

Development of creativity: The influence of varying levels of implementation of the DISCOVER curriculum model, a non-traditional pedagogical approach

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Abstract

Development of creativity is influenced by multiple factors, including the environment, developmental changes, and measurement tools. In this study, we investigated the relationship between creativity development and implementation of the Discovering Intellectual Strengths and Capabilities while Observing Varied Ethnic Responses (DISCOVER) curriculum model. Using the Test of Creative Thinking–Drawing Production (TCT-DP), 1986 culturally diverse, low-income students, K through 6, in four elementary schools in the U.S. were assessed for three consecutive years. The creativity of all children increased from grades K to 6, but children in classrooms of low implementers demonstrated a dip and some “pauses.” Differences in scores of children in middle/high and low implementers’ classrooms were significant. The implication is that creativity development is supported through active learning, student choice, access to varied materials, exploration, self-evaluation, problem finding, and problem solving. Additional analyses need to be conducted to uncover cultural and linguistic influences in these four schools.

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Development of creativity, intelligence, and the ability to solve a variety of problems is important to individuals, educators, psychologists, and societies. The development of *creative* problem solving is influenced by multiple factors, including level of education (Simonton, 1984b), knowledge gained in schools or out of school (Sak & Maker, 2006; Sternberg & Lubart, 1995; Weisberg, 1999), internal and external motivation (Amabile, 1982; Amabile, Hennessey, & Grossman, 1986; Eisenberger, & Shanock, 2003; Harackiewicz, Abrams, & Wageman, 1991; Hennessey, 2004), cultural and familial factors (Aviram & Milgram, 1977; Lubart & Lautrey, 1998 [cited in Lubart & Georgsdottir, 2004]; Marino, 1971; Ng, 2001; Niu & Sternberg, 2001; Straus & Straus, 1968; Williams et al., 1995), development of conventional or logical thinking (Dudeck, 1974; Georgsdottir, Ameal, & Lubart 2002; Lubart & Georgsdottir, 2004; Rosenblatt & Winner, 1988), and age-related changes (Sak & Maker, 2006; Simonton, 1984a).

The focus of this study is on the educational environment and its impact on the longitudinal development of children’s creativity. In many of the earliest studies (c.f., Torrance, 1968), even though the influence of environment on creativity was recognized, the developmental trends and patterns found were perceived as inevitable results of the existing educational system. More recent research (Besançon, 2006), however, has shown that different pedagogical practices influence creativity development in different ways. Moreover, in even the recent studies, the degree to which teachers implemented the pedagogical approaches was not known, nor was it included as a variable in the analysis of results. In this study, we were interested in knowing whether the degree to which teachers implemented a creativity-enhancing, non-traditional pedagogical approach would impact the development of children’s creativity over a three-year period.

1. Developmental trends in creativity

The first studies of creativity development were those conducted by E. Paul Torrance using the Torrance Tests of

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Creative Thinking (TTCT). [Torrance \(1968\)](#) found an early increase in creativity, a decline at around age 6 (beginning of more formal schooling), a greater decline at the fourth grade, and a later increase. This “fourth grade slump” was found in as many as seven countries ([Torrance, 1967](#)). The belief that creativity development showed clear peaks and slumps influenced research and practices for many years. However, a review of research over the past 50 years from a variety of fields using a variety of instruments and experimental tasks yields a more complex picture of development. Researchers and theorists such as [Amabile \(1983, 1996\)](#), [Lubart \(1994, 1999\)](#), and [Sternberg and Lubart \(1995\)](#) take a multivariate approach to creativity, proposing that creativity depends on cognitive, conative, and environmental factors that combine in an interactive fashion. From this perspective, the complexity of creativity development is recognized, as is its interaction with other developmental changes in children. In addition, the domain studied, the inclusion of “integrative” creativity (making one product rather than many products) or divergent thinking (making many products or giving many responses), and the instrument used are all factors to include when analyzing the trends found.

To demonstrate the complexity of the findings across studies, we have analyzed representative studies in which children of elementary school age were included, listing the author and date, the age or grade of students, the general trends in development, the domain or ability assessed, and the instrument or analysis completed ([Table 1](#)). Examination of these studies shows three periods of interest in which varied results have been found: entry into formal schooling (usually at ages 5 to 7), grade 4, and grade 6. Please note that an extensive and in-depth review was not possible, so only general trends are reported, and readers are advised to consult other more extensive discussions of development such as [Lubart and Georgsdottir \(2004\)](#) and [Runco and Charles \(1997\)](#).

