987, 1988; Wilson, Shulman, and Richert, 1987), University of Pittsburgh's Learning Research and Development Center (Leinhardt and Greeno, 1986; Leinhardt and Smith, 1985), the ordered-tree/knowledge structure studies by Roehler and her
associates (Roehler, Duffy, Conley, Herrmann, Johnson & Michelson, 1987; Roehler, Duffy, Herrmann, Conley & Johnson, 1988), and the Cognitively Guided Instruction Project (Fennema, Carpenter & Peterson, in press). Together, these studies represent the seeds of a new and rapidly growing paradigm that investigates the professional knowledge base of classroom instruction from a variety of perspectives. A summary of these four groups of research studies follows.

The Stanford University Knowledge Growth in Teaching Project

The Knowledge Growth in Teaching Project investigated the development of professional knowledge among new teachers (Shulman, 1987; Shulman, 1988; Wilson et al., 1987). Longitudinal case studies were conducted on 20 prospective secondary school teachers who were enrolled in teacher education programs at three different California universities. Each subject completed coursework in an academic specialty prior to a year of teacher education. After completing the teacher education program, 12 of the novices were investigated during their first year of high school teaching. They taught either English, math, science, or social studies. Classroom observations, formal or informal interviews, field notes, personal or intellectual biographies, and structured tasks were used to gather knowledge-relevant information throughout the project.

Taken together, the case studies completed under the sponsorship of this research project reported that teachers' subject matter knowledge plays a major role in high school classroom teaching (Shulman, 1988). Background or prior knowledge
in a specific subject area influenced the manner in which novice teachers selected and presented subject matter for instruction, chose learning experiences and assignments for students, and used textbooks and curriculum materials. The depth and character of their subject matter knowledge affected the content, style, and processes of instruction, and influenced what teachers emphasized during lessons. The extent of teachers' academic training in a content area influenced the style and substance of their instruction. Also, teachers with more extensive academic training generally had greater understanding of the substantive and syntactic structures of their subject area, and tended to express teaching goals that emphasized the syntax of their subjects. More substantive knowledge enabled the teachers to provide conceptual explanations to their learners, and be more cognizant of how pieces of information are interconnected.

Case studies from the same project documented the importance of teachers' pedagogical content knowledge during high school classroom instruction (Shulman, 1988). This is a special understanding of subject matter for the purpose of teaching. It enables teachers to transform their understanding of subject matter into multiple representations and modes of presentation that make sense to learners of diverse interests and ability levels. One study that was an outgrowth of this project provided evidence that showed that expert classroom teachers organized their pedagogical content knowledge into elaborate and well defined models which helped guide their instruction (Grossman & Gudmundsdottir, 1987).
According to Shulman (1987), this component of knowledge is most likely to discriminate the content specialist from the expert pedagogue. Minimally, pedagogical content knowledge consists of five categories: "knowledge of alternative frameworks for thinking about teaching a particular subject; knowledge of student understanding and misconceptions of a subject; knowledge of curriculum; knowledge of particular content; and knowledge of topic-specific pedagogical strategies" (Shulman, 1988, p. 19).

Finally, this research project demonstrated the growth of professional knowledge during teacher education and during the first-year of high school instruction (Shulman, 1988). Initially, novice teachers lacked the subject matter understanding required to explain particular topics to their students. This was observed despite the fact that they majored in an academic specialty during their undergraduate education. As they planned for and taught lessons, they gradually increased their knowledge and understanding of subject matter, and developed pedagogical content knowledge. Other sources of pedagogical content knowledge included: modeling teachers from their own previous schooling, college coursework, and their field experiences.

While the primary focus of this project was on the knowledge growth of beginning teachers, other studies that evolved from this research investigated the role of professional knowledge among experienced high school classroom teachers (Baxter, 1986; Gudmundsdottir & Shulman, 1987; Hasweh, 1985; Shulman, 1987). Generally, these case studies revealed that teachers who possessed
higher levels of subject matter knowledge and pedagogical content knowledge demonstrated more expert teaching behaviors. The latter knowledge component was more influential.

The University of Pittsburgh subject matter knowledge studies

Research at the University of Pittsburgh Learning Research and Development Center (Leinhardt and Smith, 1985) explored the organization, content, and use of subject matter knowledge among expert and novice fourth-grade arithmetic teachers. Measures related to teachers' knowledge of fractions were obtained from classroom observations, videotapes of lessons, stimulated recall interviews, and math card sort tasks. Later, the measures were analyzed and used to construct semantic nets, planning nets, and flow charts representing different facets of subject matter knowledge. Taken together, the results indicated that teachers' knowledge of subject matter was interrelated with their knowledge of lesson structure. Lesson structure refers to the general skills and strategies needed to plan for and conduct a lesson. The authors argued that, "subject matter knowledge supports lesson structure and acts as a resource in the selection of examples, formulation of explanations, and demonstrations. (and it) constrains lesson structure in that the content of the lesson strongly influences how it is to be taught" (p. 247).

The more expert teachers in the Leinhardt and Smith (1985) study generally demonstrated more refined and hierarchically organized knowledge structures than the novices. However, the semantic nets that were constructed revealed that there was wide
variability in the experts' knowledge of fraction concepts. Only two of the four experts possessed knowledge structures with multiple linkages across concepts. In depth analysis of the classroom explanations of the three experts who had the most similar knowledge of fractions showed substantial differences in what was emphasized in their presentations, how topics were introduced, the level of conceptual information covered, the problem solving methods used, and the representational systems used to explain the topics. The overall results indicated that subject matter knowledge strongly influences how a teacher instructs a lesson.

**Knowledge structures and ordered-tree studies**

Based on descriptive and observational data of teachers, it has been suggested that experts organize their knowledge of subject matter and content-specific instruction in a more coherent and integrated manner than novices or less effective teachers (Roehler et al., 1988). This is consistent with the findings of research on experts and novices in other fields (Chi, Glaser, and Rees, 1982). According to this view, experts organize their declarative knowledge about content and pedagogy into a highly sophisticated network of concepts and/or chunks of concepts. A highly organized network enables the expert teacher to access a relevant category in the knowledge structure with ease, and to use this knowledge to "assume cognitive control of instructional situations by making substantive curricular and instructional decisions" (Roehler et al., 1988, p. 164). In contrast, novices are less likely able to
exhibit cognitive control and sound professional decision making because their knowledge structures consist of isolated bits of professional information that are difficult to access during instructional situations.

A number of recent investigations have used an "ordered tree technique" (Naveh-Benjamin, McKeachie, & Tucker, 1986) to describe the characteristics of teachers' knowledge structures (Duffy & Roehler, 1986; Herrmann, 1987a; Herrmann, 1987b; Herrmann, 1988; Roehler et al., 1987; Roehler et al., 1988). In using this technique, teachers construct written diagrams that represent the concepts and the network of relationships stored in their knowledge structures. The ordered trees are then content analyzed with numerical and coherence measures. The numerical measures involve counting nodes, chunks, the average number of concepts per chunk, and the extent of the ordered trees' depth and width. The coherence measures assess the logical relationships within chunks and across clusters of conceptual chunks. It is hypothesized that "certain numerical characteristics regarding concepts, chunks, levels and integrations, and a certain amount of coherence both within and across chunks, will predict teachers' cognitive control of instruction and effectiveness in creating student outcomes" (Roehler et al., 1988, p. 163). Taken together, this research has shown that teacher education affects the development of preservice teachers' knowledge structures (Duffy & Roehler, 1986; Herrmann, 1987; Herrmann 1987b; Herrmann, 1988; Roehler et al., 1987; Roehler et al., 1988). Semester-long reading methods courses that
integrated field-based teaching experiences tended to facilitate the development of expert-like knowledge structures for reading and reading instruction (Roehler et al., 1987). Prospective elementary and early childhood teachers who completed a teacher effectiveness course and a methods class developed more extensive but less coherent knowledge structures as new knowledge was acquired (Herrmann, 1987b). In contrast, a similar study by the same author reported that preservice elementary and early childhood teachers who were enrolled in a teacher effectiveness course, a practicum class, and a reading methods course built more coherent but less extensive cognitive structures about effective teaching (Herrmann, 1988). In both of the latter studies, there was a tendency to develop course-specific knowledge structures, rather than systematically organizing newly acquired concepts into one coherent and integrated cognitive structure about effective teaching. Thus, the prospective teachers had difficulty retrieving chunks of knowledge that they learned in previous teacher education coursework.

