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A Comparison of Pedagogical Knowledge Structures of Preservice Students and Teacher Educators in Two Institutions

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Understanding how the knowledge structures of preservice teachers develop as expertise is acquired would seem to be an important aspect of teacher preparation. The purpose of this study was to compare the pedagogical knowledge structures about effective teaching of preservice teachers and teacher educators in the professional preparation programs of two different institutions. Two groups of preservice teachers at two different points in their preparation program at each of the two institutions were asked to complete a concept map (Roehler et al., 1987) about effective teaching. One group completed the concept map just after the first teaching methods course, and the other group completed the map just prior to student teaching. These data were compared with concept maps of teacher educators at each institution. Quantitative and qualitative data revealed differences between the groups of preservice teachers and between the preservice teachers and the teacher educators.

A recent emphasis on the knowledge base for teaching has provided the stimulus for an increased emphasis in studying not only what the teacher knows but how that information is structured and organized. Knowing is conceived as a process in which an individual constructs a model of reality from interactions in the environment (Jonassen, 1987), and these models are stored as related constructs referred to as *cognitive structures*. The concept of knowledge structures has emerged primarily from recent research in cognitive psychology (Frederiksen, 1986; Schuell,1986) and perhaps more importantly from the comparison of experts and novices in a variety of fields (Chi, Glaser, & Rees, 1982). Schon (1987) suggested that individuals holding different conceptual frameworks pay attention to different facts and make different interpretations of the information.

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A variety of techniques have been used to measure the organization of knowledge. Among these are hierarchical ordered trees (Naveh-Benjamin, McKeachie, Lin, & Tucker, 1986; Reitman, & Reuter, 1980); digraph analysis (Geeslin & Shavelson, 1975; Shavelson, 1972); card sorting of concepts (Shavelson & Stanton, 1975); concept sorting (Champagne, Klopfer, Desena, & Squires, 1981); concept mapping (Morine-Dershimer, 1989, 1990); hierarchical concept maps (Roehler et al., 1987); and construct, pattern notes (Jonassen, 1987). There are advantages and disadvantages for particular techniques. For further discussion of the advantages and disadvantages of these techniques, the interested reader should consult Kagan (1990) or Reitman, Olson, and Biolsi (1991).

Educational research has used either of two similar concept-mapping techniques: concept maps (Morine-Dershimer, 1989, 1990) and hierarchical concept maps (Roehler et al., 1987). Concept maps, sometimes called cognitive maps, have been used both as a teaching tool and as a measure of organizational structure and relationships between ideas (Diekhoff & Diekhoff, 1982). Concept maps require subjects to select and categorize a list of starter words on a large concept, such as effective teaching, and to draw a graphic representation of concepts to show how they are conceptually related. Concept maps have the advantage of more comprehensively identifying the meaning a subject attaches to a construct because there is no predetermined structure and no limitation on the number of concepts.

Other techniques (digraph analysis, card sorting of concepts, ordered trees) used to elicit knowledge structures often give a limited number of concepts to the subject and ask the subject to either rate the relatedness of pairs of words, order a list of concepts based on associations, or arrange the concepts into self-generated categories. Although these techniques reveal much concerning the structure of the concepts, they tell us little about the strength of the representation of given concepts within the subject's knowledge base. Concept maps allow one to assess *what* concepts are most meaningful to the subject and provide information about the way concepts are organized and conceptually framed. Concept maps have traditionally been analyzed in terms of the number of concepts an individual includes, the coherence of the organization, and how concepts are chunked (grouped) into meaningful units.

Research on classroom teaching indicates that teachers who have more coherent and organized knowledge structures exhibit more effective teaching behaviors than do teachers with less organized and coherent knowledge structures for teaching (Herrmann, 1987a, 1987b, 1988; Morine-Dershimer, 1989, 1990). Not only have experts acquired more knowledge, but they are able to organize information into meaningful units (chunks), make sense out of their experiences, and establish logical relationships between chunks of knowledge. Such organization makes knowledge it more accessible to individuals.

There have been initial attempts in physical education to access knowledge structures of novice and experienced teachers in physical education (Griffey, Hacker, & Housner, 1988). In general, this work supports research in the classroom, concluding that the knowledge structures of novice teachers in physical education are less extensive and less coherent than those of experienced teachers. Ennis, Mueller, and Zhu (1991) assessed the knowledge structures of both novices and experts involved in a concept-based curriculum using the hierarchical concept, mapping techniques used by Roehler et al. (1987). Ennis et al. suggested that

differences in the knowledge structures of novices, experienced students, and experts exhibited characteristics of learning processes (accretion, tuning, and restructuring) described by Rummelhart and Norman (1978).

Novices appeared to develop knowledge primarily through *accretion* (Ennis et al., & Zhu, 1991), an incremental accumulation of facts. This type of learning occurs through exposure to the concepts to be acquired. Information processing transforms the acquired information into memory representation, which is then added to the existing knowledge representation. No type of reorganization or structural change within the information processing system is needed to accommodate the new information (Rummelhart & Norman, 1978).

Experts and more experienced students exhibited characteristics of *tuning* and *restructuring* learning processes (Ennis et al., 1991). Tuning involves changes in the categories used to interpret new information (Rummelhart & Norman, 1978). Once a set of categories are developed, they undergo modification to bring them more in line with the functional use of the categories (Rummelhart & Norman, 1978). Thus, tuning involves rearranging and redefining concepts on a continual basis to better functionally use the concepts in task appropriate ways.

Restructuring is a more difficult and lengthy learning process. It occurs when new structures or organizations are created for interpreting new information. These new organizations then allow for new interpretations or uses of the knowledge (usually improved accessibility of the knowledge) and for the acquisition of new knowledge (Rummelhart & Norman, 1978). Restructuring requires that a critical mass of information be developed first, which presumably takes place only after a considerable amount of time. Rummelhart and Norman (1978) suggest that the accumulated volume of information and its unorganized nature gives rise to the need for restructuring.

In sum, accretion is merely adding facts or concepts. Tuning refines concepts by adding or deleting exemplars that better define the concept and its application. Restructuring involves a change in the overall structure of existing relations between a developed set of concepts.

There are two limitations of previous work in physical education. First, the analyses conducted and reported by Ennis et al. (1991) did not present overall frameworks of the concepts that might reflect restructuring processes across levels of expertise. For example, the major headings, their horizontal and vertical arrangement, often reflect conceptualization of a body of knowledge. Second, the concepts actually contained within the knowledge structures of experts and novice teachers were not reported. For example, the quantitative analyses reported by Ennis et al. (1991) gave no reference to the actual content of the concepts deemed important by experts and novices. A good illustration of the importance of examining the concepts included in the concept maps of prospective teachers is provided in Morine-Dershimer (1989, 1990).

If content and structure of knowledge of effective teaching possessed by experts differs from those teachers with less expertise, it is important to know how more sophisticated knowledge structures develop. The idea that an individual can increase expertise by increasing the depth and coherence of the knowledge structure is appealing but is, at this point, premature. A substantial research base that extends our understanding of the nature of the knowledge structures of the novice and of how knowledge structures develop through preservice education is needed.