1.1. Entry into formal schooling

Increases in creativity were found in this age group by [Chae \(2003\)](#), [Daugherty \(1993\)](#), and [Smolucha and Smolucha \(1985\)](#) while decreases were found by [Smith and Carlsson \(1983\)](#), [Torrance \(1962, 1963\)](#), and [Urban \(1991\)](#). Both Chae and Urban used the Test of Creative Thinking–Drawing Production (TCT-DP), and found different trends. However, Chae’s research was with Korean children, and Urban reported results of norming studies, mostly in Germany, but including other countries as well. Smolucha and Smolucha studied fluency and flexibility in arrangement of shapes (a hands-on task with plastic shapes) and Smith and Carlsson conducted a qualitative analysis of visual perception using the Percept–Genesis model. All these studies included visual tasks. In Daugherty’s study, the semantic content of children’s private speech was analyzed (verbal), and the Thinking Creatively in Action and Movement (TCAM) was administered. Torrance’s studies were of divergent thinking in both figural and verbal domains using the Torrance Tests of Creative Thinking (TTCT). Finding a pattern in these results is difficult, as both divergent thinking and integrative tasks either

declined or increased, and both verbal and figural creativity declined or increased. Even use of the same instrument yielded different results.

1.2. Grade 4

Like [Torrance \(1968\)](#), [Georgsdottir and colleagues \(Georgsdottir et al., 2002\)](#), [Lubart and Lautrey \(1995\)](#), [Rosenblatt and Winner \(1988\)](#), and [Smolucha and Smolucha \(1985\)](#), found declines in creativity at this grade. However, an equal number of researchers found increases: [Smith and Carlsson \(1985\)](#), [Camp \(1994\)](#), [Urban \(1991\)](#), [Lopez, Esquivel, and Houtz \(1993\)](#), and [Charles and Runco \(2000–2001\)](#). [Besancon’s \(2006\)](#) results were mixed. In two of the studies, the same instrument was used: both Lopez, et al. and Torrance administered the TTCT Verbal and Figural. However, Lopez, et al. found an increase in her small population of mostly Hispanic, culturally diverse students in a special school for gifted students, while Torrance reported decreases in a larger group of English-speaking students. Across all the studies except [Besancon’s](#), both integrative creativity and divergent thinking showed both increases and decreases. For example, Smith and Carlsson studied integrative creativity with the percept genesis model, Rosenblatt and Winner analyzed art products, Lubart and Lautrey included storytelling, and [Georgisdottir et al. included Duncker’s \(1945\) candle task](#). Divergent thinking in both figural and verbal areas was assessed in Camp’s study using [Williams’ \(1993\) model](#); Charles and Runco used the verbal instances tasks from the Wallach–Kogan Creativity Tests (WKCT, [Wallach & Kogan, 1965](#)); Lubart and Lautrey administered the TTCT-Verbal; and [Georgisdottir et al. administered a free-association task](#). [Besancon](#), using a variety of tasks across both figural and verbal domains, found linear increases in integrative creativity and phases of decline in divergent thinking. No patterns can be found based on the domains studied, as both decreases and increases were identified in both figural and verbal domains.

1.3. Grade 6

At this grade level, the results are more consistent. Only three studies including children in grade 6 showed decreases in creativity from grade 5 to grade 6 while eight studies showed increases. [Claxton, Pannels, and Rhoads \(2005\)](#) found a decrease in divergent thinking using [Williams’ \(1993\) figural divergent thinking battery](#), the Creativity Assessment Packet (CAP), [Smolucha and Smolucha \(1985\)](#) found a decrease in fluency and flexibility in arrangement of shapes, and [Smith and Carlsson \(1990\)](#) found a decrease in creativity as measured by their visual Percept–Genesis model. All these studies were of the figural domain—some of integrative creativity (Smith and Carlsson) and some of divergent thinking (Smolucha and Smolucha and Claxton et al.). Increases were found in divergent thinking in both verbal and figural domains ([Camp, 1994](#); [Cheung, Lau, Chan, & Wu, 2004](#); [Lopez, et al., 1993](#); [Lubart & Lautrey, 1995](#); [Torrance, 1968](#)) and in integrative creativity in both verbal (Lubart & Lautrey) and figural

