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A Review of Spectrum Research: The Contributions of Two Eras

It has been 33 years since Muska Mosston introduced the Spectrum of Teaching Styles in his book, Teaching Physical Education (1966). Many in the field of physical education and education alike from around the world have embraced the Spectrum of Teaching Styles as a framework for delivering instruction in schools (Gerney & Dort, 1992; Greenspan, 1992; Mellor, 1992), designing undergraduate teacher preparation programs (Ashworth, 1992; Byra, in review; Mueller & Mueller, 1992), and conducting research (Byra & Jenkins, 1998; Goldberger & Gerney, 1986, 1990; Telama, 1992). In marking the silver anniversary of the Spectrum, the *Journal of Physical Education, Recreation, and Dance* (Franks, 1992) featured a collection of articles to reflect the importance the Spectrum has had on physical educators, teacher educators, and researchers in the arena of physical education. The impact of the Spectrum on research in physical education is the focus of this paper.

In the early 1970s scholars in physical education believed that the Spectrum represented a plausible theoretical framework for conducting research on teaching in physical education. Nixon and Locke (1973) claimed that the Spectrum of Teaching Styles (Mosston, 1966) was "the most significant advance in the theory of physical education pedagogy in recent history" (Nixon & Locke, p. 1227), even though it had "yet to undergo full experimental testing" (p. 1227). Based on the results from two early studies (Dougherty, 1970; Mariani, 1970) Nixon and Locke deemed that the Spectrum could predict both teacher behavior and student outcomes. However, to meet its full potential, they confirmed that much more research involving the Spectrum was required.

Approximately 20 years later Goldberger (1991; 1992) describes the Spectrum as an inclusive, yet discriminating framework that has specific definitions and parameters for which to systematically explore teaching in physical education. Given 25 years of research and reflection Goldberger (1992) concludes that, "although the theory [Spectrum] has not yet completed the full program of testing Nixon and Locke called for, results to date confirm the theory's power to both describe teaching events and predict learning outcomes" (p. 45). Mosston's (1966; 1981) and subsequently Mosston and Ashworth's (1986; 1994) Spectrum of Teaching Styles has provided researchers with a framework to systematically study teaching and learning within the context of physical education.

The research that has been conducted over the past 30 years on the Spectrum has been closely linked with the development and refinement of the Spectrum of Teaching Styles. During the initial development of the Spectrum, Mosston (1966) conceptualized the command style of teaching as having the "least amount of value" and teaching styles that involved problem solving or creativity as having the "greatest amount of value." Mosston perceived value to be associated with learner decision making and independence. In the command style of teaching learner decision making is minimal (to adhere or not to adhere to the teacher presented model), which forces the learner to be wholly dependent on the teacher. In contrast in the problem solving teaching style learners are intimately involved in the decision making that transpires during the lesson. This leads the learner toward independent learning. This early conception of the teaching styles, as stated by Mosston (1981), was "based on the VERSUS--- one style vs. the others" (p. viii).

In the second edition of Teaching Physical Education, Mosston (1981) emphasized the Spectrum from a "non-versus" perspective. A decade or more of experimentation resulted in the understanding that each style of teaching was not inherently better or more effective than the others, but rather that each style met a specific set of unique objectives or goals. For example, in the reciprocal style immediate feedback and cooperative behavior are the essence of the style and learners are given an opportunity to practice a given task under the direct observation of a peer. Theoretically this provides the learner with high practice time and frequent, immediate feedback. In comparison, the goal of the command style is to learn to do a rote task accurately in a short period of time. The teacher provides the stimulus, or model, and the learner replicates that model on command. Rather than focusing on the disparity among the teaching styles, Mosston "highlighted the relationships among the styles" (Mosston, 1981, p. 4) in his second edition of Teaching Physical Education. This change had a monumental effect on the advancement of Spectrum research.

Other changes to the Spectrum from its inception in 1966 include the refinement of the decision categories, the addition and elimination of several teaching styles, the expansion of the individual teaching styles, and the clarification of all styles. These changes appear to have strengthened the philosophical basis and structure of the Spectrum. However, the effect that these changes have had on the advancement of Spectrum research is minimal in comparison to the "versus" issue.

Spectrum research that has been completed over the past 30 years is examined in the remainder of this paper. Dissertation studies and data-based studies published in journals and conference proceedings (written in the English language) are reviewed. The studies have been organized around two time periods, 1970 to 1980, and 1980 to the present. These time periods are titled the "early era" and the "recent era." Grouping the studies as "early" and "recent" help to describe the relationship that existed between the emergence of Spectrum research and the evolution of the Spectrum of Teaching Styles. This paper is written with the expectation that the reader has a basic understanding of the landmark teaching styles associated with the Spectrum.