A longitudinal, one-year study of preservice teachers enrolled in a teacher education program documented the development of their knowledge structures for reading and reading instruction across a school year (Duffy & Roehler, 1986; Roehler et al., 1988). This research revealed that there was an inverse relationship between the complexity and coherence of prospective teachers' knowledge structures. More coherent knowledge structures were associated with ordered trees which showed integration of conceptual
information. Finally, preservice teachers' knowledge structures tended to increase in complexity early in the school year, but diminish in complexity as the school year progressed.

Other recently completed research suggests that certain characteristics of classroom teachers' ordered trees may predict their pedagogical actions (Johnson, 1987; Roehler et al., 1987). Prospective teachers who possessed more highly rated ordered trees for reading and reading instruction were found to be more effective in providing appropriate responsive elaborations during reading lessons (Roehler et al., 1987). Another study reported that pre-service teachers who constructed ordered trees that connected chunks of knowledge in a coherent and integrated manner generally taught more coherent and integrated lessons than prospective teachers who produced unorganized trees (Johnson, 1987). Finally, findings from expert-novice research suggest that the degree of stability of an ordered tree may predict teaching expertise (Duffy & Roehler, 1986). Analyses of various experts' ordered trees revealed striking similarities in the number of concepts, chunks, average concepts per chunk, and the depth and width measures. In contrast, novice teachers varied greatly in these numerical measures.

The Cognitively Guided Instruction Project

The Cognitively Guided Instruction Project investigated elementary school teachers' pedagogical content knowledge in the context of teaching addition and subtraction to first grade children (Carpenter, Fennema, Loef & Carey, in progress;
Carpenter, Fennema, Peterson, & Carey, 1988; Carpenter, Fennema, Peterson, Chiang & Loe, in press; Fennema et al., in press; Peterson, 1988; Peterson, Carpenter & Fennema, 1988; Peterson, Fennema, Carpenter & Loe, in press). The subjects in these studies were 40 first-grade teachers from 27 schools in the Madison, Wisconsin area who volunteered to participate in the research project and their intact classes. Thirty-eight of the teachers were experienced. The mean number of years of teaching experience for the 40 teachers averaged 10.9 years.

The initial phase of this project collected baseline data that described various components of the 40 teachers' pedagogical content knowledge (Carpenter et al., 1988). Subsequent studies investigated the effects of a four-week workshop on 20 teachers who were provided with research-based knowledge on how young children learn mathematics with understanding (Carpenter et al., in press; Fennema et al., in press; Peterson, 1988; Peterson et al., 1988). The 20 teachers who did not attend the workshop sessions served as a control group. Upon completion of the workshop training, the teachers instructed arithmetic to their intact classes over a seven-month period. Two researchers systematically observed 16 of the lessons. Subtraction and addition achievement tests were administered to their students before and after the instructional period. The third phase of the project took place during the following school year. Six of the experimental group teachers who participated in the workshop training sessions during the previous year were selected to take
part in case studies that were designed to describe how pedagogical content knowledge influenced their instructional decision-making and actions during first-grade math lessons.

The results of the pre-workshop phase of the project revealed that most of the teachers could identify the important distinctions between different types of arithmetic word problems and the major strategies that the children used to solve these problems (Carpenter et al., 1988). However, this pedagogical content knowledge was not organized into a coherent network that linked together teachers' understandings of distinctions, children's solutions to problems, and problem difficulty. They had difficulty identifying how children's (counting) strategies could be modified and applied to other math problems. The teachers' ability to predict student success in solving specific types of word problems was the only pedagogical content knowledge measure correlated with student achievement. A related study on the same group of teachers indicated that teachers' pedagogical content knowledge and pedagogical content beliefs of addition and subtraction seem to be interconnected (Peterson et al., in press). That is, teachers with beliefs corresponding to a high cognitively-based perspective tended to have higher levels of pedagogical content knowledge than those with a low cognitively-based perspective.

The workshop intervention studies demonstrated that giving teachers access to research derived information about children's thinking, learning, and mathematics problem solving influenced the development of their pedagogical content knowledge (Carpenter et
This knowledge growth was accompanied by positive changes in teachers' beliefs about learning and instruction (Carpenter et al., in press). They developed a comprehension of their students' knowledge of subject matter and problem-solving strategies (Carpenter et al., in press). The knowledge that was presented to them during the workshop sessions impacted their instructional processes and classroom actions (Carpenter et al., in press; Fennema et al., in press). They emphasized problem solving rather than simple computations and number facts learning (Carpenter et al., in press; Fennema et al., in press), and spent more time listening to and questioning students about their problem-solving processes (Peterson et al., 1988). They planned their lessons to build upon what their students already knew (Carpenter et al., in press; Fennema et al., in press). After a year of instruction, these changes had a positive affect on students' number facts and problem-solving achievement (Carpenter et al., in press; Fennema et al., in press; Carpenter & Peterson, in press; Peterson et al., 1988), and on their confidence in solving word problems (Carpenter et al., in press; Fennema et al., in press).

The phase three case studies conducted during the following year supported the results of the experimental studies described above (Carpenter et al., in progress). The six teachers used their knowledge of problem types, solution strategies, and children's mental processes in various ways to determine what students knew about addition and subtraction and in making instructional
decisions. The studies demonstrated that children could be taught to learn math with understanding using a variety teaching approaches provided that the teachers possessed high levels of pedagogical content knowledge. This includes knowledge of subject matter, instructional techniques, and children's content-specific cognitions.

Collectively, the aforementioned groups of studies are bound together by a common paradigm that emerged in response to criticisms of earlier approaches to teacher behavior research. Previous paradigms were criticized because they demonstrated a lack of concern for the subject matter that was taught, and overemphasized generic teaching skills that were not content specific. Thus far, studies organized under this new research framework have shown that classroom teachers draw upon many types of knowledge as they plan and conduct academic lessons. Subject matter knowledge and pedagogical content knowledge play important roles during classroom instruction. Despite the recent research interest in classroom teachers' knowledge, investigators have not examined the professional knowledge base of physical education teachers, nor have they studied how various components of teachers' knowledge influence sports skill instruction and student learning/achievement.

A framework for knowledge research in physical education

What are the categories of knowledge that teachers draw upon as they plan for and conduct physical education lessons?

Investigators from Stanford University's Knowledge Growth in
Teaching Project (Wilson et al., 1987) have developed a model that describes the components of the professional knowledge base of teaching. Minimally, seven components have been identified: knowledge of subject matter, pedagogical content knowledge, knowledge of other content, knowledge of curriculum, knowledge of learners, knowledge of educational aims, and general pedagogical knowledge. A simplified version of the model depicts three broad categories of knowledge, including: general pedagogical knowledge, subject matter knowledge, and pedagogical content knowledge. While this model was constructed to describe the knowledge base of high school classroom teachers, the categories seem to be applicable to physical education instruction. Using the simplified version of the Stanford model as a framework, the author will attempt to describe the categories of knowledge that may be needed to teach a six-week overhand throwing unit to kindergarten children.

The teacher must possess a high degree of general pedagogical knowledge. This component of knowledge includes the techniques, strategies, and generic process skills needed to manage student behavior and organize a learning environment irrespective of the subject matter taught. Many of these so-called generic skills and techniques are an outgrowth of the process-product research tradition.

An in depth understanding of subject matter is central to the teacher's knowledge base. The teacher must be knowledgeable of the facts, concepts, and current research literature related to overhand throwing technique and development. He/she must be
Cognizant of the characteristics of mature and efficient throwing. That is, the child strides forward with the foot opposite the throwing arm allowing for full rotation of the hips and weight transfer. The mature thrower exhibits differentiated rotation of the pelvis and spine, and a whiplike arm action with a delayed forearm lag. The teacher must also be knowledgeable of the body actions associated with immature throwing. This requires a familiarity of the developmental stages of the foot, pelvis/spine, and arm actions.

More importantly, the teacher must have a high level of pedagogical content knowledge. This special understanding of content and pedagogy enables the teacher to transform his/her understanding of overhand throwing into multiple representations, explanations, and demonstrations that are comprehensible to learners of various skill, ability, and maturity levels. Included in this knowledge component are the content-specific strategies that a teacher applies to instruct children to step with the opposite foot, rotate the body, throw forcefully, and forearm lag. Successful implementation of these strategies requires expertise in observing and analyzing throwers, knowledge of the developmental aspects of children, understanding of the learning problems or misconceptions immature throwers commonly experience, and a familiarity of verbal feedback cues that are more easily understood by young children ("step-throw", "twist", "throw-hard", "arm-back"). The teacher must be familiar with a variety of alternative (research-based) approaches to teach throwing. He/she
also must be knowledgeable of the curricular materials, supplies, and equipment that are available to implement these approaches.