Table 1
Developmental trends in studies of creativity

Author/date	Age/grade	Trend(s)	Domain(s)	Instruments/analysis
Besaçon, 2006	Ages 6–11	Phases of decline in DT	Figural and verbal	DT tasks were semantic fluency (name as many round or blue things as possible), new uses of a cardboard box, improvement of a toy, parallel lines
Camp, 1994	Grades 1–12	Linear increases in integrative creativity High scores to 6th grade and a drop until 12th Inconsistent, with increase from 9 to 12	Figural and verbal Figural fluency, flexibility, and originality; verbal flexibility and fluency Figural elaboration	Integrative tasks were invent a story and invent a drawing Creative Assessment Packet (CAP)
Chae, 2003	Ages 4, 5, and 6	Dramatic increase from age 4 to 5, slight increase from 5 to 6	Drawing	Test of Creative Thinking–Drawing Production (TCT-DP)
Charles & Runco, 2000–2001	Grades 3–5	Peak at grade 4	Verbal responses to visual/auditory ideas scored for fluency, flexibility, originality, cueing, and appropriateness	Instances tasks from Wallach–Kogan battery (round things and things that make noise)
Cheung et al., 2004	Grades 1–4	Increase in most indices	Verbal and figural	Individual administration of Hong Kong Wallach–Kogan Creativity Tests (WKCT)
	Grades 4–9	Increase at most grades with decline at grade 7	Verbal and figural	Group administration of WKCT
Claxton et al., 2005	Grades 4, 6, and 9	Decline in figural originality at grade 6 Increase in figural elaboration from grade 6 to grade 9	Figural DT and Divergent Feeling (DF)	CAP: DT, completion of unfinished pictures and DF, self-report
Daugherty, 1993	Ages 3–6	Decline between ages 3 and 5 with increase at age 6 Decline	Fluency and originality Originality	Qualitative analysis of semantic content of private speech and Thinking Creatively in Action and Movement (TCAM)
Georgsdottir et al., 2002	Ages 8–10	Decline at age 9 and increase at age 10	Verbal flexibility	Free-Association task and Duncker's (1945) candle task
	Study 2	"Pause" between ages 8 and 9, progression between 9 and 10	Verbal and figural flexibility	
Lopez et al., 1993	Grades 1–8	Increase	Verbal and figural	Torrance Tests of Creative Thinking (TTCT)
Lubart and Lautrey, 1995	Ages 8–12	Decline at 9 to 10 in unusual uses task	Verbal	TTCT Verbal and storytelling
Rosenblatt and Winner, 1988	Ages 6, 8, 10, and 12	U-Shaped development	Art	Qualitative analysis of children's realistic and unrealistic drawings
Smith & Carlsson, 1983	Ages 6–8	Decline	Visual perception	Percept–Genesis model
Smith and Carlsson, 1985	Ages 10–11	Increase (peak)	Visual perception	Percept–Genesis model
Smith and Carlsson, 1990	Age 12	Decline	Visual perception	Percept–Genesis model
Smolucha and Smolucha, 1985	Ages 2–57	J-Shaped with peak at 6 and higher peak in 20 s	Fluency and flexibility in arrangement of shapes	Eight plastic shapes arranged by participants
Torrance, 1962, 1963	Grades K–1	Decline	Verbal and figural	TTCT
Torrance, 1968	Grades 3–4	Decline	Verbal and figural	TTCT
Urban, 1991	Ages 5–6	Decline	Drawing	TCT-DP
	Ages 6–8	Increase		

(Rosenblatt & Winner, 1988) domains. In addition, Claxton, et al., who found decreases in divergent thinking using the CAP, found increases in divergent feeling using the parallel form of the instrument.

1.4. Possible influences on development

As one can see from the above analysis, no clear patterns emerge across instruments, domains, and ages. However, researchers have

suggested that a number of factors are important to consider. Lubart and his colleagues (Lubart & Georgsdottir, 2004; Lubart & Lautrey, 1995; Georgsdottir et al., 2002) hypothesize that decreases in creative thinking occur when logical thinking abilities increase. Similarly, Runco and colleagues (Charles & Runco, 2000–2001; Runco & Charles, 1997) posit that the development of evaluative and evaluative thinking accompanies decreases in creativity. Others discuss the possible impact of developmental stages using a Piagetian approach (Dudeck, 1974; Smolucha & Smolucha, 1985).

Clearly, more research is needed to clarify the inconsistent findings of research on development of children's creativity.