Early Era of Spectrum Research

During the 1970s and early 1980s numerous dissertation studies (Ashworth, 1983; Boschee, 1972; Chamberlain, 1979; Dougherty, 1970; Gerney, 1980; Jacoby, 1975; Johnson, 1982; Virgilio, 1979) and one published study (Mariana, 1970) were completed specific to the Spectrum of Teaching Styles. In each study two or more teaching styles from the reproductive cluster were examined in light of learner skill, social, and/or cognitive development. These researchers attempted to investigate Mosston's (1966) proposal that the greater the decision making afforded the learner, the greater the advantage for change in learner growth on the physical, social, emotional, and intellectual dimensions (the "versus" issue). An underlying research question for these researchers was, which style(s) produces the best results (e.g., the greatest amount of learning).

The results from these studies were characterized by no significant differences. For example, Dougherty (1970) reported no significant differences between the command, task, and individual program styles of teaching on learner fitness and motor skill performance. In a study involving these same three teaching styles, Boschee (1972) found no significant differences between the teaching styles on learner physical, social, emotional, and intellectual development. And in a study of the reciprocal and practice (task) styles of teaching, Gerney (1980) reported no significant differences between the two styles on the skill acquisition of a hockey task.

When a significant difference was revealed, few of which were, the findings were mixed. For example, for the backhand tennis stroke Mariana (1970) found that learners receiving instruction in the task style posted higher scores on a posttest than learners receiving instruction in the more traditional command style of teaching. On the other hand, for the forehand tennis stroke no group differences were revealed on posttest skill scores; learners instructed in the command style performed just as well as learners instructed in the task style.

The premise upon which the studies were conducted during the early era is no longer supported by Mosston (1981) and Mosston and Ashworth (1986; 1994). In the three most recent editions of the text, Teaching Physical Education, the authors espouse the "non-versus" notion. Mosston (1981) explains that "the conceptual basis of the Spectrum rests on the "non-versus" notion. That is, each style has its place in reaching a specific set of objectives; hence, no style, by itself, is better or best. . . . Each style is equally important" (p. viii). Asking the question, which style is better, is deemed unproductive within the definition of the concept of "non-versus".

In addition to violating the concept of "non-versus," several scholars in the field of physical education voiced concerns about the methodological procedures employed in Spectrum research that was conducted during this early era. Griffey (1983), Locke (1977) and Metzler (1983) raised issues about the (a) inadequate definition of experimental treatment, (b) inadequate control over treatment applications, (c) adoption of abbreviated treatment periods, often too short to promote any change in student learning, (d) the use of college students as study participants rather than elementary and secondary school students, and (e) research being conducted by graduate students rather than experienced university researchers. It was suggested that these issues in combination likely contributed to the numerous methodological problems which plagued the early Spectrum research. Metzler (1983) submits that the frequent absence of significant differences between teaching styles for skill acquisition is "attributable to the nearly complete vacuum of information about process variables" (p. 151) in the studies. Level of learner skill performance prior to the application of treatment (teaching style) was not factored into the statistical procedures used in Mariani's (1970) study or Dougherty's (1970). Nor were any process measures for teacher and student behavior systematically collected to verify the application of the different teaching styles. These examples

of methodological deficiencies, as well as others, raise doubts about the findings in Dougherty's (1970) and Mariani's studies (1970) as well as in other studies conducted during this era.

More recently, the issues identified by Griffey (1983), Locke (1977), and Metzler (1983) have also been raised by Michael Goldberger, the foremost scholar in Spectrum research and advisor to many of the graduate students who completed the early Spectrum studies (1992). In his review of early Spectrum research, Goldberger found that the investigators (a) failed to systematically verify style implementation, (b) lacked knowledge of Spectrum theory, (c) made claims that were illogical according to the style specific learning conditions being studied, and (d) failed to provide treatment periods sufficiently long enough to produce learning outcomes. Although researchers were attempting to find the answer to an unanswerable question (which style is better?) during this time period, and the methods employed to study this question were at best problematic, the research conducted during the early era seems to have served an important function in the overall evolution of Spectrum research. The importance of the research conducted during the early era will emerge once you read the review of Spectrum research completed during the recent era.