In sum, findings from classroom research suggests that effective teaching depends on at least three broad categories of teacher knowledge: general pedagogical knowledge, subject matter knowledge, and pedagogical content knowledge. It would appear that the same categories underlie effective sports skill instruction, although physical education researchers have ignored the role of teacher knowledge in their research paradigms. A clear understanding of effective physical education instruction will only be achieved if investigators undertake significant research efforts that focus on the relationships between teacher knowledge, teacher thinking/decision making, content-specific instruction, and student learning/achievement. The present study was a first step in that direction.
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Yerg, B. J., & Twardy, B. M. (1982). Relationship of specified instructional teaching behaviors to pupil gain on a motor skill task. In M. Pieron & J. Cheffers (Eds.), *Studying the teaching in physical education*. Liege, Belgium: International Association of Physical Education in Higher Education.
APPENDIX B

Questionnaire to Assess Teacher Throwing Experience
Teacher Questionnaire

Name of teacher ____________________________ School ________________________
Years experience as a teacher ______

COLLEGE EDUCATION

<table>
<thead>
<tr>
<th>School</th>
<th>Major/Minor</th>
<th>Degree (if no degree, #SH's)</th>
</tr>
</thead>
</table>

Did you take any physical education classes while in college? (specify which ones)

Were you required to take a physical education methods class(es) during your undergraduate/graduate training?

What varsity sports (if any) did you participate in during:
  - Junior high school
  - High School
  - College

In what organized sports (outside of school) have you participated in (e.g., organized summer leagues, youth league baseball, etc.)? Specify sports, number of years of participation and when.

Have you had any direct or indirect experience with youth/little league baseball or softball (e.g., as a coach, parent of playing child, spouse of coach). If yes, describe.

While growing up as a child, how often did you participate in sports activities with your father (and older brother if appropriate)? Describe.

Describe any other sports related experience (use back of form).
APPENDIX C

Generic Teaching Skills Assessment Information
TADS-MTP FORM

Category Descriptions, Performance Indicators, and Teaching Behaviors
CATEGORY 1 - KNOWLEDGE OF SUBJECT MATTER

Teaching behaviors in this assessment category indicate the extent to which the teacher demonstrates command of the subject matter taught during the lesson observed. The information gathered to make assessments in this category must reflect direct observation of what the teacher says or does relative to the content of the lesson.

There are two performance indicators in this category:

A. Subject Matter Content

B. Subject Matter Presentation

Indicator A requires the observer to first, recognize subject matter errors and second, to be able to give an accurate count of their frequency. Substantial errors include major misconceptions and information imparted to learners such as incorrect conjugation of verbs in a language arts class and using wrong units of measurement in a science class. Minor errors include such things as inaccurate dates and arithmetical slips. Observation of a substantial error or a number of minor errors reflecting a lack of subject matter knowledge is sufficient for denying credit for this indicator.

The second performance indicator focuses on the manner in which the content of instruction is presented during the lesson observed. The observer makes judgments about four teaching behaviors which reflect the timeliness and sequence of information/topics presented, teacher emphasis on important dimensions and applications of topics/activities and presentation of subject matter at a variety of cognitive levels.

The TADS-MTP FORM performance indicators and teaching behaviors for assessment Category I are included on the following page.
CATEGORY I - KNOWLEDGE OF SUBJECT MATTER

Performance Indicators and Sample Teaching Behaviors

*A. Subject Matter Content

1. Makes no errors indicative of lack of knowledge of subject matter taught.

*B. Subject Matter Presentation

1. Information is up-to-date and timely.

2. Important dimensions or applications of topics are utilized to enhance instruction.

3. Subject matter is presented at more than one cognitive or performance level.

4. Sequence of information presented is logical.

*Denotes Performance Indicator
CATEGORY II - TECHNIQUES OF INSTRUCTION

The teaching behaviors and performance indicators in this category of the TADS-MTP FORM define several key elements of an effective learning situation. First, instruction is presented at a level where learners can be successful. Learners are matched to lesson objectives through a variety of techniques and strategies, and materials and methods are chosen to accommodate the intellectual and developmental needs of the learners.

Secondly, instruction should be well-organized. Efforts should be made to present lesson activities in a sequential and orderly fashion with no missing links. Where media or other instructional aids and materials are used, their purpose should be to facilitate instruction.

Thirdly, communication, explanations and directions should be clear. Clarity of expression has been recognized as a critical element in effective teaching. Further, teachers should be sensitive to the need for additional explanation throughout a lesson so that clarification is provided whenever necessary.

Fourthly, instruction is an active process in which learners interact verbally and in other ways with the teacher, with each other and with varied learning materials. The teacher should facilitate and encourage interactions which are pertinent to lesson objectives. Additionally, a teacher should monitor the effectiveness of instruction, make adjustments if needed and provide feedback to learners about their performance and progress.

Nine performance indicators, each defined by four or more specific teaching behaviors, comprise this TADS-MTP FORM category. These indicators and teaching behaviors are presented on the pages that follow.
CATEGORY 11 - TECHNIQUES OF INSTRUCTION
Performance Indicators and Sample Teaching Behaviors

*A. Matches Instruction to Learners
1. Instruction is appropriate for the needs and abilities of the learners.
2. Learners have sufficient opportunity to practice lesson objectives.
3. Learners participate in two or more activities which require more than passive listening.
4. The teacher and the learner interact in more than one group size (i.e., class-sized groups, small groups or individual learners) or the teacher is responsible for only one learner.
5. The lesson is personalized for learners by using the learners' own experiences or by providing examples that are relevant to them.

*B. Aids are Used to Facilitate Instruction
1. Instructional aids (e.g., chalkboard, pictures, slides, or films, etc.) are appropriate for learners.
2. Instructional aids are appropriate for objectives.
3. Instructional aids are used at appropriate times in the lesson.
4. Instructional aids are used skillfully.
5. Instructional aids enhance accomplishment of instructional objectives.

*C. Materials are Used to Facilitate Instruction
1. Instructional materials are appropriate for the needs and abilities of the learners.
2. Instructional materials are appropriate for learner objectives.
3. Instructional materials are used at appropriate times in the lesson.
4. Supplemental and/or differentiated materials are used.
5. Instructional materials enhance the accomplishment of lesson objectives.
**D. Instruction Follows an Appropriate Sequence**

1. Lesson is initiated with a motivating introduction.
2. Necessary background is or has been established.
3. Instructional components are sequenced in a logical order.
4. Lesson is closed appropriately.

**E. Clear Explanations and Directions are Provided**

1. Learner attention is ensured before directions and explanations for lesson content are provided.
2. Explanations of lesson content are clear and easy to follow with appropriate vocabulary for learners.
3. Communication is precise with few false starts, interrupters or inappropriate qualifiers.
4. Major points or potential areas of difficulty are emphasized by verbal and/or non-verbal cues and/or by repetition.
5. Examples and/or demonstrations are used to illustrate lesson content.

**F. Directions and Explanations are Clarified When Necessary**

1. Areas of confusion are identified and communications restated before learners ask questions or no confusion is evident.
2. Attempts are made to clarify confusion which occurs or no clarification is needed.
3. Different words and ideas are used in clarification or no clarification is needed.
4. Clarifications are made for individual learners rather than the entire class when necessary or no clarification is needed.
5. Attempts to clarify explanations are effective.

**G. Opportunities are Provided for Verbal Interaction**

1. Learners who try to contribute are acknowledged.
2. Comments, questions, examples, demonstrations and other contributions are sought from learners throughout the lesson.
3. Responses are sufficient to address learners' questions or comments.
4. Learners' ideas are elaborated in the lesson through extended wait-time or teacher comments and/or questions.
H. Makes Informal Assessments of Learner Performance and Progress During the Lesson

1. Monitors learners' performance as learners engage in activity.
2. Solicits responses or demonstrations from learners for assessment purposes.
3. Multiple levels of learning are monitored where appropriate.
4. Learners evaluate their own and/or each other's performance.
5. Bases for learner difficulties or misunderstandings are sought where probing is not necessary.

I. Information is Provided to Learners About Their Progress

1. Expectations about learner performance are communicated at the beginning of activities.
2. Specific feedback is provided to learners about inadequacies in performance.
3. Specific feedback is provided to learners about adequate performances.
4. Suggestions for improving performance are provided to learners.
CATEGORY III - CLASSROOM MANAGEMENT

This TADS-MTP FORM category assesses teacher performance relative to five important elements of teaching: 1) time devoted to instruction; 2) management of routine tasks; 3) pupil engagement in learning; 4) strategies used to manage off-task behavior; and 5) management of pupil behavior. These are important teacher concerns because they are related to the opportunity pupils have to learn and to pupil involvement in instructional activities. Research studies suggest that there are large variations in the amount of time teachers spend organizing children for learning as opposed to the amount of time pupils are engaged in some kind of instructional or learning activity. Inefficient teachers spend more time organizing for instruction than actually teaching.