The purpose of this study was to compare the knowledge structures for effective teaching of undergraduate preservice teachers at two universities with different approaches to teacher education course work. Measures of knowledge structure were obtained after the first teaching methods course and again after the completion of all methods courses immediately before student teaching. A secondary purpose of this study was to compare the knowledge structures of teacher educators from the two programs with each other and with the preservice students. The data were analyzed to examine differences in the actual concepts included in each group's concept maps as well as the structure of the concepts represented. The analyses reported were devised to detect changes in knowledge structures that may reflect different learning processes (accretion, tuning, restructuring).

Method

Subjects

Participants in the study were undergraduate students enrolled in the teacher education programs in physical education and teacher educators at Louisiana State University (LSU) and the University of South Carolina (USC). Figure 1 provides a summary of the teacher education in physical education curriculum at each university. The general education requirements and course work in the movement sciences are similar. Both programs have an introductory course in teaching effectiveness. At LSU the introductory course is taught by faculty in the College of Education outside of physical education and provides generic teaching concepts such as principles and practices of classroom instruction, management, and evaluation within the context of the reflective analysis of teaching. At least 1.5 hours per week of observation of physical education instruction in the schools is required in this course.

The introductory course at USC is taught by physical education faculty and is structured to present the principles and practices of effective teaching specific to physical education. Topics include planning, task presentation, content development, feedback, and the development of basic instructional skills applied primarily to direct instruction through micro, peer-group teaching experiences.

Following the introductory course, the students at LSU take a 9-hour elementary and secondary curriculum and instruction block of courses just prior to student teaching. One course is devoted to work with elementary school physical education, a second course to work with secondary school physical education, and a third course to curriculum. The preservice students at USC follow the introductory block with a four-credit elementary school experience taught at an elementary school, a content course in elementary school physical education, a four-credit secondary school physical education course, and an analysis and evaluation of teaching course. The elementary and secondary block methods courses are taught at the schools. Small groups of students are involved in weekly planning, teaching, and evaluating experiences under the direction of university teacher educators. Work in curriculum is taught simultaneously with student teaching.

The design was cross-sectional. Two groups of undergraduate students at LSU were recruited as preservice subjects. The beginning preservice students

Louisiana State University	*University of South Carolina*
Principles and practices in professional education (4 hours, sophomore year)	Instruction in physical education (4 hours, 1st semester junior)
Novice preservice teacher data collection	
Elementary and secondary curriculum and instruction block (9 hours, senior year)	Teaching the young learner (4 hours, 2nd semester junior)
Elementary physical education (3 hours)	Elementary physical education (3 hours, 2nd semester junior)
Teaching secondary physical education (3 hours)	Teaching secondary physical education (4 hours, 1st semester senior)
Content for K–12 physical education	Evaluation and analysis of teaching (3 hours, 1st semester senior year)
Experienced preservice teacher data collection	
	Curriculum in physical education with student teaching (3 hours)

Figure 1 — Comparison of teacher education methods courses.

(Group A, n = 10) had completed the effective teaching course. The second group of preservice subjects (Group B, n = 10) had completed the methods sequence and were entering student teaching the following semester. Preservice (Group A, n = 16) data at USC were obtained after the beginning course in basic instructional skills taught on campus. Data were collected on experienced preservice students (Group B, n = 16) at USC just prior to student teaching. Two teacher educators responsible for course work in methods of teaching at USC and 3 teacher educators at LSU completed the procedures for comparative purposes.

Procedures

The hierarchical concept-mapping technique introduced by Roehler et al. (1987) was used to obtain concept maps for "effective teaching." This technique has been used in studying classroom teaching (Herrmann, 1987a, 1987b, 1988, 1989) and in physical education (Ennis et al., 1991). It differs from other concept-mapping techniques reported in the literature (e.g., MorineDershimer, 1989, 1990) in that this technique (Roehler et al., 1987) asks subjects to construct a hierarchical arrangement of the concepts, whereas other techniques (e.g., Morine-Dershimer, 1989, 1990) do not require a hierarchical arrangement.

The same protocol was used at both universities to train subjects in this technique using the written procedures from Roehler et al. (1987). Students were given a written description of the characteristics of a hierarchical concept map

and were given practice in constructing a map. Subjects read a description of a hierarchical concept map and an example of the steps to construct a possible knowledge structure for the concept *dogs*. Sample words for dogs (*cocker spaniel, bloodhound, bark, black, whine, collie, white, tail, shed, paw, growl, terrier, brown, spotted, poodle, cold nose, pet*) were provided. Subjects were instructed to first categorize words that seemed to go together. Examples of possible categories for *dogs* were types of dogs (*cocker spaniel, bloodhound, terrier, collie, poodle*), parts of dogs (*tail, cold nose*), what a dog does (*bark, whine, shed, growl*), and colors of dogs (*black, white brown, spotted*). Subjects were told that each broad concept should be labeled and that in many cases they would have to generate a label that made sense to them. Each concept could be considered a branch or subbranch of a tree. Once concepts had been developed, subjects were instructed that the concepts could be arranged in ways that showed how one thinks about a given topic. Subjects were then shown a possible arrangement for dogs in which the first concept (kinds of dogs with related words: *cocker spaniel, terrier, poodle bloodhound*) was placed above the second concept (what all dogs are like). Subconcepts under the second concept included what dogs have (*tail, paw, hair*), what dogs do (*bark, run away*), and sounds dogs make (*bark, growl, whine*).

Several points concerning these instructions are important. First, notice that concept labels often were not present in the word list. Subjects often have to generate concept labels. Second, notice that the second concept label (what all dogs are like) was generated to organize groups of concepts that were placed under it. Thus, subjects often have to generate labels to organize words into concepts and to identify groups of related concepts that they deem functionally related.

After the example of a concept map of *dogs* was read and thoroughly explained, subjects were then given a short word list (15 words) and were asked to complete a concept map for *schools* by first organizing the words into concepts, generating labels for each concept, generating other labels for additional concepts if needed, arranging concepts spatially to represent hierarchical relationships, and finally connecting concepts with drawn lines to represent associations between or among them.

Following these preliminary steps, subjects were asked to brainstorm for words to describe effective teaching in physical education. After the subject could no longer think of words, a word list was provided. The word list was provided to enhance the recognition of meaningful concepts in long-term memory. Subjects were then instructed to organize and integrate their word list with the starter list, organize the words they were familiar with into meaningful concepts, label each concepts, and draw associations between or among concepts.