Recent Era of Spectrum Research

The recent era of Spectrum research emerged during the early 1980s following the publication of the Griffey (1983), Locke (1977), and Metzler (1983) articles. The issues raised by these three scholars, and later by Goldberger (1992), about the employment of inadequate research methodologies were addressed by investigators from the onset of the recent era of Spectrum research. The research presented in this section is categorized according to the cluster of teaching style it belongs. During the early era, research was restricted to the reproductive cluster of teaching styles. Research conducted during the recent era spans both the reproductive and productive clusters of teaching styles.

Reproductive Teaching Styles.

The Spectrum of Teaching Styles is divided into two genres or clusters, reproductive and productive. The reproductive cluster includes the command, practice, reciprocal, self-check, and inclusion teaching styles. In this cluster the learner is called upon to reproduce known material or knowledge. The focus is on replication of a specific model. Often the subject matter involves concrete facts, rules, or specific skills. Therefore, the learner must be provided a correct model to emulate, adequate time to practice the model, and congruent feedback related to the original model. The research reviewed in this section involves the command, practice, reciprocal, and inclusion styles of teaching. No research involving the self-check style has been conducted to date.

Griffey (1983) was one of the first investigators to conduct a Spectrum study for the purpose of addressing some of the methodological shortcomings of the earlier research. Specifically, in his study Griffey systematically verified the application of treatments and considered students' initial ability level. Student skill learning of the volleyball forearm pass and serve within the command and task styles was examined. The findings of this study showed that higher ability high school-aged learners performed better when instructed in the task style. Griffey suggests that the higher ability learners had sufficient knowledge of the skill to make informed decisions about appropriate use of practice time, while lower ability students lacked this knowledge.

The task style as presented by Mosston (1966) is best described as a combination of Mosston and Ashworth's (1994) practice and inclusion styles of teaching. Given that the task style (Mosston, 1966) doesn't match any one of the more recent Spectrum styles (Mosston, 1981; Mosston & Ashworth, 1986; 1994), it is difficult to compare the results of Griffey's study to those conducted more recently.

Goldberger, Gerney, and Chamberlain completed several studies of the practice, reciprocal, and inclusion styles of teaching during the first half of the 1980s. In two of these studies middle school children learned popular motor tasks while receiving instruction within their regular intact physical education classes (Goldberger & Gerney, 1986; Goldberger, Gerney, & Chamberlain, 1982). The goal of these studies was not to determine which style was better, but rather to see if different formats produced different levels of learning. The methodological problems associated with the early research were addressed by Goldberger and his colleagues in this series of studies. Specifically, treatment conditions (teaching styles) were well defined, the length of treatment time was sufficiently long, the implementation of each style was systematically verified, the statistical procedures used were appropriate, and the research team leader was an investigator who was knowledgeable in the Spectrum and an experienced researcher.

The results showed learner skill gains to be associated with all three styles. Although not significantly different from the other two styles, students who received instruction under practice conditions consistently produced the highest rates of change. In the practice style the learners work at their own pace and complete teacher-designed tasks in the order they choose. Often the class is organized around stations; while a small group of students completes the task(s) at a given station, the teacher provides individual feedback to the learners.

The results from other practice style studies grounded in sound methodology reflect the findings revealed in the Goldberger et al. research (Goldberger & Gerney, 1986; Goldberger, Gerney, & Chamberlain, 1982). The practice style of teaching was found to be effective in fostering skill changes in college-aged students as they performed soccer-ball-juggling (Beckett, 1990) and rifle shooting (Boyce, 1992), and in school-aged children as they performed striking with a racquet (Jenkins & Byra, 1997). These researchers ascertained that the instructional approach employed in the practice style was effective in promoting motor skill changes in school-aged and college-aged learners.

In a more recent study Goldberger and Gerney (1990) examined the effect of two different organizational “formats” as presented within the instructional framework of the practice style of teaching. Under one format (teacher-rotate) the participants, fifth grade boys and girls, rotated from station to station, in a specific order, every few minutes on the command of the teacher. Under the second format (learner-rotate) the fifth graders decided the order in which to rotate (from station to station), the amount of time to spend at each station, and when to rotate (from station to station). Both formats were found to be effective in fostering student learning. In addition the learner-rotate format was found to be more effective for the low-ability students than the high-ability students.