2. Impact of the educational environment on development of creativity

Perhaps one of the reasons for such inconsistent findings of developmental research is that the educational environment has a greater impact than expected. In the developmental studies cited, with the exception of Lopez et al. (1993), descriptions of the educational programs in which children are involved are lacking. Although Torrance (1981) asked the students in his longitudinal study to think of an incident in which one of their elementary teachers had encouraged creative behavior, and how their support had made a difference in their careers, this information was not used as a variable when examining the results of creativity testing. As Runco and Charles (1997) point out, although between 45 and 61% of the fourth-grade students in Torrance's (1968) study experienced a "slump" on at least one measure, 38% of the students experienced growth in elaboration, 22% in originality, 20% in flexibility, and 11% in fluency. Did this growth occur in certain classrooms and not in others? Did the slumps occur more frequently in particular classrooms? What was the impact of being in classrooms of teachers who encouraged creativity for several years in a row? What happened to children who had an encouraging teacher one year and a discouraging teacher the following year? All these questions are important to those who wish to truly understand the development of children's creativity.

Several recent meta-analyses of the effects of creativity training programs (Ma, 2006; Pyryt, 1999; Scott, Leritz, & Mumford, 2004) have shown that these programs are effective in increasing creativity as measured in a variety of ways. Ma found that the overall effect size for the 37 studies analyzed (all with control and experimental groups) was .77, while in Scott et al.'s analysis of 70 studies, the effect size was .68. Interestingly, Scott et al. found that the effects generalize across criteria, settings, and target populations while Meador found that effect sizes were greater in older participants. Pyryt found a correlation between the number of divergent thinking lessons included and performance on divergent thinking tests while Ma found no differences in outcomes that were related to duration of training.

What elements of these training programs contribute to their success? The two meta-analyses in which this question was addressed in depth were Scott et al. (2004) and Ma (2006). Scott et al. identified two distinct types of programs: those emphasizing divergent thinking and those designed to develop problem solving. Similarly, Ma separated programs into those emphasizing creativity without evaluation (divergent thinking) and creativity with evaluation (problem solving). In the divergent thinking programs, emphasis is placed on ways to generate alternative ideas, and on deferring the tendency to evaluate so that multiple answers are considered. Scott et al. used Mumford and colleagues (Mumford et al., 1991) review of problem solving process models as their description of programs designed to develop creative problem solving

(creativity with evaluation). In this model eight "core processing operations" are essential to the approach: identification of the problem (problem-finding), gathering information, searching for and identifying key concepts, combining concepts, generating ideas, evaluating ideas, planning for implementation, and monitoring of action. Both types of programs are successful in producing the desired outcomes: divergent thinking programs result in increases in divergent thinking and problem solving programs result in better problem solving. In addition, training also influences creative performance and the behaviors and attitudes needed in creativity (Scott et al., Ma).

In Ma's (2006) analysis, some programs were classified as simple ideation training: brainstorming, incubation, forced relation, catalog, part improving, morphological synthesis, attitude training, synectics, and idea checklists. A second set of programs was classified as composite programs because they combined several techniques. Attitude training and one of the composite programs (The New Directions in Creativity Program) had the highest mean effect sizes (1.46 and 1.41 respectively), while simple ideation (.99), Creative Problem Solving (.82) and Khatena's Training method (.82) also had high mean effect sizes. Scott et al. (2004) included an in-depth analysis of the impact of both content and course design variables on effect sizes. Content variables included the theoretical approach (cognitive, social, personality, motivational, confluence, and other), core problem solving processes included, and techniques (divergent thinking, convergent thinking, critical thinking, metacognition, ideation, elaboration, and many others). Delivery methods included course design (number of days in course, general model applied, domain specific exercises, realistic practice, difficulty of material, and other variables), media (lecture, video or audio, computer assisted, discussion, cooperative learning, and others), and practice exercises (classroom exercises, field exercises, self-paced exercises, written exercises, performance/production exercises, and others). Although all the results of their analysis cannot be reviewed here, some important findings were the following: (a) cognitive frameworks were the most successful; (b) problem identification and idea generation made the strongest contributions of all the process variables, while idea evaluation had a negative effect; (c) critical thinking, convergent thinking, and constraint identification were the most successful techniques; (d) course design variables such as the amount of practice provided, the general model applied, realistic practice, and the amount of time spent in practice were important to the success of the training programs; (e) use of media in which information was given contributed to success; and (f) the use of domain-based performance exercises was most important when the outcome measure was problem solving or performance rather than divergent thinking.

One can conclude from this analysis, then, that creativity training programs including certain techniques can be successful in producing changes in divergent thinking, problem solving, and development of attitudes that will enhance creativity. If relatively short-term, self-contained creativity-enhancing programs are successful, then what will happen if these methods are incorporated into daily instruction or are part

of an overall pedagogical approach to education of elementary school children?