The five performance indicators in this TADS-MTP FORM assessment category describe a classroom in which activities are well administered, academic engagement is high and pupils are able to understand expectations and work efficiently with little disruption. The five performance indicators in this category are:

A. Most of the Observational Period is Devoted to Some Form of Instruction Rather than to Organizational Activities, i.e. Roll Taking, Distribution of Supplies/Materials and Regrouping for Instruction

B. Attends to Routine Tasks

C. Maintains Learner Involvement Throughout the Instructional Period

D. The Teacher Uses Strategies to Prevent, Identify and Redirect Off-Task Learners

E. Pupil Behavior is Managed Appropriately

Each of these performance indicators is measured by three or more specific teaching behaviors. The five performance indicators comprising TADS-MTP FORM Category III with their associated teaching behaviors are presented on the pages that follow.
CATEGORY III - CLASSROOM MANAGEMENT

Performance Indicators and Sample Teaching Behaviors

*A. Most of the Observation Period is Devoted to Some Form of Instruction Rather Than to Organizational Activities, i.e., Roll Taking, Distribution of Supplies/Materials and Regrouping for Instruction

1. Instructional activities begin promptly.
2. There are no unnecessary delays during instruction, (e.g., during transitions due to different completion times of group work or during routine tasks).
3. There are no undesirable digressions.
4. Instructional activities fit the allocated time period.

*B. Attends to Routine Tasks Effectively

1. Learner attention is ensured before providing directions or explanations for routine tasks.
2. Procedural directions necessary to implement the class activity are clear and complete (e.g., who, what, where, how).
3. Necessary materials are on hand and ready for use.
4. Routine tasks are dealt with in an efficient manner.

*C. Maintains Learner Involvement Throughout the Instructional Period

1. Approximately 85% or more of the learners are on-task throughout the lesson.

*D. The Teacher Uses Strategies to Prevent, Identify and Redirect Off-Task Learner(s)

1. Stimuli for learners are varied by changing voice, movement, focus of attention, etc.
2. Active involvement is sought from learners who are involved only passively in instruction or no learners are only passively involved.
3. Non-verbal techniques are used to redirect learners who are persistently off-task or there is no persistent off-task behavior.
4. Verbal techniques are used to redirect learners who are persistently off-task or there is no persistent off-task behavior.
5. Efforts to redirect learners who are persistently off-task are successful **or** there is no persistent off-task behavior.

6. Techniques are used to maintain the attention of learners who have been redirected **or** there is no persistent off-task behavior.

**E. Pupil Behavior is Managed Appropriately**

1. Expectations about behavior are made clear to learners **or** learner behavior indicates that expectations have been made clear.

2. Consistent expectations about behavior are maintained throughout the lesson.

3. Behavior of the entire class is monitored throughout the lesson.

4. Learners are provided verbal and/or non-verbal feedback about specific behavior(s).

5. Learners who interact inappropriately or otherwise interfere with the work of others are identified and dealt with quickly **or** learners do not interfere with instruction.

6. Learners who interact inappropriately or otherwise interfere with the work of others are dealt with appropriately (i.e. firmly and with suitable consequences) **or** learners do not interfere with instruction.
CATEGORY IV - TEACHER-STUDENT RELATIONSHIPS

The teacher's interpersonal behavior with students has a significant influence on whether teacher-student relationships will be positive. The teacher demonstrates respect for and fairness with learners by including all learners in lesson activities, assisting learners who have difficulty and providing personalized feedback to learners who do well. A comfortable and positive interpersonal learning environment is also promoted by demonstrating warmth and friendliness with and among learners, by showing patience and empathy and demonstrating enthusiasm for teaching, learning and the subject being taught.

In teacher-student relationships, there is allowance for a wide range of ways of interacting. The obviously negative ways of relating to and interacting with other human beings, if exhibited by the teacher, are sufficient cause for denying credit for performance in this TADS-MTP FORM category. This category addresses the social and emotional dimensions of the classroom environment and the teacher's attempts to stimulate and maintain a positive learning climate. The criteria for judging teacher-student relationships are built around a concept of fairness and impartiality to all students regardless of race, social class, ability level, sex or religion.

Three performance indicators comprise this category:
A. Systematically Attempts to Involve All Learners in Class Activities
B. Promotes a Positive Interpersonal Environment
C. Demonstrates Warmth and Friendliness

Each of these performance indicators is assessed by four or more specific teaching behaviors. The TADS-MTP FORM Category IV performance indicators and teaching behaviors are presented on the following page.
CATEGORY IV - TEACHER-STUDENT RELATIONSHIPS

Performance Indicators and Sample Teaching Behaviors

*A. Systematically Attempts to Involve All Learners in Class Activities*

1. Learners are provided equal opportunities to participate in class activities.

2. Learners who respond poorly or who have difficulty are encouraged.

3. Involvement is sought from learners who appear reluctant to actively participate — or — there is no necessity for such encouragement.

4. Learners who do well are personally/individually recognized for specific performances.

*B. Promotes a Positive Interpersonal Environment*

1. Fairness and impartiality are demonstrated when dealing with learners.

2. Patience or empathy or understanding is demonstrated when learners respond poorly or have difficulty.

3. Comments to or about learners are free of demeaning sarcasm and personal ridicule.

4. Establishes a climate of courtesy and respect.

5. Enthusiasm is communicated for teaching, learning and the subject being taught.

6. The importance of topics to the content area or to real life is stated to learners.

*C. Demonstrates Warmth and Friendliness*

1. Warmth and friendliness are demonstrated by a positive tone of voice and eye contact which accompany verbal interaction(s) with learners.

2. Warmth and friendliness are demonstrated by knowledge and use of student names.

3. Warmth and friendliness are demonstrated by smiling, laughing or demonstrating a sense of humor.

4. Warmth and friendliness are demonstrated by sitting or standing near students.
Teacher Name: ___________________________  Observer: ___________________________
Date of Observation: ___________________________  Observer Position: ___________________________
School: ___________________________  Start Time: ___________________________
Subject Matter: __________  Grade: _________  End Time: ___________________________
Class size: ______

Teacher Signature: ___________________________
Observer Signature: ___________________________

I. Knowledge of Subject Matter
   A. 1
   B. 1 2 3 4

II. Techniques of Instruction
    A. 1 2 3 4 5
    B. 1 2 3 4 5
    C. 1 2 3 4 5
    D. 1 2 3 4
    E. 1 2 3 4 5
    F. 1 2 3 4 5
    G. 1 2 3 4
    H. 1 2 3 4 5
    I. 1 2 3 4

III. Classroom Management
    A. 1 2 3 4
    B. 1 2 3 4
    C. 1
    D. 1 2 3 4 5 6
    E. 1 2 3 4 5 6

IV. Teacher Student Relationships
    A. 1 2 3 4
    B. 1 2 3 4 5 6
    C. 1 2 3 4

*Teacher Signature: ___________________________ Date: ___________________________

*Teacher signature indicates that the results of the TADS - MTP Form assessment have been discussed with the teacher in a supervision conference.
Table C-1

TADS-MTP Scores, Education Background, and Years of Teaching Experience for Volunteer Teacher Subjects

<table>
<thead>
<tr>
<th>Teacher</th>
<th>TADS-MTP Score*</th>
<th>Education</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET1</td>
<td>74</td>
<td>M.Ed.+15</td>
<td>18</td>
</tr>
<tr>
<td>ET2</td>
<td>73</td>
<td>B.S.</td>
<td>12</td>
</tr>
<tr>
<td>ET3</td>
<td>71</td>
<td>B.A.+</td>
<td>18</td>
</tr>
<tr>
<td>ET4</td>
<td>68</td>
<td>Specialist</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M=71.50</td>
<td>M=16.50</td>
</tr>
</tbody>
</table>

| CT1     | 74              | M.A.        | 5          |
| CT2     | 73              | B.S.        | 18         |
| CT3     | 69              | B.S.        | 19         |
| CT4     | 69              | M.A.+30     | 24         |
|         |                 | M=71.25     | M=16.25    |