The reciprocal style was also examined by Goldberger, Gerney, and Chamberlain (Goldberger & Gerney, 1986; Goldberger, Gerney, & Chamberlain, 1982). In this style learners form partners, and as one learner (doer) performs, the other (observer) gives specific feedback to the doer based on information provided by the teacher (criteria sheet). When the doer completes the task(s), the doer and observer switch roles. The extent of peer teaching in the reciprocal style is specifically the provision of feedback from one learner to another. In addition to improved skill performance, Goldberger, Gerney, and Chamberlain found that learners in the reciprocal style “provided more feedback, expressed more empathy, offered more praise and encouragement to each other, and requested more feedback from each other when compared to the control group” (Goldberger, 1992, p. 43). The results from Goldberger, Gerney, and Chamberlain's studies support Mosston and Ashworth's (1994) contention that feedback is provided at a much higher rate when the instructional strategy requires learners to provide task-related information to a partner.

Byra and Marks (1993) examined the effects different learner pairings had on students while engaged in the reciprocal style of teaching. The results showed that the elementary-aged learners gave more specific feedback to partners who were identified as friends, and felt more comfortable receiving feedback from friends than non-acquaintances. The authors also found that grouping by ability had no effect on amount of feedback given or received, or the comfort level of either the observer or the doer. This study provides evidence to support Mosston and Ashworth's (1994) claim that the most appropriate pairing technique for peer teaching is self-selection.

In an attempt to examine how student learning (physical, cognitive, and social) is best facilitated in the reciprocal style of teaching, Ernst and Byra (1998) paired junior high school learners by skill ability during an eight lesson unit on juggling. All learners improved their juggling scores from pretest to posttest (except those in the control group). The greatest amount of skill achievement was accomplished by low-ability learners regardless with whom they were paired. In terms of knowledge gains (ability to identify skill elements of the movement), all learners (except those in the control group) improved their score from pretest to posttest. Once again, with whom a student was paired was of no significance. Level of comfort working with a partner was perceived to be high by all students. All of the students, regardless of the pairing, reported that giving feedback to and receiving feedback from a partner was a positive experience.

In a comparative study that involved elementary-aged gymnasts, Cox (1986) examined four types of student behavior in the reciprocal, practice, and command styles of teaching. The purpose of this study was to demonstrate liabilities and assets of different teaching styles as they pertain to gymnastics instruction. The number of attempts made at prescribed movements, feedback statements offered, nature of feedback statements, and anti-social behaviors were recorded as the gymnasts received instruction in the three different teaching styles. The results revealed that the number of skill movements attempted was very similar across the three styles. On the one hand,

this was surprising in that in the reciprocal style each learner assesses a partner half of the time, a condition that is not associated with either the command or the practice styles. On the other hand, the finding is not surprising in that this study was conducted in an environment that necessitated some queuing in all of the teaching episodes because of a lack of space and equipment.

Differences were found in the number and type of feedback statements provided and anti-social comments made (Cox, 1986). Three times the number of feedback statements were offered to performers in the reciprocal style and 10 times more positive feedback compared to the command and practice styles. Anti-social behaviors were frequently recorded in the command and practice styles; in the reciprocal style they were almost non-existent. For those teachers who value the development of social relationships between pairs and the conditions for immediate feedback, the results of this study, as well as the others (Byra & Marks, 1993; Goldberger & Gerney, 1986; Goldberger, Gerney, & Chamberlain, 1982) support the contention that skill and knowledge gains can transpire while engaging in the socializing process unique to the reciprocal style.

Goldberger, Gerney, and Chamberlain (Goldberger & Gerney, 1986; Goldberger, Gerney, & Chamberlain, 1982), as well as Beckett (1991), Goudas, Biddle, Fox, and Underwood (1995), Byra and Jenkins (1998), and Jenkins and Byra (1997) have investigated learner performance and decision making related to the inclusion style, the last of the five reproductive styles. Within the inclusion style of teaching, learners choose level of difficulty within a task and assess their own skill performance (self-referenced evaluation). The primary goal of the inclusion style of teaching is to provide students opportunity to engage in activity at an appropriate skill level. In choosing level of difficulty, learners are given the opportunity to compare their aspirations to reality of performance. In assessing their own skill performance, the learners compare and contrast skill execution against the model and then conclude what is correct and incorrect. As reflected in the preceding statements, thinking and reflecting are critical to the role of the learner in the inclusion style of teaching.

Goldberger, Gerney, and Chamberlain (1982) and Goldberger and Gerney (1986) found the inclusion style of teaching effective in producing improvement in learner skill performance, but not at the same rate as found with the practice style. In addition, the authors found the inclusion style to be less effective for exceptional learners. This finding is inconsistent with Spectrum theory. Spectrum theory suggests that the conditions provided by the inclusion style should promote success for all learners.

