Cognitive style differences within an analytical curriculum: Examples of success and nonsuccess

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Abstract:

This research was conducted to examine field dependence/independence cognitive style differences exhibited by young children in analytically-oriented movement education curricula. It was hypothesized that an analytical focus demands mental energy, memory storage/retrieval capacity, and cognitive flexibility that are especially challenging for field-dependent children. The behaviors of field-dependent (FD) and field independent (FI) children were videotaped within the natural school context. Examples of success and nonsuccess were examined using the critical incident technique to compare the teacher's directions and comments with FD or FI students' performances. Results suggested that FI children experienced success 76.6% of the time, while FD children were successful 46.6%. Teachers permitted FI children to respond to questions and take part in demonstrations more frequently that FD children. FD children's behavioral responses to complex problem solving situations are discussed.

Article:

The role of the field dependence/independence (FDI) construct appears to go beyond personality differences to influence academic achievement and success. According to cognitive science research, differences in the performance of field-dependent (FD) and field-independent (FI) individuals may be attributed to levels of mental energy, memory capacity, and cognitive flexibility. Researchers (e.g., Frank, 1983; Widiger, Knudson, & Rorer, 1980) found that FDs are less likely than FIs to respond to relevant cues in the environment, focus on problems to be solved, and seek alternative solutions. The implications of this research for FD children in academic settings suggest that they may experience difficulty comprehending instructions, recalling and following directions, analyzing problems, and focusing on tasks. This limited capacity to process information may inhibit the cognitive involvement and achievement of FD students in academically-oriented classrooms (Saracho, 1989).

FD learners seem to experience greater difficulty than FIs when recalling factual information (Frank, 1984; Spiro & Tirre, 1980), understanding ambiguous material (Lefever & Ehri, 1976), and retrieving knowledge previously stored in memory (Annis, 1979; Frank, 1983). Widiger and associates (1980) suggested the relatively limited capacity for cognitive flexibility exhibited by FD children is consistent with FDI as an ability dimension. Thus, contrary to Witkin's (1978) assertion that both FI and FD styles should be equally valued in society, there is increasing evidence that FD children are likely to experience greater levels of frustration and failure in schools as the intensity of the academic experiences increases. This may occur both as the FD child increases in age and grade level and as traditionally non-academic subject areas, such as art, music, and movement education, incorporate more analytically oriented approaches to curriculum.

This research was conducted to examine FDI cognitive style differences exhibited by young children in analytically-oriented movement education programs. It was hypothesized that an analytical focus demands mental energy, memory storage and retrieval capacity, and cognitive flexibility that are especially challenging for FD children. Traditional physically-oriented curricula in primary grades have emphasized low-organized games, rhythmical activities, and social interactions (Barren, 1985) that directly involved FD children in the

content. There is increasing evidence (e.g., Ennis, 1991; Ennis & Chepyator-Thomson, 1991), however, that contemporary approaches to movement education (e.g., Logsdon *et al.,* 1984) focus on the analysis of movement concepts thought to enhance the educational impact and increase the credibility of the program in the school. In these curricula, children continue to play as before, but there is greater concern for the development of thinking skills, enhancement of cognitive understandings, and analysis of motor performance associated with basic concepts.

It was the purpose of this research to describe the behavior of FD and FI children within the natural school context. Examples of success and nonsuccess within an analytical curriculum were examined by comparing the teacher's directions with FD or FI students' performance. The significance of this research lies in the ability to describe academic success and nonsuccess experienced by children associated with mental energy, memory, and cognitive flexibility within daily school settings. Although cognitive style differences are evident in controlled laboratory settings, it is not always clear how they are demonstrated in the classroom. The movement education setting (Logsdon *et al.,* 1984) provided an educational environment with an emphasis on motor, affective, and cognitive objectives, thus allowing study of FDI within a broad, educationally balanced curriculum. The results of the research may provide insight into particular curricular and instructional components that enhance or diminish the learning of FD children.