Because the specific language for certain terms used to describe effective teaching in physical education differs slightly at different institutions using different instructional texts, word lists differed slightly at each institution. Figure 2 presents the starter words that were common at each institution, as well as specific words used only at LSU or USC. The words are listed in random order as they were originally presented to the subjects for data collection. The words used specifically at USC mainly reflected more features used to describe instructional terms common to both word lists. The words specific to the LSU program focused more on content. Subjects were instructed to use only those words on the list

Common to both		*LSU only*
planning	closed skill	aerobic
task presentation	summative evaluation	attention
practice	sumarizing	balance
cues	corrective feedback	body awareness
demonstration	general feedback	cardiovascular
equipment	part/whole	competition
cognitive	previous experience	direct teaching
questioning	short-term goals	dribble
content development	individual feedback	endurance
affective	refinement	flexibility
evaluation	teacher expectation	fundamental skills
modeling	positive feedback	heart rate
guided practice	negative feedback	hop
student behavior	engaged time	jump
dance	student grouping	laterality
extensions	motivation	locomotor skills
gymnastics	movement tasks	motor learning
formative evaulation	massed practice	participation
checks for understanding	distributed practice	problem solving
prerequisites	communication	reaction time
games	extrinsic	self-concept
long-term goals	individualization	sport skills
open skills	reciprocal teaching	sportsmanship
class rules	clear, concise, complete, correct	stretch
unit	transfer	strength
objectives	modification	teaching styles
teaching strategies	readiness to learn	warm-up
interactive decision making	rewards	teacher behavior
expectations	retention	extrinsic
review	direct instruction	
sequencing	station teaching	
repetition	success rate	
management	teacher	
automatic stage	feedback	
simple	motor development	
ALT-PE	learning domains	
games		

Figure 2 — Starter word lists from the two programs. ***(continued)***

USC only

teacher intention	preactive planning	sample questioning
teacher action	parents	group questioning
psychomotor	overlapingness	Christmas
vacation	student learning	heterogeneous
set induction	eye contact	signal response
congruent	daily planning	choral response
teacher talk	weekly planning	Bloom's taxonomy
gymnasium	chalk	group feedback
procedures	criteria	stduent expectations
teacher scanning	dog	specific feedback
teacher movement	associative stage	incongruent feedback
examples	selection	evaluative feedback
independent practice	apparatus	nonexamples
conditions	Monday	principal
closure	complex	allocated time
wittiness	teacher focus	

Figure 2 — *(continued)*

that were most meaningful. Several "filler" words or distractor words (e.g., *Christmas, vacation, dog*) were included to help eliminate any tendency to use every word on the list, even if the words were not meaningful.

Results

Overall Quantitative Analyses

Three quantitative measures were obtained from the data: the number of words included, the number of concepts, and the average number of words per concept. A concept (chunk) was defined as a verbal label (one word or phrase, e.g., *types of dogs*) with word at least two words (features, e.g., *poodle, German shepherd*) associated with it. A chunk could be determined from the graphic representation of lines drawn between the words and the concept indicating a relationship. Separate 2 × 3 (University × Experience Level) analyses of variance were used to test for differences in the overall number of words included, number of concepts, and the average number of words per concept. The alpha level was set a $p < .05$.

The main effect for experience level was significant for the number of words included, $F(2, 51) = 29.73$, $p < .01$, and the number of chunks, $F(2, 51) = 34.35$, $p < .01$. No other effects were significant. Student Newman Kuels tests were conducted to determine group differences. Follow-up analyses of the mean number of words included and of the number of chunks revealed that novice preservice students were significantly different from experienced preservice students and that experienced preservice students were significantly different from the teacher educators. Teacher educators had the highest number of words (M =

Table 1 Mean Number of Words, Number of Chunks, and Average Number of Words per Chunk at Each University

	University of South Carolina			Louisiana State University		
	Words	Chunks	Average words/chunk	Words	Chunks	Average words/chunk
Group A	47.0	7.5	5.9	55.2	12.1	7.4
Group B	74.5	12.2	6.2	79.9	17.9	6.0
Teacher educator	152.5	33.0	4.5	107.3	33.3	3.3

Note. Group A = novice preservice students. Group B = experienced preservice students.

125) and chunks (M = 33), followed by experienced preservice students (words, M = 77; chunks, M = 14.6) and novice preservice students (words, M = 50; chunks, M = 8.4). The means for each group at each university are presented in Table 1.

Analysis of Critical Concepts

An analysis of the concept maps was conducted to compare the specific concepts used and the manner in which concepts were organized. Critical concepts were identified. The presence of these concepts and whether they were a single concept or a chunk was determined. Most concepts were common to both institutions: planning, objectives, short-term goals, long-term goals, content development, task presentation, teaching strategies, management, behavior, time, organization, monitoring, content, domains, game stages, evaluation, feedback, and interactive teaching.

An analysis was conducted to determine which of these concepts were present as words on the maps of the subjects and which were labeled by the concept name and represented as a chunk of words associated with that concept. For example, the word *task presentation* could appear in the concept map as either (a) a separate chunk labeled "task presentation" that had at least two exemplar words connected to it or (b) a word that was part of a global chunk labeled more broadly than just "task presentation." Figure 3 gives examples of appropriate exemplar words for four concepts (objectives task presentation, teaching strategies, content development). If concepts appeared in the maps as a verbal label with at least two appropriate exemplars associated with it, the concept was judged as a chunk. In some cases, concepts had few appropriate exemplars (i.e., learning domains). Thus, the criteria was set at two exemplars in order to be judged a chunk.

Independent coders at each institution examined the concept maps of their respective subjects. Whether each of the critical concepts identified was present and whether the concept was chunked was recorded for each subject. The frequency of concepts present and the number of concepts chunked was determined for each group and converted to a percentage for each group.

No statistical analyses were conducted for these data. The number of concepts (n = 19) would have deemed 19 statistical tests. The experimentwise

Objectives	*Task presentation*	*Teaching strategies*	*Content development*
criteria	set induction	interactive	informing
behavior	summary cues	indirect	extension
psychomotor	demonstration	peer teaching	refining
affective	check for understanding	station teaching	applying
cognitive	closure	reciprocal teaching	
		self-paced	

Figure 3 — Examples of some appropriate exemplars for selected concepts.

error rate for that number of tests would inflate the alpha level to the point that any statistical significance would be questionable. Adjustment of the alpha level by the Bonferroni technique would decrease the power to a nominal level. Therefore, these data are presented descriptively and differences are discussed only when meaningful trends in the data appear warranted. Table 2 summarizes the analysis of critical concepts present in the concept maps of Preservice Group A (novice), Preservice Group B (experienced), and teacher educator groups at each institution. The percentage of subjects in each group who included a given concept and the percentage of subjects who chunked associated words with that concept are presented. The teacher educators included these concepts in their concept maps fairly consistently. Most concepts were present in the teacher educator maps and categorized into a chunk of associated words.

There are several interesting patterns in the concept analysis of the preservice students. First, there were differences (greater than 20 percentage points) between novice preservice students (Group A) in the inclusion of specific concepts. Group A students at USC were more likely to include *planning, short-term goals, content development, task presentation, management, behavior, time, organization, monitoring, learning domains,* and *feedback* than were LSU novices. The novice students at LSU included *long-term goals, teaching strategies,* and *evaluation* in their maps more frequently than did USC novice students. Both groups were similar for *objectives* and *content.* These differences are likely the result of different emphases in the course work taken by each group. The LSU students had taken a generic teaching course within education that included a broader perspective on teaching and the curriculum/instruction process. USC students had taken a physical education specific teaching course that focused more narrowly on instruction.