Note. ET = Experimental Teacher

CT = Comparison Teacher

*Does not include the 5 subject matter related items
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Agreement</th>
<th>Disagreement</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>3</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>1B</td>
<td>12</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>2A</td>
<td>14</td>
<td>1</td>
<td>.93</td>
</tr>
<tr>
<td>2B</td>
<td>15</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>2C</td>
<td>13</td>
<td>2</td>
<td>.87</td>
</tr>
<tr>
<td>2D</td>
<td>12</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>2E</td>
<td>13</td>
<td>2</td>
<td>.87</td>
</tr>
<tr>
<td>2F</td>
<td>15</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>2G</td>
<td>12</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>2H</td>
<td>14</td>
<td>1</td>
<td>.93</td>
</tr>
<tr>
<td>2I</td>
<td>12</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>3A</td>
<td>11</td>
<td>1</td>
<td>.92</td>
</tr>
<tr>
<td>3B</td>
<td>11</td>
<td>1</td>
<td>.92</td>
</tr>
<tr>
<td>3C</td>
<td>2</td>
<td>1</td>
<td>.67</td>
</tr>
<tr>
<td>3D</td>
<td>14</td>
<td>4</td>
<td>.78</td>
</tr>
<tr>
<td>3E</td>
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<td>.89</td>
</tr>
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<td>4A</td>
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<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>4B</td>
<td>17</td>
<td>1</td>
<td>.94</td>
</tr>
<tr>
<td>4C</td>
<td>12</td>
<td>0</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Total 230 16 .93
Table C-3

Interrater Reliabilities for the TADS-MTP Form Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Teacher 1</th>
<th>Teacher 2</th>
<th>Teacher 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>.90</td>
<td>.95</td>
<td>1.00</td>
<td>.95</td>
</tr>
<tr>
<td>III</td>
<td>.86</td>
<td>.81</td>
<td>.90</td>
<td>.86</td>
</tr>
<tr>
<td>IV</td>
<td>.93</td>
<td>1.00</td>
<td>1.00</td>
<td>.98</td>
</tr>
<tr>
<td>Total</td>
<td>.90</td>
<td>.93</td>
<td>.98</td>
<td>.93</td>
</tr>
</tbody>
</table>

Note. Category I = Knowledge of subject matter
Category II = Techniques of instruction
Category III = Classroom management
Category IV = Teacher-student relationships
APPENDIX D

Teacher Knowledge Assessment Information
### Data Sheet for the Teacher Knowledge Assessments

<table>
<thead>
<tr>
<th>Child #</th>
<th>Immature actions described</th>
<th>Identified stages of development</th>
<th>Instructional strategies provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Transcribed Statements from a Knowledge Trained Teacher's Knowledge Assessment

Question 1: Do you have any thoughts about this child as a thrower? She seems to be in the very beginning stages and a very immature thrower. You can see with the feet there is no movement at all and they are immature---stage #1. No body rotation but a little toward the end when she was throwing a little harder there was some bending at the waist. So I would say her trunk rotation (action) would be between stages 1 and 2. Her arm would be stage 2---she was bringing it right behind the back of her head and just throwing/snapping. She seems to be throwing hard but she's glued to the ground, so I'd consider her a very immature thrower.

Question 2: If you observed her in your physical education class what statements would you make to him/her, if any? Well I would start with the feet and try to get her to move the opposite foot. Even I might put something on the ground and tell her to step over with the opposite foot as she began to throw.
### Scoring of a Knowledge Trained Teacher's Knowledge Assessment Interview

<table>
<thead>
<tr>
<th>Immature actions described</th>
<th>Stages identified</th>
<th>Instructional strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>*No foot movement (glued to the ground)</td>
<td>*Stage #1</td>
<td>*Start with opposite foot movement</td>
</tr>
<tr>
<td>*No body rotation (some bending at waist for later throws)</td>
<td>*Between stages #1 and #2</td>
<td>*Use marker on ground to step over</td>
</tr>
<tr>
<td>*Bringing arm right behind the back of her head</td>
<td>*Stage #2</td>
<td></td>
</tr>
</tbody>
</table>

**Scores:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Immature actions described</td>
<td>3</td>
</tr>
<tr>
<td>Stages identified</td>
<td>3</td>
</tr>
<tr>
<td>Instructional strategies</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
</tr>
</tbody>
</table>

**NOTE:** This is the scoresheet for the transcribed statements shown on page 104.
Sample Transcribed Statements from a Knowledge Deficient Teacher's Knowledge Assessment

Question 1: Do you have any thoughts about this child as a thrower? I think she did a good job in her throwing. She did not try to go past the marker (marker on the ground) and she was very straight in her throwing.

Question 2: If you observed her in your physical education class what statements would you make to him/her, if any? I would tell her she did a very good job in throwing. She did not go past the marker and I really like that because so many times children try to go past the marker and she didn't.
Scoring of a Knowledge Deficient Teacher's Knowledge Assessment

Interview

<table>
<thead>
<tr>
<th>Immature actions described</th>
<th>Stages identified</th>
<th>Instructional strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>* ________________________</td>
<td>* ________________</td>
<td>*General praise</td>
</tr>
<tr>
<td>* ________________________</td>
<td>* __________________</td>
<td></td>
</tr>
<tr>
<td>* ________________________</td>
<td>* __________________</td>
<td></td>
</tr>
</tbody>
</table>

*The three levels represent immature actions and developmental stages for the foot, pelvic-spine, and arm actions respectively.

Scores:

<table>
<thead>
<tr>
<th>Immature actions described</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stages identified</td>
<td>0</td>
</tr>
<tr>
<td>Instructional strategies</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
</tr>
</tbody>
</table>

NOTE: This is the scoresheet for the audiotaped statements shown on page 106.
Answers to the Supplementary Two Question End of the Unit Knowledge Assessment

Question #1: Think about some of the children in your class who in your opinion are good/mature throwers. Can you describe what makes their overhand throws efficient? Describe specific body actions.

Answers: 1) Step with the opposite foot.
2) Differentiated body rotation.
3) Efficient arm/shoulder actions (arm cocked back, whiplike/throws hard, forearm lags, follow-through).

Question #2: Think about some of the children in your class who in your opinion are extremely immature (poor) throwers. Can you describe what makes their overhand throws not as efficient? Describe specific body actions.

Answers: 1) Absence of stepping.
2) Lack of pelvic/spine rotation.
3) Inefficient arm/shoulder actions (arm not cocked back/slight retraction, pushing/not throwing forcefully, absence of overhand action).
Table D-1

Number of Teachers Correctly Describing the Mature Body Actions Sought in Question 1 of the Supplementary End of the Unit Knowledge Assessment

<table>
<thead>
<tr>
<th>Body Actions</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge trained</td>
</tr>
<tr>
<td>1) Step with the opposite foot</td>
<td>4</td>
</tr>
<tr>
<td>2) Differentiated body rotation</td>
<td>4</td>
</tr>
<tr>
<td>3) Arm/shoulder actions</td>
<td></td>
</tr>
<tr>
<td>A. Arm cocked back</td>
<td>4</td>
</tr>
<tr>
<td>B. Whiplike/throws hard</td>
<td>4</td>
</tr>
<tr>
<td>C. Forearm lags</td>
<td>2</td>
</tr>
<tr>
<td>D. Arm follow-through</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>
Table D-2

Number of Teachers Correctly Describing the Immature Body Actions Sought in Question 2 of the Supplementary End of the Unit Teacher Knowledge Assessment

<table>
<thead>
<tr>
<th>Knowledge Trained</th>
<th>Knowledge Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Absence of foot stepping</td>
<td>4</td>
</tr>
<tr>
<td>2) Lack of pelvic-spine rotation</td>
<td>4</td>
</tr>
<tr>
<td>3) Arm/shoulder actions</td>
<td></td>
</tr>
<tr>
<td>A. Arm not cocked back (slight retraction)</td>
<td>3</td>
</tr>
<tr>
<td>B. Pushing/not throwing forcefully</td>
<td>2</td>
</tr>
<tr>
<td>C. Absence of overhand action</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
</tr>
</tbody>
</table>
APPENDIX E

Stimulated Recall Interview Information
STIMULATED RECALL INTERVIEW PROCEDURE

Prior to the interviews, the researcher provided the following instructions: I am interested in what you were thinking while you were teaching this lesson—especially what you were thinking as you decided what to do next at various points in the lesson. As I play back the lesson, please tell me to stop the tape whenever we reach a point where you were consciously saying to yourself, "Let's see, I think I'd better do this now" or, "I guess I'll try doing this". I may stop the tape myself at a couple of points, but you should tell me to stop it whenever there is a point in the lesson where you made a specific decision about what to do next in the lesson. There are no right or wrong answers. I am interested in what you were thinking. Any questions?

When the teacher stopped the tape, the interviewer asked: "What were you thinking at that point?"; "What were you noticing"? and; "Was there anything else you thought of doing at that point but decided against?". If the teacher said yes to the latter question without elaborating, the interviewer asked, "What was it?".

The interviewer stopped the tape and asked the same questions when the teacher shifted activities in which the pupils were engaged, when the teacher provided individual assistance to a student who was practicing throwing activities, or when a critical incident occurred that affected the flow of the lesson.