RATIONALE FOR ACADEMIC SUCCESS AND NONSUCCESS BASED ON COGNITIVE STYLE

Within cognitive science, both the information processing model and the Theory of Constructive Operators can be useful in providing insight into cognitive style differences associated with mental energy, memory storage/retrieval, and cognitive flexibility. Researchers using information processing models have noted differences in working memory and retrieval capacity. Frank (1983) argued that FD learners have a smaller memory capacity that FIs and are more likely to demonstrate rigid information processing capacity resulting in nonsuccess. Because FD learners must store and retrieve cognitive information using identical cue structures, even slight deviations in the retrieval cue from the original storage cue can result in knowledge that is irretrievable (Cochran & Davis, 1987).

Within the principle of encoding specificity (Tulving & Osler, 1968), potentially helpful retrieval cues can be useful in facilitating successful recall only when the learner explicitly associates them with information at the time of storage and then uses the same cue for retrieval. The storage-retrieval processes of FD learners may be so inflexible that retrieval cues similar (though not identical) to the storage cue may be irrelevant and confusing. Because FD learners do not perceive the relationships between cue and stored information, they often remain passive and uninvolved in the learning process (Shuell, 1986). This behavior has been described as a spectator approach to learning (Goodenough, 1976).

FD learners may also rely on others to make cognitive connections, frequently resulting in momentary passive behavior followed by imitation as the FD child duplicates the performances of other children. Within information processing, FD children are described as less able to (a) identify and analyze basic components of a predefined task, (b) impose structure on ambiguous stimuli, and (c) reorganize a given field to reflect a novel pattern (Goodenough, 1976). They may also experience nonsuccess associated with task analysis, information recall, or cue-relevance recognition. In the latter instance, FD learners appear unable to recognize the role of relevant information in the solution of ongoing problems or tasks. This leads to a dependence on others for assistance in the integration of new knowledge with previously learned information (Witkin, 1987).

Pascual-Leone (1970) postulated an organismic structural model that is also useful in explaining individual differences in successful and nonsuccessful learning and performance. Within the Theory of Constructive Operators, learners function using both a subjective system of goal-directed schemes influenced by the environment and an internally activated system of scheme boosters that determines the order and likelihood of scheme utilization. Low level schemes are often activated in response to environmental features that are meaningful and relevant within the system. As low-level schemes are repeated, they are stored as networks or superschemes that may be retrieved and utilized more efficiently than simple schemes.

Superschemes may occur either as the result of overlearning or as learning boosted by mental energy (Pascual-Leone 1974). The overlearned schemes are typically interlocked into rigid, inflexible chunks, while superschemes boosted by mental energy are created and selected on demand to address specific task requirements. Mental energy or concentration is required to boost schemes into superschemes. These superschemes have the capacity to override overlearned schemes resulting in greater flexibility. When FDI is conceptualized within this theory, FT children are thought to possess higher levels of mental energy resulting in greater concentration and persistence with a task. Because they can generate a number of possible alternative solutions by rearranging schemes, they appear able to work more independently and for longer periods before requiring assistance.

FD children, on the other hand, may be unable to boost schemes into superschemes and thus are dominated by inflexible, overlearned structures. They tend to adopt and maintain poor problem solution strategies, such as trial and error, even when consistently unsuccessful (Pascual-Leone & Goodman, 1979). Further, limitations in memory storage capacity may result in an inability to process several schemes simultaneously. Thus without either the ability to utilize large efficient superschemes or storage capacity for a number of smaller schemes, FD children may be unable to participate in complex problem solution. They remain passive and uninvolved in the cognitive process. In instances in which they attempt to solve complex problems, they may choose to simplify the task, completing each component before beginning the next. This is an inefficient strategy both in energy expended and time consumed.

FD children's propensity for task simplification and passivity has been reproduced in two studies by Ennis and her colleagues. In research by Ennis and Lazarus (1990), 7-year-old FD and FI children intercepted a ball rolled down an inclined ramp. The child began running perpendicular to the path of the ball in order to contact it "as quickly as possible." FL children decreased the angle of their approach to the ramp, while FDs increased their angles to allow more time to monitor and analyze the speed and path of the ball. Essentially, the FD children simplified the task by dividing it into three parts. As the ball was released, they ran to a point opposite the end of the ramp, turned to face the ramp, and waited for the ball to come to them. Although they were successful in contacting the ball, they ignored the directions to intercept it as quickly as possible.