The percentages of experienced preservice students (Group B) at both institutions who included *planning, objectives, short-term goals, teaching strategies, time,* and *feedback* were similar. Percentages were higher at USC for some concepts (*task presentation, interactive teaching*) and higher at LSU for other concepts (*long-term goals, content, evaluation*). These differences are presumably attributable to program emphasis. Task presentation is heavily emphasized at USC. A high percentage of novice students (75%) and an even higher percentage of the experienced students (93.7%) included *task presentation.* The lower percentages at USC for *long-term goals* is predictable because these students had

Table 2 Percentage of Subjects Who Included and Chunked Specific Concepts

	Louisiana State University						University of South Carolina					
	Concepts			Chunks			Concepts			Chunks		
	A	B	Faculty	A	B	Faculty	A	B	Faculty	A	B	Faculty
Planning	70.0	100.0	100.0	10.0	100.0	100.0	93.7	100.0	100.0	56.2	75.0	100.0
Objectives	40.0	90.0	100.0	20.0	20.0	66.7	43.7	93.7	100.0	0.0	56.2	100.0
Short-term goals	30.0	60.0	33.3	20.0	20.0	0.0	75.0	68.7	50.0	0.0	0.0	0.0
Long-term goals	50.0	100.0	66.7	40.0	50.0	33.3	37.5	68.7	100.0	0.0	0.0	100.0
Content dev. planning	0.0	40.0	100.0	0.0	20.0	100.0	37.5	68.7	50.0	0.0	37.5	0.0
Content dev. instruction	30.0	60.0	100.0	20.0	40.0	66.7	43.7	31.2	100.0	18.7	18.7	100.0
Task presentation	40.0	70.0	100.0	10.0	40.0	100.0	75.0	93.7	100.0	25.0	50.0	100.0
Teaching strategies	70.0	80.0	66.7	50.0	80.0	66.7	31.2	75.0	100.0	0.0	62.7	100.0
Management	40.0	90.0	100.0	20.0	60.0	100.0	68.7	75.0	100.0	18.7	18.7	100.0
Behavior	30.0	40.0	100.0	10.0	20.0	100.0	62.5	75.0	100.0	25.0	31.2	100.0
Time	10.0	70.0	100.0	0.0	10.0	66.7	68.7	75.0	100.0	18.7	37.5	50.0
Organization	20.0	30.0	100.0	0.0	20.0	100.0	62.5	50.0	100.0	0.0	12.5	50.0
Monitoring	10.0	20.0	100.0	0.0	0.0	66.7	62.5	62.5	100.0	12.5	25.0	100.0
Content	30.0	70.0	100.0	30.0	60.0	100.0	31.2	37.5	100.0	18.7	37.5	100.0
Domains	10.0	50.0	66.7	10.0	30.0	66.7	43.7	31.2	100.0	43.7	31.2	100.0
Game stages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	6.2	0.0
Evaluation	70.0	80.0	100.0	30.0	60.0	100.0	43.7	37.5	100.0	6.2	18.7	100.0
Feedback	60.0	100.0	100.0	30.0	70.0	66.7	87.5	100.0	100.0	68.7	87.5	100.0
Interactive	0.0	40.0	100.0	0.0	10.0	100.0	0.0	62.5	100.0	0.0	12.5	50.0

Note. A = Novice preservice students. B = Experienced preservice students.

not taken coursework in curriculum (see Figure 1). The inclusion of *content* at LSU is probably due to minor differences in the word list and possibly more emphasis on integration of content with effective teaching in coursework at LSU. The percentage of students at USC who included *evaluation* was low (43% novice and 37.5% experienced). These students were not integrating evaluation into their conceptual framework for effective teaching, which may indicate a potential area of weakness in the students' preparation.

There are two other interesting patterns between the two experienced groups of students. More USC students included *content development* in *planning*, whereas more LSU students included *content development* under *instruction*. This is interesting because the USC faculty associated content development more with instruction, as evidenced by both teacher educators chunking *content development* under *instruction* rather than *planning*. The other pattern was in the organization of management information. The experienced students at LSU included *management* (90%) and tended to chunk *management* (60%). LSU

students had lower percentages for *behavior, organization,* and *monitoring,* which could be considered related to management. Most students at USC included *management* (75%), but also had higher percentages for *behavior, organization,* and *monitoring.* The LSU teach educators included *behavior, organization,* and *monitoring* as concepts as well; however, few of the experienced LSU students included these concepts (40%, 30%, and 20% respectively).

Qualitative Differences

Qualitative analyses were performed to identify (a) the major concepts used as organizers for the framework, (b) the horizontal/vertical spatial relationships between the concepts, and (c) the accuracy/appropriateness of the relationships described. Identifying the specific concepts used as organizers and the manner in which they are spatially related provides insight into the structure of the knowledge base and meaning of relationships between concepts.

Identifying inappropriate groupings of words was useful for recognizing subjects whose understanding of concepts and exemplars was incomplete or inappropriate or was a result of insufficient tuning.

Teacher Educators. There were minor differences among the teacher educators in the hierarchical organization of the framework for effective teaching. Figure 4 is an illustration of the concept map of Teacher Educator 1 at USC. In the interest of space, only the major headings are shown, and the details of the subconcepts and words are not included. The exact spatial arrangement of the major headings is given in Figure 4 to illustrate relationships between ideas. For this particular teacher educator, there are clear foundations for curriculum (i.e., knowledge of learners, philosophy and values, knowledge of content, knowledge of teaching and learning theory), a clear hierarchial relationship between curriculum and instruction, and dynamic relationships between instructional constructs.

The major headings of the other teacher educators are presented in Figure 5 as they were spatially arranged vertically and horizontally in the maps. We chose to present these in this form to save space and because the horizontal and vertical placement within the educators' concept maps was not compromised in this format. Thus, the hierarchical framework used by each subject is presented. The two teacher educators at USC used major headings similar to Schulman's (1987) categories for the knowledge base for teaching to frame their representation of effective teaching. The teacher educators at LSU primarily used a preactive–active–evaluation framework. Each of the LSU teacher educator maps contained large headings reflecting planning or preactive processes, and active or concepts related activities during instruction.

Two of these teacher educators had a large heading for *evaluation.* Notice that the frameworks for the two teacher educators at USC also included large headings for *planning/curriculum* and *active instruction.* In fact, Teacher Educator 1 at USC organized the major chunk labeled the "process of instruction" into three subconcepts *prelesson planning, teaching,* and *evaluation.* LSU Teacher Educator 1 had headings for *preactive* and *active* under *teacher behavior* and *student behavior.* Teacher Educator 2 had headings for *planning,* several active teaching functions (*interactive teaching, classroom management, behavior management, learning environment*), and *evaluation.* Teacher Educator 3 organized headings into *preactive, active,* and *reflection* (evaluation).