At the end of the interview session, the teacher was asked one additional question: "What were your primary objectives in this lesson?". The responses to this question were analyzed separately from the stimulated recall data.
Decision Log for Teacher's Interactive Thinking

Before coding the interview, read the entire transcript to get a general idea of the subject's thoughts. Code the interview by individual segments. A segment consists of the four questions that were asked each time the interviewer or teacher stopped the videotape replay. During the second reading, underline the overhand throwing knowledge concepts that are nested within the teacher thoughts (e.g., foot stepping, pelvic-spine rotation, whipping arm/lagging forearm, force production, stages of development, throwing specific drills). After reading a segment a third time, identify and code the categories of teacher thoughts that deal with concerns, information sources, and awareness levels. Next, code the pupil and plan related decisions. A specific category should not be coded more than once within a segment. If the same thought pattern extends into the next segment, code the category again in the new segment. Mark the codings next to the teacher thoughts on the interview transcript. Sequences of thought patterns and thoughts which do not fit the categories of the coding system should be noted. Record the number of instructional procedures that were carried out in response to cues and/or concerns about overhand throwing developmental body actions. After coding the transcribed interview, transfer the coded data to the stimulated recall data sheet.
Part One. Decisions

The kind of decision or non-decision that the teacher makes during a lesson segment. A decision is assumed to underlie each conscious teacher action. In the event that the stimulated recall questioning was initiated by a shift/change in lesson activities, assume that a decision was made by the teacher.

1) Pupil-related. The characteristics or behavior of a pupil, group of students, or the class are the basis of the teacher's decision. The behavior may be skill or management related. Example: "Since she wasn't stepping, I actually picked up her foot and put it over the line" (3-12-1-9).

2) Plan-related. The teacher reports that a decision to behave in a particular way was based chiefly upon the original goals/plans of the lesson. Unplanned decisions which are made without consideration of the characteristics or behavior of the students are also coded in this category (supplementary decisions). Example: "It was toward the end of the lesson and I was switching to the newspaper (ball) activity. I put all the girls on one side and all the boys on the other side of the rope for a little competition, for a whole group activity. When I planned, it was a good way to get them all together from the various stations" (2-10).

NOTE: If plan-related and pupil-related decisions are made simultaneously within the same segment, code both.
Part Two. Concerns

Factors that the teacher expresses concern about.

3) Pupil learning-skill (form). The teacher expresses concern about the throwing form performance of a student(s) by referring specifically to the appearance/absence of developmental body actions related to oppositional foot stepping, body rotation, and/or a whiplike arm action. Key descriptors include the following: stepping, twisting/rotating the body, bringing/pulling the arm back (cocked back), throwing hard, coordinated hand/foot movement, whiplike arm action, forearm lag, pushing arm action, no trunk action, bending at the waist, stepping with the same foot, immature/immature stages, and following-through. Example: "She wasn't twisting, she wasn't throwing hard, (and) she's just pushing the beanbag right in front of her" (3-12).

NOTE: Category 3 can be coded with category 4, but not with category 5. In the latter case, only code category 3.

4) Pupil learning-skill (outcome/accuracy). The teacher shows concern for the accuracy or distance of the thrown object. Concern over how many balls were thrown by the child over the course the lesson (for monitoring purposes) may also fit this category. Example: "She was aiming her toss down at the concrete instead of her partner" (4-13).

NOTE: Category 4 can be coded with either category 3 or 5.

5) Pupil learning-skill (general). The teacher expresses concern over the throwing performance of a student in a general or vague manner.
None of the developmental body action components described in category 3 are mentioned by the teacher when this category is coded. References to throwing with the non-dominant hand, not throwing overhand, incorrect gripping of the object, and throwing sidearm or underhand are examples of thoughts associated with this category. Code category 3 if the teacher refers to throwing performance in a general way and also mentions developmental body action(s) in the same segment. Example: "He threw it but didn't do it correctly" (5-14).

NOTE: Category 5 can be coded with category 4.

6) Pupil attitude/mood/feelings. The teacher shows concern for the affective well-being of the student(s). Example: "She is not the type of child who enjoys physical activity and I hope some things like this might encourage her and make her feel successful at something physical" (6).

7) Pupil understanding of directions/routines. The teacher refers to events where students have difficulty understanding/following directions or completing routines. Example: "I was wondering whether they understood the directions I gave them. I said all of the children who had not got it through the hoop to get their beanbag" (7).

8) Pupil behavior/attention/lack of participation. The teacher expresses a concern for the behavior of students. Example: "Jeremy wasn't participating again. He was over by the hedge pulling the leaves off" (8-16).
9) **Procedure-instruction (learning-related).** The teacher's attention is on instructional techniques to facilitate student learning of skills, knowledges, or concepts. This category is tallied if the teacher describes a specific type of action to improve or maintain skill learning (e.g., feedback, manual assistance, verbal instruction, reinforcement of desirable body actions). This category is also recorded if the teacher expresses a concern for the appropriateness of an instructional approach for the students in the class. Example: "...I was showing her to step on the right foot" (1-9).

10) **Procedure-organization/equipment/facilities/safety/extraneous variables.** The teacher shows concern for organizational routines, grouping, formations, spacing, equipment, facilities, safety, or the environment (e.g., rain). Example: "I want to make sure that they're lined up correctly and the first person in line has several feet, or at least two feet between them and the person behind them so we won't get any noses smashed" (10).

11) **Procedure-management/discipline/control.** The teacher's attention is on measures to engage the pupils, keep them on task, or get them involved in the lesson or, the teacher refers to procedures to discipline/control the behavior of pupil(s). Example: "The kids were getting a little bit rowdy and I thought I needed to speed this up a little bit to give them less time to talk and fidget" (16-8-1-11).
Part Three. Information Source.

Cues used by the teacher to govern thoughts, decisions, and/or actions.

12) Observation-skill performance (form). The teacher's focus is on visual cues dealing with the appearance or absence of developmental body (form) actions such as oppositional foot stepping, body rotation, and/or a whiplike arm action (refer to category 3 for the descriptors). When the teacher expresses a negative concern for these actions, category 3 is also coded. Example: "I noticed that she was rotating, pulling her arm back, and throwing hard" (12).

13) Observation-skill performance (outcome/accuracy). The teacher's focus is on visual cues related to the accuracy or distance of the thrown object. When the teacher expresses a negative concern for these actions, category 4 is also coded. Example: "I noticed that he hit the target" (13).

14) Observation-skill performance (general). The teacher's focus is on visual cues related to the general/non-specific aspects of the throwing performance. None of the developmental body action (form) components described in categories 3 and 12 are mentioned by the teacher when this category is coded. When the teacher expresses a negative concern for these actions, category 5 is also coded. Example: "I was noticing that Amanda had done the throw incorrectly that time" (14-5).

15) Other sources-skill performance. The teacher focuses on non-visual cues to obtain information about student skill performance. These include student verbalizations, auditory cues (e.g., sound of ball), teacher expectations, teacher hunches, and/or teacher recall.
Example: "I heard her saying, I threw it hard. I threw it hard!" (15).

16) Observation-non skill learning. The teacher focuses on visual cues in order to obtain information about student behaviors not directly related to skill learning performance (e.g., attention, cooperation, following directions). Example: "I looked over and Ryan was hanging on the pole" (16-8).

17) Other sources-non skill learning performance. The teacher focuses on non-visual cues to obtain information about events and behaviors not directly related to skill learning. These include student verbalizations, auditory cues, teacher expectations, teacher hunches, and/or teacher recall. Example: "They were telling me they were getting tired" (17).

Awareness

Events and issues/topics that the teacher becomes cognizant of during the lesson.

18) Student interest/having a good time/participating. The teacher is aware that the students were interested in the class activities, were enjoying the lesson, were participating in the lesson, and were doing what they were supposed to be doing (busy/happy/good). Example: "Jeremy was participating. I noticed that." (16-18)

19) Teacher feelings. This refers to the emotions that the teacher experiences at a particular point in the lesson. Example: "I was a little bit more angry with him and annoyed with him than I realized, but it has been a bad week" (19).
Stimulated Recall Interview Data Sheet

Teacher ____________________________ Lesson # _______
School ____________________________ Date ___________________

<table>
<thead>
<tr>
<th>Segment #</th>
<th>Codings</th>
<th>Underlying throwing concepts</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
<td></td>
</tr>
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<td>2</td>
<td></td>
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<tr>
<td>3</td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Excerpts from a Stimulated Recall Interview With a Knowledge Trained Teacher (May 10, 1988)

* What were you thinking at that point? I was giving directions—"step with the opposite foot", emphasizing "step-throw", and I told them to step with the opposite foot over the rope in front of them and to twist. What were you noticing? ______

Was there anything else you thought of doing at that point but decided against? No.