In a second study by Ennis (in press) FD and FI children were paired and encouraged to complete several problem-solving tasks. Although the FD child was involved in the task, s/he was content to allow the FI child to remember the teacher's directions, organize the task, and retrieve the critical content from memory. The FD child did experience a successful partnership and appeared to learn the content exemplified in the task. However, s/he was rarely involved in cognitive processing, preferring to permit the FI child to identify alternatives and select the most likely possibilities.

In the present study, 2nd grade (7-year-old) FD and FI children were videotaped during their regular movement education classes taught by FI teachers using an analytical concept-based curriculum. It was assumed that the FI teachers (teaching with an analytical curriculum model) would create a cognitive style-curriculum match between the FI children and the analytical curriculum and a mismatch between the FD children and the analytical curriculum (Frank & Davis, 1982; Saracho & Spodek, 1981). The camera focused directly on each FD and FI child during two different class periods over a four-month period to record instances of success and nonsuccess in actual class settings. The videotapes were analyzed for the presence of curricular and instructional elements that appeared to enhance or diminish learning for FD and FI children.

METHOD

Subjects

Second grade students (N = 254) in four elementary schools were tested using the Children's Embedded Figures Test (CEFT) to identify their cognitive styles (Witkin, Oltman, Raskin, & Karp, 1971). Children with scores in the first quartile (> 17, n= 62) were categorized as FI while those with scores in the fourth quartile (< 8, n = 63) were classified as FD. A random stratified sample was drawn from these data with 15 students in each cognitive style category. The samples were stratified by race and gender to reflect the demographics in the

quartile groups. Children in the FI sample were 71% white, 19.4% black, 4.8% Asian, and 4.8% Hispanic. They were 59.7% male and averaged 7 years 2 months of age. Children in the FD sample were 54% white, 33.3% black, and 12.7% Asian. They were 57.2% female and averaged 7 years 5 months of age.

Teachers were selected based on their scores on the Group Embedded Figures Test. Each of the four teachers received a score > 15 out of 18 and were categorized as FI. Each of the teachers was female and had been teaching for a minimum of 17 years. All of the teachers were white and three had completed master's degrees.

Data Collection

Data for this study were collected using a high-resolution videocamera. The child to be filmed was randomly selected from the sample group just prior to filming. He or she was identified to the researcher by the classroom teacher upon arriving at the movement education class. The movement education teacher was unaware of which student was being filmed. Filming began as soon as the child was identified and continued until the child left the room at the end of the 30 minute class. Each child was filmed twice during the four month period with a minimum of four weeks between each filming. The videocamera permitted both close-up and wide angle filming so that facial expressions and behaviors of the child within the larger context of the classroom could be recorded. The teacher wore a wireless microphone to facilitate recording of teacher instructions and interactions.

Data Reduction and Analysis

Data were reduced using the critical incident technique (Flanagan, 1954). The technique "consists of a set of procedures for collecting direct observations of human behavior in a way as to facilitate their potential usefulness in solving practical problems . . ." (Flanagan, 1954, p.327). It is based on the systematic definition of significant events that meet specific criteria. Flanagan (1954) described incidents as observable human activities that "permit inferences and predictions to be made about the person performing the act" (p. 327), Flanagan's work described procedures used to analyze interview data for task and personnel analyses.

In the present study threats to reliability typically associated with analysis of classroom events were minimized by recording events on videotape. The critical incident technique was used to reduce incidents from videotapes and then categorize them into success and nonsuccess categories. Criteria for academic and behavioral success or nonsuccess focused on the extent to which the student's responses matched the teacher's instructions. Academic success was defined as a change in the child's performance as a result of instruction and practice, while behavioral success was limited to cooperation with the teacher and other students as defined by the teacher within the classroom context.