So why these results? Goldberger, Gerney, and Chamberlain (1982) and Goldberger and Gerney (1986) observed numerous learners making inappropriate decisions for their skill level in the inclusion style episodes. The learners chose levels that appeared too difficult for them to reach success, and even with encouragement or prompting from the teacher would not change levels. Perhaps self-concept or peer pressure influenced the student's decision making. In combination this may have contributed to the inconsistency between Spectrum theory and the findings reported.

In a study of college-aged students, Beckett (1991) found the inclusion style to be as effective as the practice style for learner skill performance, and as suitable for learners of average and exceptional aptitude for learning motor skills. These findings do not support the conclusions of Goldberger, Gerney, and Chamberlain (1982; 1986). Beckett suggests that differences in students' ages (college students versus fifth-graders), motor tasks learned (soccer juggling versus floor hockey accuracy task), and settings (natural versus laboratory) may help to explain why the findings from his research support Mosston and Ashworth's (1994) contentions specific to the inclusion style, and why Goldberger, Gerney, and Chamberlain's do not.

Goudas et al. (1995) examined the motivational effects of the inclusion style of teaching in the sport of track and field. An intact class of 24 12- and 13-year old girls received track and field instruction in the practice and inclusion styles of teaching for a 10 week period of time. Based on this experience, the girls reported a preference for the inclusion style of teaching for reasons associated with intrinsic motivation. The girls specifically expressed that they perceived to have greater control over what they did and the amount of effort they put forth, and less anxiety as a result of being able to select level of task difficulty, in the inclusion style of teaching. Individualizing instruction to permit greater student success is the underlying premise of the inclusion style of teaching (Mosston & Ashworth, 1994). These findings support of this premise.

Byra and Jenkins (1998) examined learner decision making in the inclusion style of teaching. Fifth-grade students from one school received instruction in striking with a bat for two 30-minute lessons. The learners performed three sets of 10 trials of a batting task each lesson and made decisions about level of task difficulty. Data

sources were the lesson task sheets and transcribed post-lesson interviews. The results indicated that the fifth-graders did select different levels of task difficulty when provided the opportunity, and made task decisions regarding level of difficulty according to their perceptions of success, challenge, and curiosity. These findings support Mosston and Ashworth's (1994) notion that when given the opportunity learners will engage in an activity at an appropriate skill level.

Beckett (1991) and Jenkins and Byra (1997) examined gains in learner knowledge in the inclusion style of teaching. Beckett found that college-aged learners who received instruction on soccer-juggling under the conditions of the inclusion style scored significantly higher on a written knowledge test than learners who received instruction under the conditions of the practice style. Jenkins and Byra (1997) found that elementary-aged learners in both the inclusion and practice styles made significant gains in the number of skill elements reported from pretest to posttest, and learners in the inclusion style reported a significantly greater number of skill elements during posttest than learners in the practice style. These findings support Mosston and Ashworth's (1994) contention that learners should understand and recall elements of task performance better when taught in a style that requires the learners to assess their own skill performance.

So what have researchers uncovered about the reproductive cluster of teaching styles during the most recent era of Spectrum research? Following is a summary of the findings.

1. The practice style has been studied most frequently, followed by the reciprocal and inclusion styles.
2. The self-check style has not been researched.
3. The command, practice, reciprocal, and inclusion styles of teaching are effective in promoting motor skill acquisition in school-aged and college-aged students (Beckett, 1990; Boyce, 1992; Byra & Marks, 1993; Goldberger & Gerney, 1986; Goldberger & Gerney, 1990; Goldberger, Gerney, & Chamberlain, 1982; Jenkins & Byra, 1997).
4. Low ability fifth-grade students perform better in the practice style when given the opportunity to allocate practice time differentially, and spend more time practicing tasks yet mastered (Goldberger & Gerney, 1990).
5. More feedback is given to the performer in the reciprocal style than in the command, practice, or inclusion styles (Cox, 1986; Goldberger, Gerney, & Chamberlain, 1982).
6. In the reciprocal style of teaching elementary-aged learners give the greatest amount of feedback to a partner who is selected on the basis of being an acquaintance (Byra & Marks, 1993).
7. In the reciprocal style of teaching pairing by ability level (same or mixed) seems to have little effect on the amount of feedback a partner provides (Byra & Marks, 1993) or student learning (Ernst & Byra, 1998).
8. Elementary and junior high learners are most comfortable giving and receiving feedback (reciprocal style) from partners who are friends (Byra & Marks, 1993; Ernst & Byra, 1998).
9. Elementary-aged students emit fewer anti-social behaviors in a physical education setting where equipment and facilities are limited when instruction is provided within the reciprocal style compared to the command and practice styles (Cox, 1986).
10. Research findings related to skill acquisition are mixed for exceptional learners (high and low) in the inclusion style of teaching. Goldberger, Gerney, and Chamberlain (1982), and Goldberger and Gerney (1986) found the inclusion style to be less effective for exceptional learners in the fifth grade. Beckett (1990) found the inclusion style to be as effective for exceptional ability college-aged learners as average ability college-aged learners.
11. When given the opportunity to engage in activity at an appropriate level (inclusion style), fifth-graders consistently selected different levels of task difficulty (Byra & Jenkins, 1998).
12. Fifth-graders reported success and challenge most frequently as reasons for making a task less or more difficult in the inclusion style (Byra & Jenkins, 1998).
13. Greater knowledge gains were reported by college-aged and elementary-aged learners in the inclusion style of teaching compared to the practice style (Beckett, 1990; Jenkins & Byra, 1997).
14. Adolescent girls reported a preference to the inclusion style (over the practice) for reasons associated with intrinsic motivation (greater autonomy and effort, and less anxiety) (Goudas et al., 1995).