* Thinking? I almost pulled her arm out of her socket (manually assisting). I was thinking that she just pushes the ball instead of throwing the ball. I was taking her arm and I was showing her how to throw hard---overexaggerating a little bit.

Noticing? She was pushing the ball with her arm.

Anything else? No.

* Thinking? I told him to throw hard.

Noticing? He was just pushing the ball.

Anything else? No. I thought he was crowded so I was trying to get the kids behind him away from him (move them back to give him more room to throw.

* Thinking? He wasn't stepping with the opposite foot ("You're not stepping").

Noticing? He just had his feet planted.

Anything else? No.

* Thinking? He made a tremendous throw.

Noticing? He was stepping into it, he was twisting, he was extending
his arm so I just gave him a little positive feedback ("Good Albert").

*Thinking? Throw it hard. Some of the girls were just not into it.
You have to keep reminding them to throw hard.

Noticing? In general, the girls were slacking off. That is, they weren't really throwing hard so it was just a little reminder. You have to prompt the kids.

*Thinking? I said "throw hard". The last time she threw she twisted and all but she just kind of pushed the ball.

Noticing? No. I just told her to throw hard that's all.

*Thinking? Camille wasn't twisting. She was stepping and she was really concentrating on her step-throw, but she wasn't twisting.
So I was just reminding her to twist.

Noticing? She needed a little prompting, that's all.

*Thinking? I was telling her to throw a little harder. She was pushing the ball, not really stepping hard into it and throwing it hard.

Noticing? 

Anything else? 

*Thinking? Valerie, I caught her at mid-throw more or less. I was just showing her how to twist---how to feel the twist. I am going through the motions with her (manually assisting her).
Noticing? ______

Anything else? ______

* Thinking? Hard! I was telling Latrina to throw hard.

Noticing? She was just throwing real easy and she was just pushing the ball.

Anything else? No, I was giving a little prompt with the hard.

* Thinking? This was the same little girl Marquetta. I was manually assisting her. She's very light and skinny so she's easy to handle. I was lifting up the leg, twisting the body, moving the arm---the whole works.

Noticing? I was trying to get her the feel for "step-throw-twist"--the whole bit! (chuckling)

Anything else? No, she was real easy to handle. She's so tiny.

* Thinking? That she was not holding the ball. It was like she was scared to completely grasp the ball. She was just kind of holding it with the ends of her fingers.

Noticing? I showed her how to hold it and then I stuck it in her hand.

Anything else? No.

* Thinking? A little bit better that time with the arm. She was kind of leading with the elbow a little bit which is like the arm movement I had gone through.

Noticing? No, just she was concentrating I think. When I'm right there with her she does. When I'm gone she doesn't.

Anything else? No.

* Thinking? Yes, that the kids are wild (teacher laughing). I don't know if it was the weather or the distraction of the balloon relay.
(lesson on adjacent field) or what. They just weren't into it.

Noticing? Nothing.

Anything else? No.

What were your primary objectives of this lesson? I was trying to get
the kids to focus in on a target using the things we had gone over about
the "step-throw", the twisting, the throwing hard, and the target was a
little bit smaller (the hoops), so I was trying to get them to focus in
on a specific area using the skills we had been practicing.
Excerpts from a Stimulated Recall Interview with a Knowledge Deficient Teacher

(May 10, 1988)

* What were you thinking at that point? Janice has been struggling with her throwing and I just thought she needed a little stroke ("Good Janice"). She hit the target.

What were you noticing? Nothing other than she hit the target.

Was there anything else you thought of doing at that point but decided against? _______

* Thinking? Sometimes I think that they just get up there and they're just throwing and they're not really aiming it at anything even though that big bunny (target) is staring them right in the face. So I was just trying to remind her that she was aiming at the bunny target.

Noticing? Nothing other than maybe she wasn't looking at the target.

Anything else? No.

* Thinking? He threw incorrectly. He was throwing down and that's what I demonstrated---the wrong way to throw it. So I was explaining to him that the reason why he didn't hit the target was because he was aiming down and he wasn't aiming at the bunny ("You're throwing it down").

Noticing? Nothing other than he wasn't aiming correctly.

Anything else? No.

* Thinking? That Jerry was aiming too high. He didn't hit the bunny because his arm was too high.

Noticing? Nothing other than the aim was too high.
Anything else? No.

* Thinking? I was thinking "Oh Manuel, you missed the whole target altogether". So I told Manuel—"You missed the target altogether".

Noticing? Nothing other than he didn't hit the target anywhere.

Anything else? No.

* Thinking? Jamaal on his first try missed the target altogether, and on his second try I told him better because he hit the target (note: the teacher didn't notice that the child lacked foot movement).

Noticing? No.

Anything else? No.

* Thinking? I was telling her that she was throwing down and there was no way she was going to hit the target if she was throwing.

Noticing? That her arm was going down instead of aiming at the target.

Anything else? ____

* Thinking? I said no good to Lenora. She threw over the target instead of at the target.

Noticing? Nothing other than she was throwing over the target instead of at the target.

Anything else? No.

* Thinking? That she wasn't centered (standing position relative to the target) and I was trying to get her centered so that she could hit the target.

Noticing? Nothing other than she wasn't centered.

Anything else? ____

* Thinking? Brandi was aiming too high and I was trying to tell her
that she needed to aim her toss a little lower.

* **Thinking?** That Brandi was aiming too high.

* **Thinking?** She hit the concrete at the bottom of the target. She
  was aiming down. At first she was too high and then she aimed too
  low. So she needed to modify.

* **Thinking?** That her aim was going down instead of at the bunny.

* **Thinking?** Brandon was standing correctly, he was tossing correctly,
  and he hit the bunny right in the center both times. I wanted the
  other children to notice if they stood and threw like Brandon they
  would hit the target.

* **Thinking?** That Brandon had the correct stance and he threw correctly
  both times.

* **Thinking?** Sometimes Sandra needs some assistance and I was just
  trying to show her how she needs to bring her arm back and follow
  through with her throw so that she could possibly be successful.

* **Thinking?** That she hit the target (note: teacher didn't notice
  the child's immature body actions).

* **Thinking?** That Timothy was aiming down. He wasn't aiming at the
bunny. So I was telling him he was throwing down and he needs to aim at the bunny.

Noticing? That his arm was going down.

* Thinking? I was thinking time was getting short and I needed to get them lined up. The partner activity (shifted to partner throwing activity)—we are going to toss at a close distance first and then a further distance with an overhand throw (approximately 10 and 20 feet, respectively).

Noticing? Nothing.

Anything else? No.

* Thinking? April had a good toss with the overhand throw. She just kind of followed through with her toss and she threw it high enough. I just thought it was a good toss.

Noticing? Same as above.

Anything else? No.

* Thinking? Timothy threw the beanbag incorrectly. He threw it underhand toss and we want an overhand toss. So I corrected him and told him to do it again.

Noticing? Same as above.

Anything else? No.

* Thinking? I had another child throw it underhand when tossing it so I was correcting him saying that he needed to throw it overhand.

Noticing? Same as above.

Anything else? No.
*Thinking? Everyone had a chance to throw at the short distance.

Now we are going to increase the distance and practice our overhand throw by throwing a little farther (from approximately 6 feet to 10 feet apart).

Noticing? Same as above.

Anything else? No.

*Thinking? April followed through with the throw and she was able to throw the distance (to the partner) and I told her that was a good throw.

Noticing? Same as above.

Anything else? No.

*Thinking? That Jennifer was throwing/aiming down. She wasn't throwing/aiming at her partner so I was correcting her.

Noticing? Same as above.

Anything else? No.

*Thinking? Cantrell was throwing a little high and I told her that she was throwing a little high.

Noticing? Same as above.

Anything else? No.

*Thinking? She was aiming her toss down at the concrete instead of her partner and I was correcting her---telling her she was aiming down.

Noticing? Same as above.

Anything else? No.