2.1. *Traditional vs. non-traditional pedagogy*

Thomas and Berk (1981) were perhaps the first to study the differential effects of traditional and non-traditional pedagogy on children's creativity across several schools. They studied six schools, and found that the best environment for developing creative performance is one that is neither too structured nor too flexible. Their results were complex, however, and showed that creativity development was influenced by the type of school, gender of the student, and the domain of creativity measured. Sefer (1995) studied the effects of an interdisciplinary program including drama, group research, and games on the development of creativity in Yugoslavian children. Children, ages 7 to 11 in both a rural and an urban school, participated in the play-oriented curriculum for a five-year period, and their creativity was assessed using a variety of methods, including the TTCT Verbal and Figural, observation during classroom activities (and also analysis of videotapes of classroom activities) by professional writers and artists as well as experts trained in evaluation of creativity, and evaluation of student products such as paintings and written stories by professional artists and writers. Teachers participating in the project were interviewed as well as teachers who worked with the students the following years. Overall results of the comparison of students participating in the experimental and control groups included significant improvement in students' creativity in all domains studied, their motivation to learn, and their ability to express ideas through various media.

Lopez et al. (1993), in a study of creative abilities of culturally diverse students in a special school for gifted students, found that the children's creativity increased each year. No periods of significant decline were noted from grades 1 through 8. Using a classroom observation instrument consisting of seven teacher behaviors previously identified as having a relationship to creative thinking, teachers were classified as high, middle, and low on these instructional variables. Four were found to be related to creativity: a) self-initiated learning, in which the teacher gives opportunities for choice of activities and encourages independent learning; b) self-evaluation, in which the teacher involves students in critiques of their own work; c) manipulating materials, in which the teacher provides opportunities for students to use concrete materials and tools; and d) open discussions, in which teachers give opportunities for students to share information among themselves and with the teacher. Although other studies have included instructional variables (see Houtz, 1990), this study is highlighted because the general school climate was one in which teachers were encouraged to use individualized instruction, small-group instruction, learning centers, and independent projects. Thus, students likely were involved for several years in classrooms in which many aspects of environments supporting creativity were present.

More recently, Besançon (2006) conducted a complex study of the development of creativity in schools in Paris and Parisian

suburbs. The creativity development of children in schools using two non-traditional pedagogies (Freinet and Montessori) was compared with the development of creativity in children attending schools using traditional pedagogy in a semi-longitudinal study. Using a variety of measures of verbal and figural creativity, and assessing both divergent thinking and integrative creativity, she found that the type of pedagogy influenced children's creativity, and that this influence was more consistent in the Montessori schools than in the Freinet schools. In addition, she found that teachers' implementation of the pedagogies differed, that this also impacted the children's creativity, and that the type of task used to assess creativity showed different results in different schools. For example, the pattern of development in the different pedagogical approaches was different for divergent thinking and for integrative tasks from year one to year two of the study. (For more information about this study, see Besançon and Lubart, 2008-this issue.)

2.2. *The DISCOVER Project*

Discovering Intellectual Strengths and Capabilities while Observing Varied Ethnic Responses (DISCOVER) is an ongoing program of research in which the theories of Gardner (1983), Sternberg (1989, 1997) and Ceci (1996) have been integrated with the early research of Getzels and Csikszentmihalyi (1967) to develop a framework for assessing and developing problem solving in children and adolescents. In this view, intelligence and creativity are seen as similar constructs, with differences being an artifact—a result of differing ways of perceiving and measuring problem solving. When intelligence and many cognitive abilities are measured, the problems solved by those being tested are well-structured—they have a clearly stated problem, the methods are specified or explained, and only one answer or solution is acceptable. On the other hand, when creativity is measured, the problems tend to be less structured or even unstructured—they may have a “fuzzy” problem or one that can be interpreted in many ways, multiple acceptable or possible methods, and numerous appropriate answers. Different ways of measuring children's and adults' knowledge and ways of using that knowledge result in the creation of two separate constellations of abilities—one called creativity and one called intelligence or cognitive abilities.

In the DISCOVER Project, early emphasis was placed on observing and interviewing adults and children as they solved problems with varying degrees of structure in different domains, and comparing these descriptive results with the predictions of the theories that formed the basis for the program (Maker, 1993). In the next series of studies, a performance-based assessment of problem solving in various domains was developed, field-tested, and refined (Maker, 1996, 2001, 2005; Sak & Maker, 2003, 2005, 2006, Sarouphim, 2001, 2002, 2004). Studies of the reliability and validity of this assessment are on-going, and conducted in various cultures, both in the US and other countries. The third phase of the project involved the creation of a curriculum and teaching model for development of problem solving in elementary school children that was based on the same theoretical framework and incorporated research-based practices

in the development of intelligence (giftedness) and creativity (Maker, Nielson, & Rogers, 1994). This third phase is the emphasis in the current study.