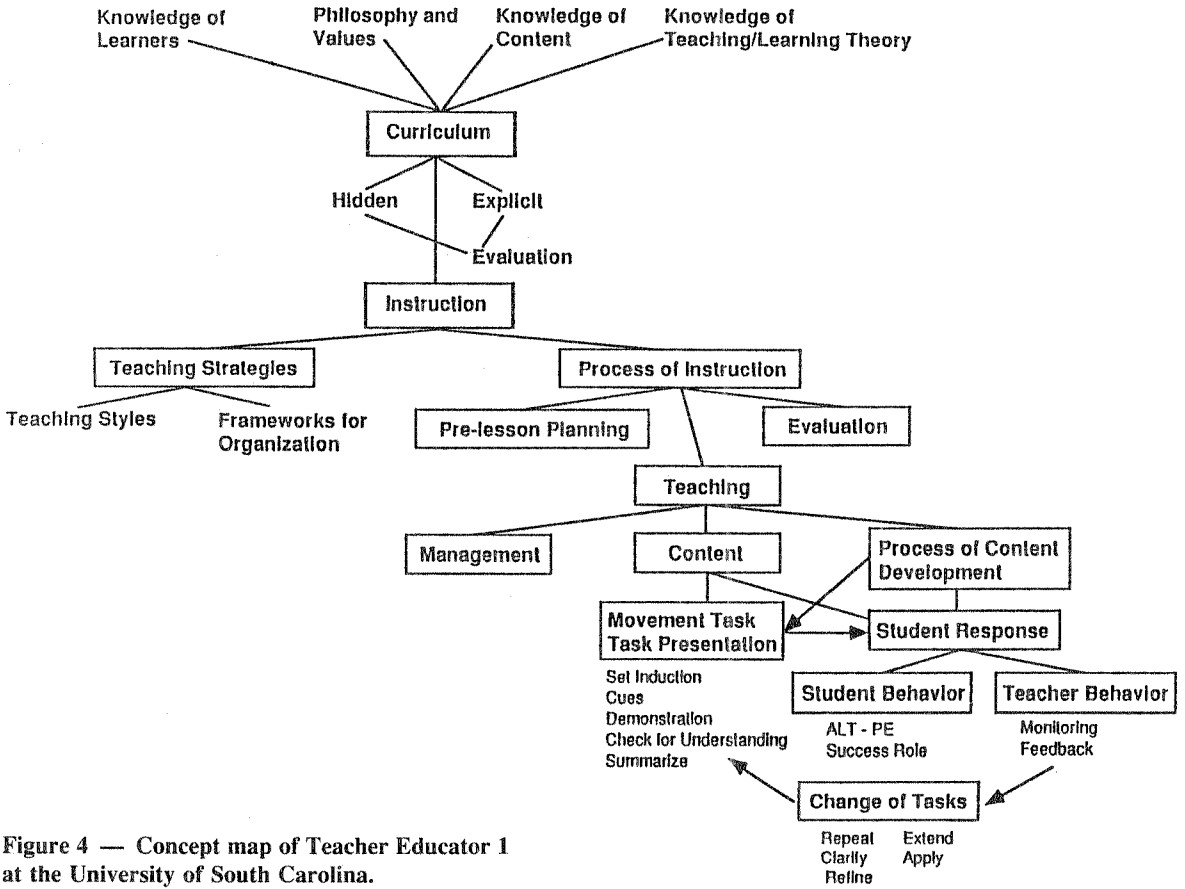

Figure 4 — Concept map of Teacher Educator 1 at the University of South Carolina.

USC Teacher Educator 2

Student	Teacher/teaching functions	Curriculum
	Teacher background	Implicit/explicit
	Planning	Content
		Planning
		Hidden curriculum
Schooling	Child/student development	Practice/learning
Physical building/ foundations	Perceptual motor development	Functions
Community, parents, principal	Cognitive development	Management
Classrooms, gyms	Psychosocial development	Feedback
	Moral development	Content development
	Motor development	Teaching strategies
		Task presentation
		Grouping
		Evaluation

LSU Teacher Educator 1

Teacher Behavior		Student Behavior	
Preactive	Active	Preactive	Active
(planning)	Management	Learned	Receiving
Management	Subject matter	ability	instruction
Subject matter	Review/introduce	Innate ability	Motor practice
	Drills		
	Stationw ork		
	Culminating activities		
	Closure		

LSU Teacher Educator 2

Philosophy
Goals and objectives
Effective teaching in physical education

Planning	Interactive teaching	Learning environment	Classroom management	Behavior management	Evaluation

LSU Teacher Educator 3

Preactive	Active teaching	Reflection
Yearly, unit, daily planning	Classroom and behavior management	
Components	Learning environment	
Goals and objectives	Interactive teaching	
Content selection	Task presentation	
Organization for teaching	Practice arrangement	
Formal assessment	Informal assessment	

Figure 5 — Major headings for the teacher educators at both institutions.

Although the major frameworks of horizontal concepts are different at the two institutions, the time requirements of the concept-mapping technique may have restricted the framework displayed by the LSU teacher educators. The word lists also did not include labels from knowledge bases outside pedagogical knowledge. Thus, the teacher educators at LSU may have chosen not to specify the influence of other knowledge bases on effective teaching.

A similar structural framework for effective teaching in physical education did not emerge from the data (Level 1 concepts between the teacher educators at each university, or across all) between the teacher educators at each university, or across the teacher educators. However, all teacher educators used *planning* (preactive) and *teacher functions* (active) as large headings in their respective maps. The level at which they were placed differed. Groups of concepts that were clustered to form coherent sequences were also present. For example, each teacher educator had an extended, coherent sequence for "the instructional process," which included logical relationships between chunks of information such as "teacher preactive/prelesson planning behaviors, teaching behaviors, and postactive reflection/evaluation." Within each of these large chunks were other smaller clusters of concepts (such as *teacher feedback, task presentation, class management*, and *knowledge of learners*) that were similar between the experts.

Preservice Students. Although the concept maps for the experienced preservice students included more concepts, the ability to establish a structural framework that would show relationships between concepts varied. The more sophisticated trees illustrate a framework that is similar to the "preactive–active" portion of the frameworks used by the teacher educators. For example, a planning component and a teaching component were fairly well integrated in the more sophisticated trees. A more coherent tree from each university is shown in Figures 6 and 7. Figure 6 presents the work of a student from LSU. Notice three major concepts emerging as a framework labeled *organizing/planning*, active teaching (*discipline, management, instruction*), and *outcomes*. Figure 7 is the map of a student at USC. This student organized major concepts vertically into planning and interactive teaching.