Productive Teaching Styles.

Until recently little research has been conducted within the "productive" cluster of Mosston and Ashworth's (1994) Spectrum of teaching styles. The productive cluster is dependent upon the learner producing new knowledge

to self or teacher. In a productive teaching style the teacher invites learners to engage in cognitive operations like problem solving, creating, inventing, or critically thinking to discover new movements. The subject matter is variable and often contains concepts, strategies, and principles. The teacher must provide the student time for cognitive processing, a class climate focused on searching and examining, and feedback for producing alternative solutions rather than a single solution.

Six teaching styles are identified in the productive cluster: (a) guided discovery and (b) convergent discovery, two styles that require convergent thinking from learners; and (c) divergent production, (d) individual program-learner design, (e) learner-initiated, and (f) self-teaching, four styles that require divergent thinking from learners. Based on informal discussions with teachers and observations of teachers in physical education classes, the guided discovery, convergent discovery, and divergent production seem to be the teaching styles most frequently used from the productive cluster in school settings.

A search of the literature in physical education revealed a total of five published papers involving teaching styles from the productive cluster. Four of these research studies have been published in the 1990s and have as the lead author Fran Cleland. One study was published in 1985 and it included an examination of both productive and reproductive teaching styles.

McBride's (1992) scholarly writing on critical thinking seems to have been as much of a stimulus for the development of Cleland's research focus as has the Spectrum itself. Of the six productive styles, Cleland and her colleagues have examined divergent production, convergent discovery, and guided discovery. In her first study Cleland studied the divergent movement patterns of children aged 4, 6, and 8 to establish baseline information about children's divergent movement patterns, and to examine different factors that might contribute to a child's production of divergent movement (Cleland & Gallahue, 1993). While being tested individually, the participants were given the following instructions: "try to move in as many ways possible using all of the equipment [at the locomotor task, stability task, or ball-handling task]" (p. 538). When asked to engage in the discovery process, the young children demonstrated that they could modify, adapt, or combine fundamental movement patterns to produce divergent movement. Experience and age were found to be factors that contributed to a child's ability to produce divergent movement. Although Mosston and Ashworth (1994) were not referenced in this paper, it was clear from the description provided that what the children did to produce divergent movements matched what they would have been required to do within the framework of Mosston and Ashworth's divergent production style. The participants were given a problem to solve and through their actions demonstrated the divergent thinking process.

In a second study of children's divergent movement ability, Cleland (1994) randomly assigned second- and third-grade children to one of three different instructional groups: (a) divergent production - content based on skill themes and movement concepts; (b) command/practice - content based on low-organized games; and (c) control, no instruction. The purpose of this study was to examine the effect of content and specific teaching styles on learner ability to produce divergent movement. The findings were favorable for the learners receiving treatment under conditions of divergent production. These students generated a significantly greater number of divergent movement patterns than those who received treatment under conditions of direct instruction or no instruction (control group). Cleland concluded that employing critical thinking strategies in the form of divergent production positively effects learner's ability to generate divergent movement patterns. It would be interesting to conduct a follow-up study of children's divergent movement production where content for both treatment groups is constant, based on skill themes and movement concepts (Graham, Holt/Hale, & Parker, 1998), and conditions of instruction different (divergent production style, command/practice style, control). Cleland's findings may be attributable to the difference in content delivered (skill themes/movement concepts vs. low-organized games), not the teaching styles employed.