The DISCOVER curriculum and teaching model is a non-traditional teaching approach based on a constructivist philosophy, in which the emphasis is on solving a variety of types of problems—including both well-structured and unstructured. In this approach, students are given many opportunities to make choices about (a) specific content to be studied within general themes, (b) types of problems to solve, and (c) formats or domains of products to demonstrate learning (e. g., written or oral stories, drawings, dramatic productions, music, mime, multi-media productions); and integrating learning from various academic domains through the use of trans-disciplinary themes (Maker, 2001, 2005; Maker, Rogers, Nielson, & Bauerle, 1996; Maker & Schiever, 2005). Teachers establish a learner-centered environment in which students' strengths are emphasized and they participate in decision-making about a variety of factors that impact their learning. Because one of the key ideas in this approach is that all children should be viewed as “at promise” for development of talents and abilities rather than “at risk” for failure, the main targets for change are schools in high-poverty areas with high percentages of children who are culturally and linguistically diverse.

When using the DISCOVER curriculum model, teachers incorporate many of the principles shown to be effective in studies of creativity training programs, particularly those in which problem solving is the emphasis. For instance, because the DISCOVER problem continuum contains a variety of problem types, both structured and unstructured or ill-defined, students are led through a process of gradually moving from the more familiar academic problem solving (a clearly stated problem with a right answer and specified methods) to the less familiar problem solving in which they can propose an unlimited number of solutions and choose a method they believe is appropriate. In the least structured type of problem, students experience “problem finding” as they define for themselves the problems they will solve. An important aspect of the model that makes it significantly different from divergent thinking programs is that academic content is integrated across areas such as science, social studies, language arts, and math; and through this integrated approach, multiple domains are included in the study of one important theme. Other aspects of the curriculum model include practice of problem solving methods across academic content areas and across domains of human ability. Many teachers also involved students in the solving of community-based, realistic problems.

In the classroom of one high implementer of the DISCOVER curriculum (grade 2, ages 8 and 9), the content was arranged around the theme of cycles (Maker & King, 1996). In one of the three sub-units, students studied seasons and weather, choosing certain activities from a list of options, and participating in certain group experiences. In this sub-unit, one of the structured problems to develop logical-mathematical thinking was for the students to find the current temperature in the classroom and outside, and to keep temperature records for a week. A less structured problem in the same domain was to formulate a

hypothesis about temperatures in different places in the school, set up an experiment, collect data for a week, and show results in tables and graphs. The least structured assignment was the following: “Using anything from the math center, create your own experiment to test a hypothesis about a weather phenomenon.” In this same unit, a structured problem designed to develop interpersonal abilities was to list differences between temperatures inside and outside the classroom; a less structured problem was to create a game about a cycle, teach the game to a group of younger students, and play it with them. The least structured problem was to “develop an interactive product to illustrate a cycle of your choice.

During an observation of this classroom, students participated in a free-choice experience in which they were learning about the water cycle. After a discussion of possible things they could do in the learning centers (containing many different manipulatives and other materials), students were asked to create something that demonstrated how the water cycle worked. They could create their products alone, with a partner, or with a group. While they were working, the teacher moved from group to group, observing what the children were doing, asking questions about how their products illustrated the water cycle, and answering questions about the cycle and the assignment. When all students were ready, each individual and group presented her or his product to the class. Prior to these presentations, the teacher led students in a discussion of the criteria they should use to evaluate and discuss all of the products. Students suggested that the main criterion was whether the product showed the cycle accurately, but also included criteria such as uniqueness and interest. Students in the audience were encouraged to ask questions of the presenters.

In the classroom of a high implementer in grade 4, one theme was patterns, and a sub-unit was poetry. In this classroom, a structured experience to develop spatial ability was to select a picture of a Navajo rug and show the recurring pattern in the rug by drawing its components. A less structured problem in the same domain was to read a poem with a distinctive rhyming pattern, select a similar patterned verse, and illustrate it using repetitive visual patterns that mirror the repetitive verbal patterns. The least structured problem in this series was to select a poem that has meaning and represent its patterns and surprise elements in a spatial form. In another 4th grade classroom, at the end of a unit of study on cultures of the Southwest, the “test” of students' learning was to create anything you want to create that demonstrates what you have learned about the cultures of the Southwest. The teacher had pushed all desks into the corners of the room, put plastic bins of math materials, art supplies, magazines, musical instruments, dress-up costumes, and a variety of materials in the center of the room. Students were given a day to create their products, either individually or in groups. During the observation of this classroom, all students were engaged—first thinking and talking to decide what to do, then experimenting with various approaches, practicing skits and plays, writing, playing music, and finally, sharing their products with the other students. After each presentation, the teacher led a discussion of the product

and asked everyone to comment on the content as well as the process used to develop the product.