Two investigators trained using sample videotapes until they were able to reduce the data using the critical incident technique with 90% agreement. Each FDI videotape was then reviewed a minimum of three times to record the teacher's directions, the FD or FI children's behaviors and responses, and the responses of other class members. The resulting data set appeared as a detailed description of verbalizations and behavior arranged in four columns: (a) the beginning and ending videotape counter numbers for the behavior or event described (identifying the exact location and duration of the event), (b) the teacher's verbalizations or behaviors initiating or responding to classroom events, (c) the FD or FI child's responses and self-initiated behavior, and (d) the general behavior of the other children in the class. This report is limited to an examination of response data from FD and FI children. The remaining data (teacher and class) were used to create a classroom context for**.** interpretation of FDI response data. Using this procedure, the FD or FI child's responses could be compared with both the teacher's directions and the other children's behaviors, providing a more complete picture of classroom events.

The resulting data sheets were then reviewed independently by two judges trained to assign events to categories reflecting successful and nonsuccessful performance (.90 reliability criterion). The videotapes were viewed simultaneously with the data sheets to provide a rich context for the interpretation of events. Clusters of

successful and nonsuccessful responses were analyzed to identify subcategories that reflected the teaching-learning process. Frequencies and percentages were then calculated from the categorized data.

RESULTS

The data reduction process extracted 6990 incidents or elements from the 60 videotaped classes. Each class contained from 75 to 198 performance elements. Teacher initiated events accounted for 480 or 6.9% of the incidents. Children's responses accounted for 5894 (84.3%) of the elements analyzed. The remaining 616 (8.8%) were recorded as child-initiated behavior. This report will focus on the children's response data. A descriptive summary is reported in Table 1. The majority (59.8%) of the children's responses were attributed to FIs. Of these 76.6% were reported in the successful category, FD children responded unsuccessfully 59.7% of the time.

Table 1 Descriptive Data for Children's Responses

		Incidents			
Category		*FD*		*FI*	
		n	*%*	*n*	*%*
Success		955	(40.3)	2700	(76.6)
	Academic	334	(34.9)	1423	(52.6)
	Social	621	(65.0)	1277	(47.3)
Nonsuccess		1415	(59.7)	824	(23.3)
	Academic	736	(52.0)	222	(26.9)
	Social	679	(48.0)	602	(73.1)
	Total	2370	(40.2)	3524	(59.8)

Success Categories

The results of this research suggested that the FI children responded successfully far more often (76.6%) than did the FD children (40.3%). Responses were in the form of both verbal answers to questions (16.3%) and motoric responses to teacher directions (83.7%). In the questioning subcategory it was found that teachers selected FI children to respond far more often (23.4%) than FDs (15.3%). In addition, teachers selected FI children to demonstrate motor tasks more frequently (15.3%) than FDs (4.4%). When the Success category was analyzed as academic and social behaviors, FI children were found to be successful in both categories about equally, while FDs were more successful in the social categories. ED children were as successful as the FIs when the academic category involved motor performance of a well-learned skill. However, FD children were less successful when academic performance involved a novel motor task or a cognitive response.

One advantage of using the critical incident technique with videotape data is that the context of the class and description of specific tasks are retained in the data analysis process. Therefore, numerous examples of success and nonsuccess were collected and described in detail. One example of a successful task for FI second grade students involved a tag game called "Dog Catcher." In this game several students were selected by the teacher to act as dog catchers, while the remainder of the children pretended to be one of four different breeds of dogs. When the head dog catcher called a breed, all those students who had chosen to assume the name of that breed were required to run to a "safe" area across the room. The dog catchers attempted to tag the dogs and send them for a short stay in the dog pound. After all four breeds had been called, the children could choose to discard the name of the original breed and assume the role of a different breed for the next round of the game.

FI children videotaped for this study appeared to enjoy both the physical and the cognitive challenge of the dog catcher game. They seemed to discard and acquire the name of a new breed easily at the beginning of each round. As dog catchers, FI children quickly realized which children were changing breeds and which remained with the same breed over several rounds, thus anticipating which children were required to run as each breed was called. This gave the FI children a distinct advantage by permitting them to edge closer to and target specific children whom they knew had assumed the name of a particular breed.