In a year long study of fifth-grader's critical thinking in physical education, Cleland and Pearse (1995) examined how the physical education specialist can structure the learning environment to promote critical thinking. Critical thinking, as defined by McBride (1992), is "reflective thinking that is used to make reasonable and defensible decisions about movement tasks or challenges" (p. 115). Children's divergent movement ability is one aspect of critical thinking. Cleland and Pearse found that critical thinking in children could be fostered via the employment of two of Mosston and Ashworth's (1994) productive teaching styles, specifically, divergent production and convergent discovery. The teachers in this study employed the practice style of teaching to deliver domain-specific knowledge to the learners relative to lesson content prior to having them engage in problem solving

activities. Conditions of the reciprocal and self-check styles were used to guide the learners in tasks that involved working individually, or working in pairs or small groups. Based on systematic analysis of videotapes, the investigators concluded that a student's ability to think critically (to produce divergent movement) "depends on the movement task and the teacher's ability to effectively use indirect [divergent production and convergent discovery] teaching styles" (Cleland & Pearse, 1995, p. 36). According to the student interviews, the learners reported that they enjoyed the critical thinking activities employed in the lessons, that they preferred to engage in tasks that involved small groups, and that written movement problems were more difficult to solve.

The research of Cleland and her colleagues (Cleland, 1994; Cleland & Gallahue, 1993; Cleland & Pearse, 1995) serves to affirm that critical thinking in children, specifically as it applies to the production of divergent movement, can be fostered through Mosston and Ashworth's (1994) guided discovery, convergent discovery, and divergent production teaching styles. Based on this knowledge, Cleland's most recent research effort focused on how teachers could promote critical thinking in children in the physical education setting (Cleland, Donnelly, Helion, & Fry, 1999). A group of four experienced physical education teachers participated in a comprehensive workshop that included: (a) instruction on how to use specific teaching styles (guided discovery, convergent discovery, and divergent production) and McBride's (1992) schema of the critical thinking process to promote an atmosphere of inquiry in class; (b) opportunity to implement lesson plans aimed at promoting critical thinking that were designed by the participants and workshop instructors in collaboration; and (c) opportunity to discuss and analyze the practice lessons taught. Three lessons of each participant's teaching was videotaped prior to participating in the workshop. After participating in the workshop, the teachers were videotaped while teaching a unit of instruction in which critical thinking strategies were employed.

The intervention employed in this study enabled the four teachers to structure the environment and frame learning tasks to promote critical thinking in physical education classes. All four participants were able to use conditions of the guided discovery, convergent discovery, and divergent production teaching styles to ascertain specific process and product variables identified within McBride's (1992) schema on critical thinking.

In the fifth study reviewed involving the productive teaching styles, Salter and Graham (1985) examined the effect of three disparate instructional approaches on four product variables in a single-lesson experimental teaching unit (ETU). The four product variables were skill learning, cognitive learning, skill attempts, and rating of self-efficacy. Instruction was delivered to the elementary-aged students under conditions of guided discovery, the command, and a no-instruction (learners performed the same task without verbal instruction/feedback).

The results of this study showed that significant skill learning occurred in all three treatment groups. However, no significant between group differences were found for skill learning. Significant cognitive learning also occurred for all three groups. However, in contrast to skill learning, the students in the guided discovery and command styles recorded significantly better scores on the cognitive criterion than the participants in the no-instruction group. No differences were found on the measure of self-efficacy. For skill attempts learners in the no-instruction group made significantly more attempts at the task than learners in both the guided discovery and command styles.

Salter and Graham (1985) attribute the lack of between group difference for skill learning to the limitations imposed by the ETU (single, 20-minute lesson) and the higher number of skill attempts performed by the learners in the no-instruction group. Practice time was higher for the no-instruction group because no skill information was given to the learners during the lesson. Under the guided discovery and command instructional conditions, where skill information was offered, learners demonstrated a higher level of cognitive understanding.

So what have researchers uncovered about the productive cluster of teaching styles during the most recent era of Spectrum research? Following is a summary of the findings.

1. When instructed within the divergent production style, children can modify, adapt, or combine fundamental movement patterns to produce divergent movement (Cleland & Galahue, 1993).
2. Experience and age are factors that contribute to a child's ability to produce divergent movement while engaged in the divergent production teaching style (Cleland & Galahue, 1993).
3. Children who receive instruction in the divergent production style are more capable of generating divergent movement patterns than children who receive instruction in a combination of the command and practice styles (Cleland, 1994).