Across the classrooms of teachers who implemented the DISCOVER curriculum model, six principles were considered common to the approach, and important as indicators of the level of the teachers' implementation of the model:

1. Integrates multiple intelligences through self-selected product formats, available/accessible tools, and choices based on interests and strengths.
2. Poses a variety of types of problems and, at times, encourages students to design their own problems, to access information and demonstrate understanding.
3. Collaborates with students to establish a learner-centered environment that includes student choice, flexible schedules and grouping, standards for behavior, sharing, openness, and acceptance.
4. Organizes content around broad-based, interdisciplinary themes.
5. Models a variety of processes and gives students opportunities to use the processes to access and transform information.
6. Encourages students to develop varied products that reflect the diverse strengths, interests, and preferences of students.

If this approach is valid, its long-term use should result in increases in both academic achievement (solving of structured problems with correct answers and known methods) and creativity (solving of ill-structured problems with many possible answers and unspecified methods). In the first pilot study of the curriculum model, [Maker et al. \(1996\)](#) selected two classrooms with children from similar ages and ethnic, linguistic and economic backgrounds. One teacher was considered a high implementer of the DISCOVER principles, while the other teacher was considered a middle level implementer. Level of implementation was determined by examining several factors, including number of years in the project, number of hours in staff development, results of teacher belief interviews, and classroom observations. Using the DISCOVER Problem-solving Assessment, the researchers found a significant increase in students' problem-solving abilities in the spatial artistic and math activities in the high implementer's classroom when compared to the scores of students in the middle implementer teacher's classroom. In addition, students' math scores also increased significantly from the pre-assessment to the post-assessment in the high implementer's classroom. The results of this study showed the potential of the DISCOVER Curriculum Model; however, the small sample size and newness of the DISCOVER Assessment limited the generalizability of the results.

Another study, conducted by [Taetle and Maker \(2005\)](#), also demonstrated the effectiveness of the DISCOVER Curriculum Model in enhancing academic success. The study involved 4th grade students from a large, inner city elementary school. Teachers in the study were offered staff development experiences in the use of the DISCOVER Curriculum Model and were then observed throughout the year to determine the level of implementation of the

curriculum for each teacher, similar to the pilot study. The students were tested using standardized State-mandated tests, which included assessments of reading, science, and writing. Significant increases were found in science, writing, and reading scores for students in the high implementers' classrooms but not in the low implementers' classrooms. The results of this study also demonstrated the impact on student academic success in a classroom integrating the principles underlying the DISCOVER Curriculum Model. Analyses of school-wide standardized testing results in the four schools studied showed that in the schools with high percentages of teachers who were high implementers of the model and a principal who agreed with the philosophy of DISCOVER and chose other compatible programs made significant gains in achievement over the three years of the program ([Maker, 2004](#)). The most dramatic gains occurred in the one school that had partnered with the DISCOVER Project in a preschool project prior to the implementation of the K–6 project. In this school, average student achievement increased from approximately the 18th percentile to the 62nd percentile (in reading, math, and language arts).

In a recent study, [Maker et al. \(2006\)](#) found that the level of children's creativity was influenced by teaching methods used consistently by their teachers. In classrooms in which teachers were high or medium level implementers of the DISCOVER curriculum model, students' creativity as measured by the TCT-DP was significantly higher than the creativity of students participating in classrooms of low implementers of the curriculum model the second year of the project. No differences were found the third year of the project, and the reasons for this result are unclear because the mean creativity scores of all students during the third year were lower than the scores for the other two years. Researchers hypothesized that because many students had taken the test three years in a row, the task was no longer novel, and they either remembered their earlier responses or were not motivated to do well.