The FD children appeared to understand the physical aspects of the game more readily than the cognitive nuances of the breed-changing strategies. They were successful at running to safety and were often able to avoid being tagged simply by running faster or dodging more effectively than the dog catchers. These skills also appeared to assist them when they assumed the dog catcher role. They moved skillfully to tag dogs or trap them against the sidelines. Both the FI and FD children seemed to enjoy the strenuous physical activity and laughed and shouted as the game became more competitive and children were eliminated.

In activities that focused on motor skill development, such as striking and throwing skills, FI children appeared able to focus on the teacher's description of the activity, respond to questions regarding movement analysis, and use movements appropriately to gain strategic advantage. They remembered the directions and continued to practice for lengthy periods, even when the task was repetitive and monotonous. FD children seemed to be most successful when the teacher's directions were concrete and delivered concisely. They enjoyed the movement, itself, especially when allowed to move to achieve product-oriented objectives without regard for the technique or quality of the performance.

Nonsuccessful Categories

Analyses of the data for FD children suggested that they responded unsuccessfully (59.7%) far more often than did the FI children (23.3%) (see Table 1). FD children rarely chose to raise their hands to answer teacher questions (15.3%) and when called on, often either could not respond or responded by discussing a different topic such as events that had occurred at home or during the school day. They were also rarely selected to demonstrate (4.4%) and, when asked, frequently were unable to complete the demonstration task. When the Nonsuccess category was disaggregated into academic and social behavior categories, the FD students were found to demonstrate nonsuccessful experiences in both categories about equally. FI students were unsuccessful primarily when they were required to work with other children in groups. Their off task behaviors appeared to be associated with impatience with others rather than an inability to perform the task correctly.

In the dog catcher game, FD children were most unsuccessful in utilizing the breed change rules to strategic advantage. They often appeared confused with the change and preferred to continue to use the same breed name. When they did change (usually as a result of teacher encouragement) several examples were documented in which the FD children could not remember their new name and were often tagged because they hesitated to begin running and were caught. When FD children assumed the role of dog catchers, they had difficulty remembering (a) the breeds of dogs used in the game, (b) which breeds had already been called, and (c) whether children had changed their names or remained with the same breed over two or more rounds. They readily accepted help from classmates to decide which breeds to call and they rarely asked to be the head dog catcher.

In other activities that were less exciting, such as learning striking skills with bats and balls, FD children had difficulty focusing on the task for the lengthy period required to give directions and skill feedback. FD children were often observed to be throwing the bat in the air, tapping it on the ground, and taking a number of practice swings. In essence they appeared to be continually moving when asked to wait for the next activity to begin. They were observed to leave their own space to talk to classmates, look out of the door or window, and jump or spin while waiting for activity to commence. More passive FD children seemed to turn their attention within themselves, absent-mindedly untying and tying shoe laces or tracing the lines on the floor with their foot or hands. When their attention was redirected to the activity, they readily participated until the next set of instructions in which they had to wait for the activity to begin again.

DISCUSSION

As FD children are confronted with challenging problems to be solved in the classroom, they may respond in a number of ways. They may become passive and uninvolved, seek social relationships with children who are successful problem solvers, or express frustration with nonsuccess by acting in a disruptive manner. (e.g., Cohen, 1968; Ennis & Chepyator-Thomson, 1991). Limitations in memory storage and retrieval capacity, cognitive flexibility, and mental energy appear to some degree to influence children's success and nonsuccess with analytical tasks. This has been documented in studies of reading comprehension (Davis, 1987), concept

formation (Ohnmacht, 1966), musical analysis (Schmidt & Lewis, 1987), and motor skill acquisition *(e.g.,* Swinnen, Vandenberghe, & Van Assche, 1986).