What were your primary objectives of this lesson? The objective of the lesson was to focus on overhand throwing by increasing
the distance. First we practiced at a shorter distance (approximately 6 feet) and then we moved to about 10 feet. So our primary objective was to throw and this is our first time trying to increase our distance.
### Table E-1

**Interrater Reliabilities for Teachers' Interactive Thoughts/Decisions**

<table>
<thead>
<tr>
<th>Categories of thoughts and decisions</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decisions</strong></td>
<td></td>
</tr>
<tr>
<td>1) Pupil-related</td>
<td>.85</td>
</tr>
<tr>
<td>2) Plan-related</td>
<td>.86</td>
</tr>
<tr>
<td>Overall reliability</td>
<td>.85</td>
</tr>
<tr>
<td><strong>Concerns</strong></td>
<td></td>
</tr>
<tr>
<td>10) Pupil learning-skill (form)</td>
<td>.98</td>
</tr>
<tr>
<td>11) Pupil learning-skill (outcome/accuracy)</td>
<td>.92</td>
</tr>
<tr>
<td>12) Pupil learning-skill (general)</td>
<td>.80</td>
</tr>
<tr>
<td>13) Pupil attitude/mood/feelings</td>
<td>.83</td>
</tr>
<tr>
<td>14) Pupil understanding of directions/routines</td>
<td>.80</td>
</tr>
<tr>
<td>15) Pupil behavior/attention/lack of participation</td>
<td>.83</td>
</tr>
<tr>
<td>16) Procedure-instruction (learning-related)</td>
<td>.83</td>
</tr>
<tr>
<td>17) Procedure-organization/equipment/facilities/safety</td>
<td>.80</td>
</tr>
<tr>
<td>18) Procedure-management/discipline/control</td>
<td>.83</td>
</tr>
<tr>
<td>Overall reliability</td>
<td>.86</td>
</tr>
<tr>
<td><strong>Information Source</strong></td>
<td></td>
</tr>
<tr>
<td>20) Observation-skill performance (form)</td>
<td>.95</td>
</tr>
<tr>
<td>21) Observation-skill performance (outcome/accuracy)</td>
<td>.89</td>
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<tr>
<td>22) Observation-skill performance (general)</td>
<td>.81</td>
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<td>23) Other sources-skill performance</td>
<td>.83</td>
</tr>
<tr>
<td>24) Observation-non skill learning performance</td>
<td>.81</td>
</tr>
<tr>
<td>25) Other sources-non skill learning performance</td>
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</tr>
<tr>
<td>Overall reliability</td>
<td>.88</td>
</tr>
</tbody>
</table>
Table E-1 cont'd

**Awareness**

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>30</td>
<td>Student interest/having a good time/participation</td>
<td>.85</td>
</tr>
<tr>
<td>31</td>
<td>Teacher feelings</td>
<td>.80</td>
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<td>32</td>
<td>Principles of teaching/classroom academics</td>
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</tr>
<tr>
<td>33</td>
<td>Alternatives</td>
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<tr>
<td></td>
<td><strong>Overall reliability</strong></td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td><strong>Total interrater reliability</strong></td>
<td>.86</td>
</tr>
</tbody>
</table>


Table E-2

Interrater Reliabilities for Identifying Knowledge Concepts within Teachers' Interactive Thoughts and Decisions

<table>
<thead>
<tr>
<th>Knowledge Concepts</th>
<th>Agreement</th>
<th>Disagreement</th>
<th>Reliability</th>
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</thead>
<tbody>
<tr>
<td>Leg/foot action</td>
<td>25</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Pelvic/spine action</td>
<td>24</td>
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<td>1.00</td>
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<tr>
<td>Arm/shoulder action</td>
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<tr>
<td>Force production</td>
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<tr>
<td>*Other concepts</td>
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<td>1.00</td>
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<td><strong>Total</strong></td>
<td>108</td>
<td>2</td>
<td>0.98</td>
</tr>
</tbody>
</table>

*NOTE: Other concepts include the identification of the developmental stages of development, miscellaneous research findings, and content specific drills.
APPENDIX F

Quality of Practice Trials Information
Table F-1

Interrater Agreement for the Quality of Practice Trials

<table>
<thead>
<tr>
<th>Description of throw</th>
<th>Lessons</th>
<th>Overall</th>
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<tbody>
<tr>
<td>Opposite foot action</td>
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<td></td>
</tr>
<tr>
<td>(stage 3 or higher)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposite foot action</td>
<td>.91</td>
<td>.95</td>
</tr>
<tr>
<td>Absence of opposite foot action</td>
<td>.90</td>
<td>1.00</td>
</tr>
<tr>
<td>Uncodable throws</td>
<td>.89</td>
<td>1.00</td>
</tr>
</tbody>
</table>
APPENDIX G

Overhand Throwing Developmental Body Component Ratings
Table G-1

Interrater Agreement for the Overhand Throwing Developmental Body Component Ratings

Agreement after 30 hour training program

<table>
<thead>
<tr>
<th>Foot action</th>
<th>Trunk-pelvic action</th>
<th>Arm action</th>
<th>Overall agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>.90</td>
<td>.97</td>
<td>.92</td>
<td>.93</td>
</tr>
</tbody>
</table>

*Average of periodic agreement checks

| .89 | .93 | .91 | .93 |

*Measured each time the coders completed rating a class of approximately 20 throwers.
## Sample Developmental Stage Rating Summary Sheet

<table>
<thead>
<tr>
<th>Throw #</th>
<th>Foot</th>
<th>Pelvic-Spine</th>
<th>Arm/Shoulder</th>
<th>Comments</th>
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<td>10</td>
<td>3</td>
<td>3</td>
<td>5</td>
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</tr>
</tbody>
</table>

**Total =** 39 39 46

**Avg. Ratings =** 3.9 3.9 4.6
Baseball Related Experiences of the Overhand Throwing Coders/Raters

Coder #1

* Four years baseball/softball coaching experience
* Eight years little league baseball playing experience
* American Legion baseball playing experience
* Three years high school baseball playing experience
* High school baseball awards included numerous district /all star team selections, and a most valuable player award
* Three years of college varsity baseball experience
* "All Conference" and "NAIA All Star" selections while in college
* Four years of softball league and tournament experience
* Umpiring experience

Coder #2

* Fourteen years softball umpiring experience
* Six years baseball umpiring experience/two years as a head umpire
* Four years baseball coaching experience
* Six years softball coaching experience (one district championship)
* Twenty years baseball playing experience
* Fifteen years softball playing experience
* Six times selected to baseball all star teams
* Four times selected to softball all star/all tournament teams
* Played on three league championship teams
* Played in three state softball tournaments
APPENDIX H

Permission Forms
Dear Parents:

Your son's/daughter's teacher has agreed to be videotaped for six weeks as she instructs throwing skills during your child's physical education period. Prior to and following the six week period of instruction, each child's throwing pattern will be videotaped. The purpose of this project will be to investigate how throwing skills develop as a result of physical education instruction.

In order for your child to participate in this project, it is necessary for us to have parental permission. Will you please give us that permission by completing the form at the bottom of this page? Return it to your child's teacher. It will be kept on file at the school.

Thank you for your cooperation.

Ed Walkwitz
Research Assistant
School of HPERD
Louisiana State University

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I give my permission for my child to participate in the six-week throwing unit and to be videotaped. Name of child____________________

Signature of parent_______________________ Date___________________
Informed Consent for the Overhand Throwing Study

*To be kept and filed by the researcher

My signature represents my willingness to participate in the overhand throwing study conducted by Ed Walkwitz. I have been informed that I can withdraw at any time, and I have been oriented to the general nature of the investigation. I understand that the data will be presented in a dissertation, and may be used for additional research projects. In presenting the data and results, my identity will not be revealed without my permission.

In signing this form, I further agree to: 1) take part in three teacher training sessions, 2) allow two observers to view my regular classroom instruction on three occasions, 3) teach a six week overhand throwing unit to my kindergarten class, 4) not seek assistance from others in planning for the lessons, 5) maintain an accurate record of my daily lesson activities, 6) allow my throwing lessons to be filmed, 7) participate in six after school interviews with the investigator, and 8) to distribute and collect the parental permission forms for the students in my class. In return for these services and inconveniences, I have been informed that I will be paid $100 at the end of the unit.

____________________
Subject's Signature
VITA

Edward Walkwitz was born May 1, 1949, in Holyoke, Massachusetts. He graduated from South Hadley High School, South Hadley, Massachusetts in June 1967. He earned a Bachelor of Science degree from Springfield College at Springfield, Massachusetts, in 1972, with a major in Physical Education. In 1974, he was awarded a Master of Science degree in the same discipline from the University of Montana.

The author has taught physical education at the elementary, secondary, college, and university levels for more than 13 years. Eight of those years were spent as a full-time faculty member at Louisiana State University. In addition, during the past year he was employed as a Program Manager with the Louisiana Department of Education.

The Doctor of Philosophy degree in Physical Education with a specialization in pedagogy was awarded from Louisiana State University on August 3, 1989.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Edward Walkwitz

Major Field: Physical Education (Pedagogy)

Title of Dissertation: Effect of knowledge on teachers' interactive thinking and childrens' overhand throwing performance.

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE

[Signatures]

Date of Examination: July 13, 1989