4. Children's ability to produce divergent movement in a physical education setting is dependent on the teacher's ability to effectively use the divergent production and convergent discovery teaching styles (Cleland et al., 1999; Cleland & Pearse, 1995).
5. Opportunity for elementary-aged learners to attempt skill trials in the guided discovery and command styles is similar (Salter & Graham, 1985).
6. The guided discovery style is as effective in fostering student skill and cognitive learning in an elementary population as the command style (Salter & Graham, 1985).

Summary

Between 1982 and 1999, the lower and upper years defining the recent era of Spectrum research, 17 data-based research studies were published in physical education journals specific to the Spectrum teaching styles. Reproductive teaching styles were examined in 12 of the 17 studies, and productive teaching styles in five. Approximately 20 different researchers have contributed to this data-based research.

Researchers who have conducted Spectrum studies during this recent era have paid close attention to the comments made by Goldberger (1992), Locke (1977), and Metzler (1983) regarding the early Spectrum research. For example, the recent research is no longer being driven by the question, which style is better. It is being conducted within the non-versus premise, that is, no single style is superior in itself to any other style; rather, each style has its own set of objectives, assets, and liabilities. Nor is the research being criticized for having methodological deficiencies. Researchers are systematically verifying style implementation, basing the conclusions of studies within the framework of each style, conducting studies for long enough periods of time to allow for student learning, and proceeding to do research only after having gained substantial knowledge of the Spectrum. Goldberger (1992) seems to have hit the nail on the head when suggesting that the "early work was necessary for us to learn how to better conduct Spectrum research" (p. 42). The research that has been completed during the recent era reflects Goldberger's thoughts.

Are we moving forward with Spectrum research? One of the major problems identified with the Spectrum in the early 1980s was the lack of research conducted to verify the assumptions of Spectrum theory (Metzler, 1983). To that point in time, few well-designed Spectrum studies had been completed. A decade later, some 10 studies later, Goldberger (1992) concludes, "although the theory has not yet completed the full program of testing Nixon and Locke called for, results to date confirm the theory's power to both describe teaching events and predict learning outcomes" (p. 45). Now, as we near the millennium, almost 20 Spectrum studies have been completed. Is Spectrum research moving forward? The answer is unequivocally yes. We have made strides in understanding Spectrum theory, however, much work remains to be done. For each question answered, three to five new questions have been raised. It seems that we have just exposed the tip of the iceberg of possible Spectrum research.

So where to now with Spectrum research? We need to continue to investigate the theoretical assumptions associated with Mosston and Ashworth's (1994) teaching styles. Some assumptions have been confirmed. For example, the reciprocal style does facilitate the provision of feedback, more so than in other styles, and having learners self-select partners based on who they like does foster partner interaction (Byra & Marks, 1993; Cox, 1986; Goldberger, Gerney, & Chamberlain, 1982). Other assumptions like, the self-check and inclusion styles move a learner further along the cognitive developmental channel, and the inclusion style equally fosters participation of low, medium, and high ability learners still need to be examined.

We need to examine Spectrum teaching styles through the eyes of the learner. Mosston and Ashworth (1994) indicate that the role of the learner changes from one teaching style to the next according to the decisions they are afforded. What do we know about their role in the various teaching styles? The results from one study suggest that learners associated success and challenge with the inclusion style of teaching (Byra & Jenkins, 1998). Would learners report as many successes in a setting where every task represented a single standard? By asking the learner, Lee (1997) suggests that "we will learn things we never knew we did not know" (p. 274).

We need to conduct replication studies to confirm what we already know about the Spectrum. For example, will the reciprocal style of teaching facilitate student learning in junior high school students in different schools and school districts in the same way as it did the junior high participants in Ernst and Byra's study (1998)? In a replication study of the practice, reciprocal, and inclusion styles, Goldberger and Gerney (1986) confirmed the student skill acquisition findings of an earlier study of same aged participants (Goldberger, Chamberlain, & Gerney, 1982). More of these types of studies are needed.

We need to complete similar studies to those already conducted but in different contexts to extend what we have learned about the Spectrum. For example, will elementary learners make skill performance selections in the inclusion style of teaching for the same reasons as secondary-aged students? Will fifth graders receiving instruction in the reciprocal style of teaching interact with a partner in the same way when performing a volleyball skill as a tennis skill? These types of studies will hopefully provide evidence that allows researchers to make greater generalizations about the Spectrum findings.

These are but a few directions that we can pursue in our quest to better understand Spectrum theory. Over the next decade we need to continue to employ the Spectrum of teaching styles as a framework to study teaching and learning in physical education.

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