Other students could not integrate the knowledge acquired in the methods courses in a meaningful way. Figures 8 and 9 show examples of trees with more concepts (LSU n = 103, USC n = 90) but little depth or integration. These students could not describe the interrelationships between the newly learned and previously learned concepts. Figure 8 is the map of a student from LSU. Notice that the words underneath each major heading are in many cases unrelated to the label. The overall major headings do not fit into a logical organization of effective teaching. Figure 9 is the map by a USC student. Few words were chunked and the arrangement does not reflect any visible framework.

Several patterns were observed related to the organization of specific chunks within the concept maps of the preservice students. First, the concept maps reflected the starter lists provided. The two initial lists differed slightly and the words displayed by the students from the two universities reflected this difference. For example, the LSU list contained more words related to content, and it was not unusual to see a chunk describing content. A typical tree from the USC group would include content in broad categories only without detail provided about specific skills or fitness components.

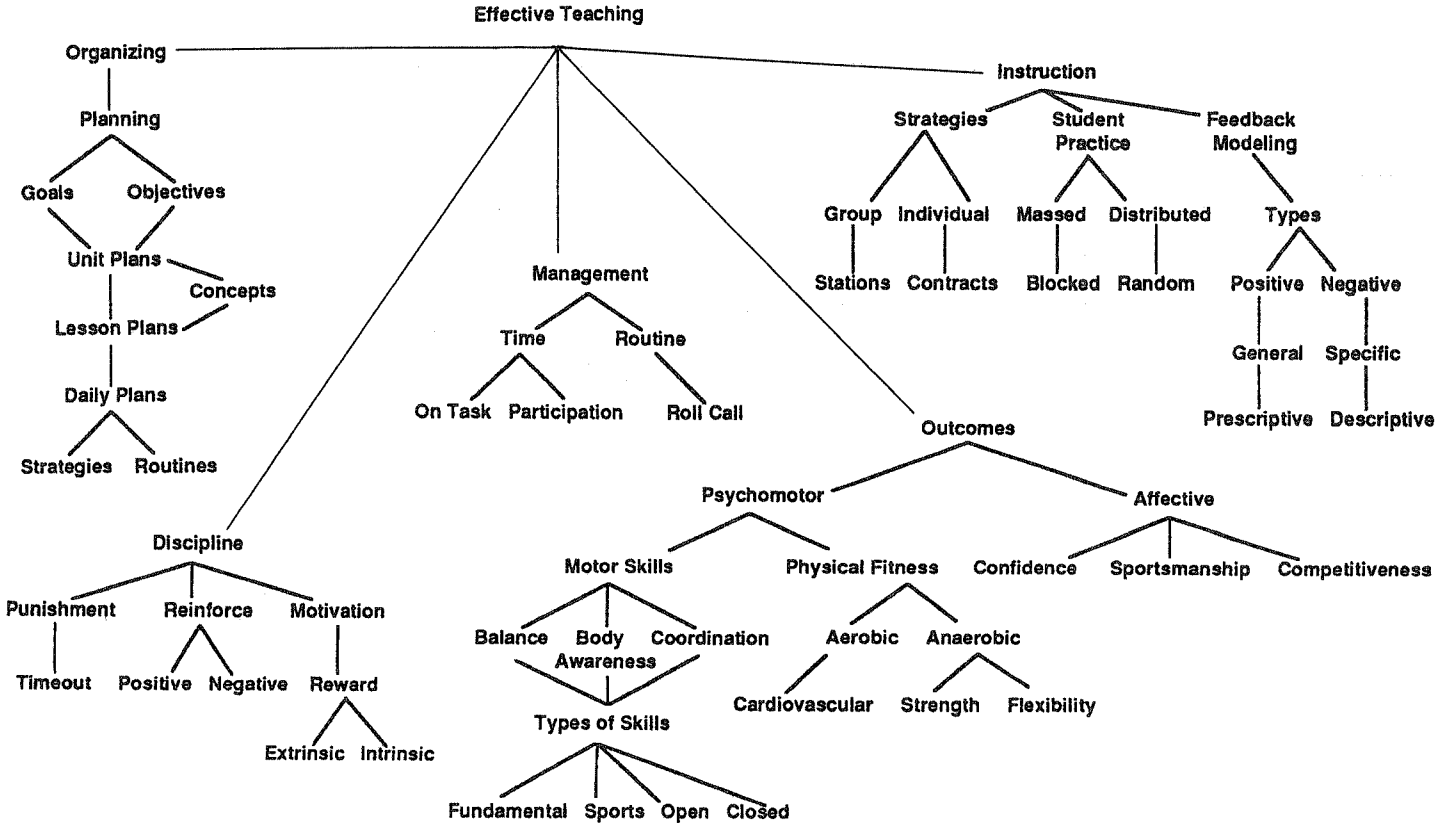

Figure 6 — Concept map of experienced preservice teacher at Louisiana State University.