In the present study, FD children were highly motivated to participate in movement activities but were limited in their ability to utilize effective strategies. Although in the dog catcher game they could participate initially without utilizing complex strategies, they often found themselves quickly tagged and eliminated. Memory storage and retrieval capacity were critically important for these 7-year-old children in a number of activities in the movement education classroom. In the dog catcher game, they were required to remember the breeds of dogs simply to participate. To be proficient, children required not only good motor skills of running and dodging, but the ability to remember and associate breeds with specific classmates. Many of the FD children chose to simplify the dog catcher game by avoiding the positions where memory retrieval was necessary and public. Specifically they chose not to assume the head dog catcher role in which they were required to call the names of the four breeds, opting instead to be a dog catcher-helper or a dog. However, as most children became comfortable with the game and began to exploit specific strategies to maximize their efforts, FD children chose to stay with the original breed and were often eliminated.

Although their failure to select strategies could have reflected an inability to remember the breed names, it could also be associated with rigidity and inflexibility in cognitive processing (Franks, 1983). The apparent choice to continue with the original breed may not have been a choice at all. Instead, FD children may have lacked the mental energy (Pascual-Leone, 1974) either to override the overlearned structure associated with the original breed choice or to generate an alternate plan for subsequent attempts. They minimized the cognitive complexity of the game by selecting to participate in only those strategies that appeared most salient — running and avoiding the dog catchers. Alternate explanations for this phenomenon could be attributed to the FD children's general lack of intelligence or preference for strategies associated with culture or social class. Additional research is necessary to determine the extent to which these differences can be attributed to these or other variables not directly linked with FDI.

As curricula for young children become more analytical, it *is* important that teachers realize the special needs of FD children. In the examples cited here, teachers presented most of the instructions verbally. FD children were required to concentrate on the teachers' verbalizations and form a mental picture of the game or skill tasks. For children with limited memory storage capacity and mental energy, it was apparent that only the most salient features of the task were remembered. Further, the complexity of the game, like many analytical tasks, required a longer and more detailed explanation of instructions than is normally provided to young children.

Principles of effective teaching (e.g., Peterson & Walberg, 1979) would suggest that accommodations be made to enhance student attention and memory. Specifically, the instructions should be provided both visually and auditorially. In the dog catcher example, the teacher may choose to write the breeds on the blackboard and perhaps show students a picture of the dog discussed. In addition, FD children should be involved directly in the discussion and demonstrations — not as spectators — but as active players. This serves the dual purposes of focusing the FD child's attention on the task and permitting the teacher to work interactively with the child to correct errors immediately, before ineffective solution strategies become rigid and over-learned.

As in all interventions, it is critical that teachers identify their FD children and make a commitment to accommodate their learning limitations while simultaneously working to increase their cognitive functioning (Saracho, 1989). Several strategies have been proposed by Ennis (in press) to emphasize content elements to FD children and to involve them actively in the lesson. For example, the explicit organization strategy encourages teachers to limit the quantity and complexity of concepts within a lesson and emphasize the most critical, using a number of modalities. In addition, the use of the variable format strategy involves the FD child emotionally in the learning experience by providing a stimulating environment in which the FD child is an active participant.

In complex problem-solving tasks, such as that presented in the dog catcher game, FD students need additional prompting through questioning to encourage them to think reflectively about the effectiveness of the strategies they are using. Teachers might use a number of progressive questions that lead the FD child to discover the advantages of alternate strategies. For example, the teacher may encourage the FD child during the game to select between two breeds rather than four, thus limiting the complexity of the task. As the FD child utilizes this strategy, additional questions that address the advantages of this process can assist the FD child to focus on the most relevant — rather than the most salient — features of the problem.

As the educational system becomes more analytical, it is becoming increasingly apparent that FD children are at a disadvantage because of a limited capacity to store and retrieve information in working memory, boost efficient, flexible strategies into superschemes, and search for alternative strategies to solve analytical problems. This appears to be occurring in movement education curricula as well as with more traditional cognitive content. Teachers should be alert to learning problems experienced by FD children and structure instructional tasks to accommodate memory limitations. Small efforts on the part of the teacher may assist FD children to learn important content and function more effectively in analytical curricula.

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