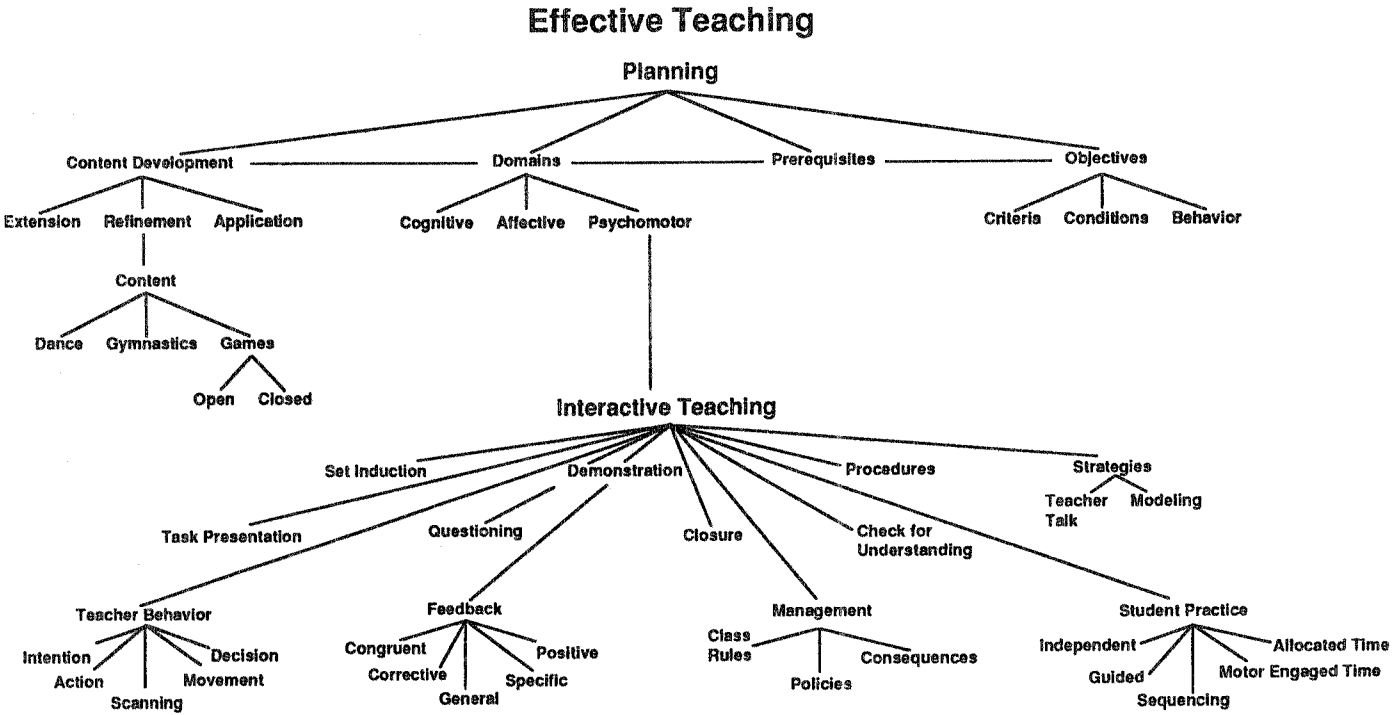

Figure 7 — Concept map of experienced preservice teacher at the University of South Carolina.

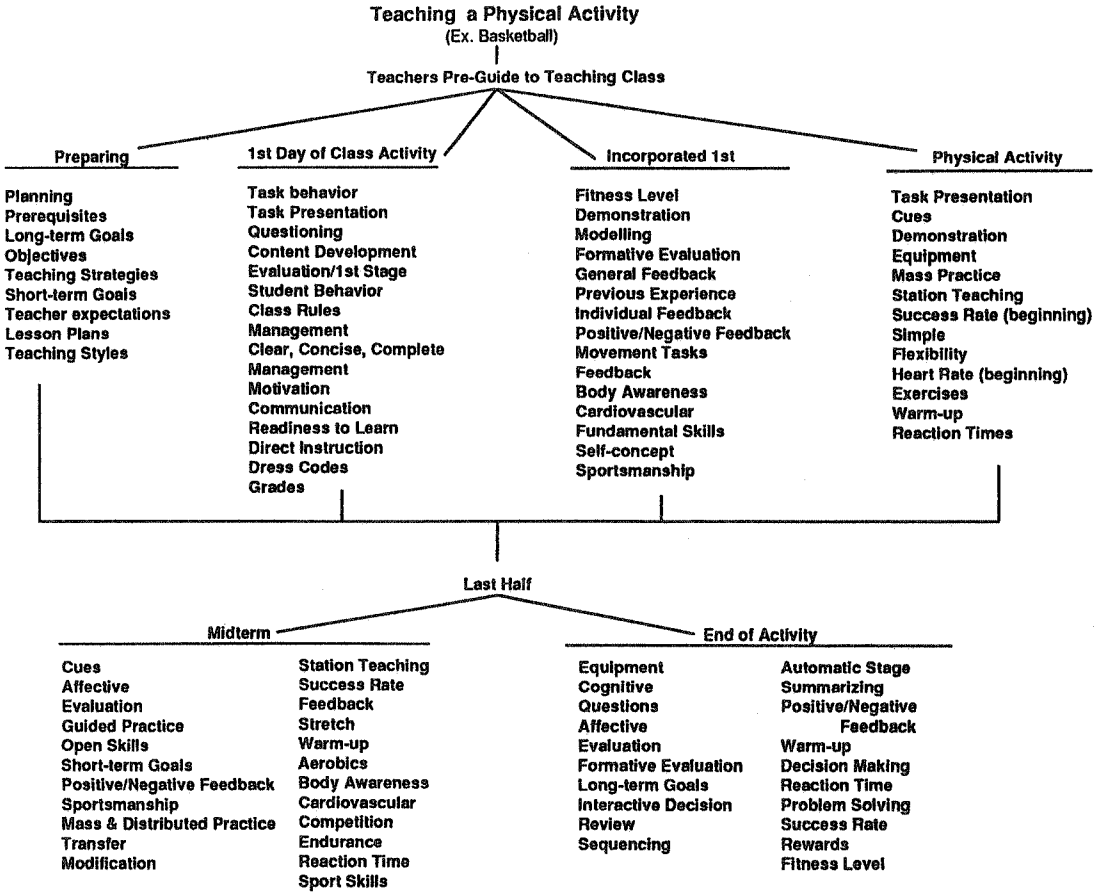

Figure 8 — Incoherent concept map of a preservice teacher at Louisiana State University.

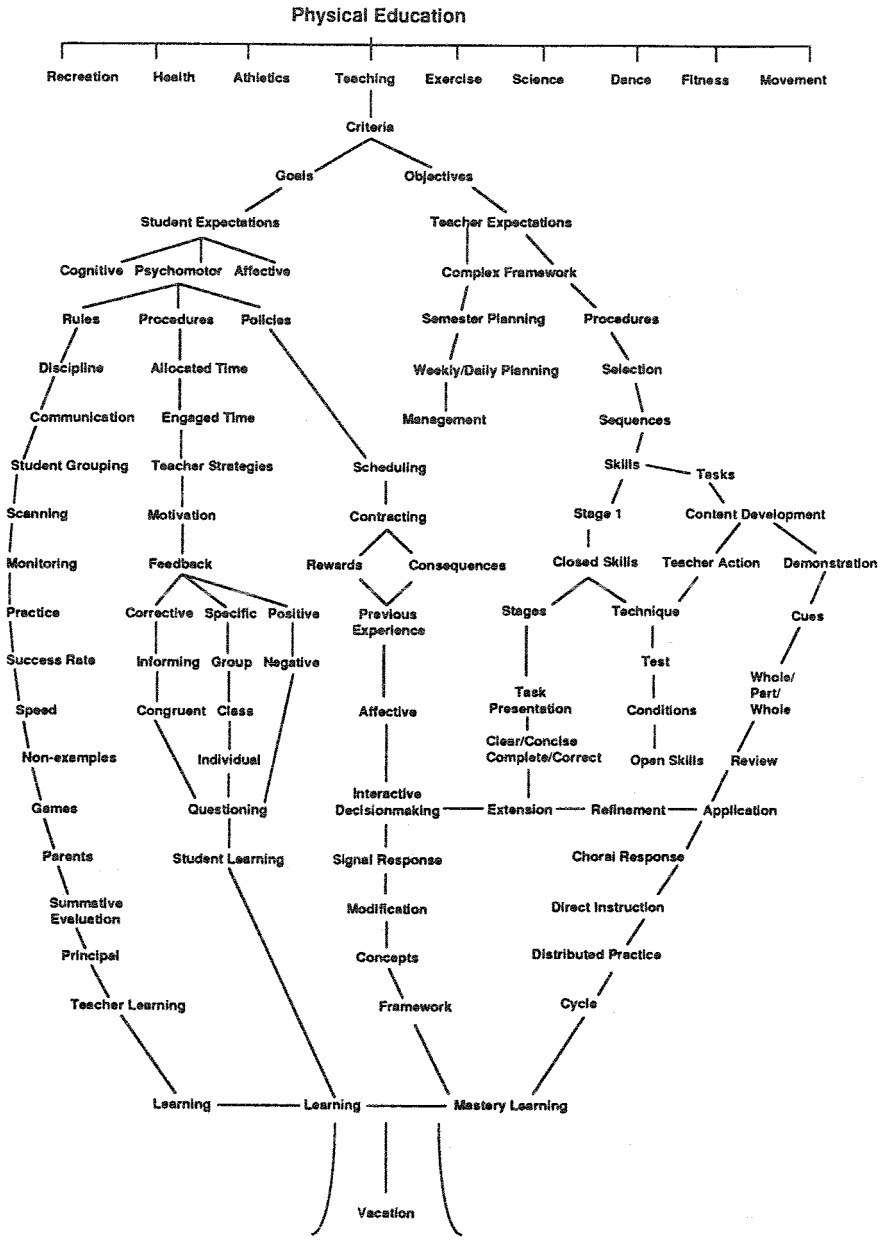

Figure 9 — Incoherent concept map of a preservice teacher at the University of South Carolina.

The tendency was for novice preservice students to include a rather large number of somewhat unrelated words grouped within a limited number of broad headings. Included within some chunks were words that were only slightly related and sometimes incorrectly grouped, showing an incomplete understanding of relationships between words and a lack of a major framework upon which to chunk ideas. An example can be seen in the groupings of the student in Figure 8, in which up to 16 only remotely related words are grouped.

Two other examples are presented to illustrate this point. A beginning concept map from LSU used the heading "getting the information to the student" and included 11 words in the chunk (*demonstration, modeling, summarize part/whole, station teaching, motivation, check for understanding, communication, simple, instruction, clear, concise, complete*, and *correct*). A USC student displayed 12 words (*teacher actions, teacher-student directed, cues, demonstration, questioning, teacher talk, eye contact, teacher directed, student directed*) under the category "ways to communicate." This pattern was more common in the maps of novice preservice students than in those of experienced preservice students.

Discussion

The overall quantitative data from the teacher educators was consistent with previous work on experts in terms of number of concepts, number of chunks, and number of concepts per chunk. The teacher educators in this study from USC and LSU, respectively, included (on average) 152.5 and 107.3 concepts, in 33 and 33.3 chunks, with 4.5 and 3.3 concepts per chunk. This data is similar to other findings using hierarchical concept maps (Ennis et al., 1991; Roehler et al., 1987). For example, Roehler et al. (1987) reported that the networks for expert teachers averaged over 100 concepts, organized into 30 chunks, with 2.5 concepts per chunk. These results should not be interpreted as a possible limit on human information processing. They probably represent a limit on the willingness of subjects to commit the large amount of time required to display all the knowledge available to the teacher educator.

There were similarities in critical concepts related to effective teaching in physical education identified in the cognitive maps of students and teacher educators at both institutions. The concepts identified by most or all teacher educators included *planning, objectives, curriculum/long-term goals, content development, task presentation, teaching strategies, management of time, behavior, organization, monitoring, content, feedback, evaluation*, and *interactive teaching*. Preservice students at each institution progressed toward identifying these same critical concepts in their cognitive maps and similarly organizing these concepts in terms of exemplars. This is indicated by more experienced preservice students than novice preservice students including more of the words for these concepts in the cognitive maps and increasingly chunking these concepts. Thus, the concept-mapping technique was able to identify patterns of consensus among preservice students and teacher educators at two different institutions regarding which concepts are related to effective teaching in physical education and how these concepts may be organized or defined by exemplars.

Teacher educators, regardless of institution, exhibited similar concepts and chunks within their maps. There were some differences in the nature of the major headings used to frame the structure. Part of this difference is probably due to

the incorporation of other knowledge bases by the USC teacher educators. However, there was one similarity within the frameworks of teacher educators: Each had a portion of their headings describing preactive planning processes and active teaching functions. Most incorporated an evaluation heading as well.

Preservice students seemed to be developing a declarative knowledge base using accretion (adding concepts to the network) and tuning (refining categories) (Rummelhart & Norman, 1978). Similar processes for knowledge development in preservice physical education students were suggested by Ennis et al. (1991). Comparison of the maps of novice and experienced preservice students at both institutions indicated that the number of words and critical concepts increased, the number of chunks and number of critical concepts that were chunked increased, and the coherence of the organization within concepts increased. These changes would indicate accretion and tuning processes.

Many preservice students in this study could not represent their knowledge in a meaningful framework that would require a process similar to restructuring (Rummelhart & Norman, 1978). Restructuring is a more difficult process and much time and effort using the knowledge is required for it to occur. Many of the preservice students did not exhibit a logical framework, but instead merely drew lines connecting groups of concepts without a conceptual orientation for how they were related. Clearly, some preservice students at each institution were capable of organizing their knowledge in a meaningful way and of graphically representing the knowledge accordingly. The experienced preservice students who did exhibit a logical framework used major headings for planning and instruction, and sometimes included evaluation similar to the pattern of teacher educators.

Rummelhart and Norman (1978) proposed two ways for restructuring to occur: pattern generation and schema induction. New structures can be formed by using a modification of an existing pattern (pattern generation) or can be induced from regularities in temporal or spatial configurations of concepts (schema induction). The most common form of pattern generation occurs through the use of analogies, metaphors, or models provided by effective teaching (Rummelhart & Norman, 1978). Schema induction occurs less frequently by creating a new schema from patterns of knowledge that tend to co-occur either spatially or temporally. The overall framework of concepts used most consistently by teacher educators and most frequently (when a framework was present) by preservice teachers was a preactive–active–evaluation framework. This framework reflects a tendency to organize based on occurrence within a time frame (schema induction). Most professional preparation programs no doubt emphasize the components of planning, instruction, and evaluation. The case could be made that teacher educators model a preactive–active–evaluation framework in many ways (pattern generation). Both schema induction and pattern generation are probably acting to facilitate organization of a framework. Thus, both types of restructuring processes should be considered when attempting to convey conceptual relationships for effective teaching to students or alleviate misconceptions.

There were two differences between the maps at each institution. First, novice preservice students who had a generic teaching methods course (LSU) incorporated fewer critical concepts into their cognitive maps of effective teaching in comparison with novice preservice students at USC who had a beginning teaching methods course that was specific to physical education. It is unclear whether students did not associate what they had learned in the generic course

with teaching physical education or whether the language on the word list affected the extent to which they could illustrate their knowledge.

The second difference is probably reflective of the influence of different starter word lists. The wordlist at LSU had more words related to content, and this difference resulted in the maps of students at LSU having much more elaborate chunks for content. Small differences in starter words influenced the elaboration of specific chunks, but the more sophisticated knowledge structures looked more similar from both programs than what might have been expected.

Hierarchical concept maps seem to show a great deal of promise for discriminating the declarative knowledge structures of teachers in physical education. The researchers in this study also found it extremely revealing as a program evaluation tool for determining which concepts were present and fully developed by the novices and which were not.

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