The current study represents an attempt to sort out the results of the previous study and to examine creativity development rather than the overall levels of creativity of all the children at the same four schools. More specifically, the purpose of this study was to examine the impact of the implementation of the DISCOVER curriculum model on the development of children's creativity. We wanted to know the trends in development of creativity across all teachers and grade levels as well as whether the trends in creativity development were different if students participated in classrooms in which the DISCOVER curriculum model was implemented at a high (consistent) level, at a less consistent level (middle implementer), and those in classrooms of teachers who inconsistently or seldom used these techniques. The teachers who were labeled "low implementers" occasionally used some of these techniques, but consistently used traditional teaching methods such as whole-group instruction, lectures and information-giving, memorization of information, solving of problems with one correct answer, and use of only verbal and mathematical domains during instruction. Because some students remained at the schools for two and three years, but many did not, two sub-samples also were important: those who were at the school for 2 consecutive years

Table 2

The number of students across grade levels, years, and teacher implementation levels ($N=1955$)

Implementation	Year	Grade levels							Total
		K	1st	2nd	3rd	4th	5th	6th	
Low level	1	18	0	7	7	34	58	22	146
	2	34	22	33	26	49	25	0	189
	3	14	33	18	45	78	58	0	246
	Total	66	55	58	78	161	141	22	581
Medium level	1	53	54	54	55	26	46	32	320
	2	19	59	40	37	39	44	0	238
	3	0	63	64	33	71	87	0	318
	Total	72	176	158	125	136	177	32	876
High level	1	41	12	23	8	24	16	14	138
	2	39	19	26	9	41	29	0	163
	3	15	39	34	32	17	22	38	197
	Total	95	70	83	49	82	67	52	498

and those who were at the school all three years of the project. Four research questions guided the study:

1. Does students' creativity as measured by the TCT-DP increase across grade levels, from Kindergarten to grade 6?
2. Is the development of children's creativity different in classrooms of teachers who are high, middle, or low level implementers of the DISCOVER curriculum model?
3. What are the differences in creativity of students who are in classrooms of teachers who are a) high implementers for two years (HH), b) middle implementers for two years (MM), c) low implementers for 2 years (LL), d) at mixed levels of implementation (i.e., those whose levels increased [INC] and those whose levels decreased [DEC])?
4. What are the differences in creativity of students who are a) in classrooms of teachers at high or middle (stable) levels of implementation, or in classrooms in which the level of implementation of the teacher increased across the three years (SI), and b) in classrooms in which the level of teacher implementation was unstable (varied from year to year) and the level of teacher implementation decreased across the three years (UD)?

3. Method

3.1. Participants

3.1.1. Students

The total number of participants in this study included 1986 students from kindergarten through 6th grade from one elementary school in a mid-eastern state and three elementary schools in two southwestern states in the US. Using the TCT-DP for 3 consecutive years, all students in the classes were assessed each year regardless of whether they were new to the school or had been present in previous years of the assessment. The sample was separated to answer the research questions. For questions 1 and 2, data from the first assessment for each child was analyzed (Table 2). The numbers were smaller for question 2, however (1955) because we included 31 children for whom the implementation level of the teacher was unknown. For question

3, scores of only children who were present for two years were analyzed (232), and for question 4, only scores of children who were assessed all three years were analyzed (37). The ethnic background of the participants was different in each school. School A was composed of 50% Caucasian and 50% African American students; school B was 98% Hispanic; school C was mixed, including 52% Hispanic, 38% Caucasian, 5% African American, 2% Yaqui Indian, and 3% Asian and mixed ethnicities; and school D was 99% Navajo Indian students.

3.1.2. Teachers

From the four schools, 108 elementary classroom teachers participated in this study. The ethnicity of teachers was similar to the ethnicity of students in the schools. Table 3 shows the number of teachers across grade levels, years, and implementation levels. Most teachers were in the study for all three years, some for two, and some for only one year.

3.2. Measurement

3.2.1. Test of Creative Thinking–Drawing Production (TCT-DP)

The dependent measure in this study was the Test of Creative Thinking–Drawing Production (TCT-DP) developed by Urban and Jellen (1996). The TCT-DP is a screening instrument used in a group setting to assess creativity, and has been used to identify creative and potentially creative individuals in a variety of cultures.

The TCT-DP includes five figural fragments inside a frame and one figural fragment outside the frame; examinees are instructed to complete the drawing in any way they wish. A student drawing is evaluated according to fourteen criteria, including boundary-breaking, proportion of new elements, completion of the elements on the page, humor, and four forms of unconventionality (originality). The sum of the scores on these criteria provides an estimate of the level of creativity, and the test is available in two forms. Each form is administered in 15 min, and the TCT-DP can be used with any age, starting with preschool children.

Table 3

The number of teachers across grade levels, years, and their implementation levels ($N=108$)

Implementation	Year	Grade levels						
		K	1st	2nd	3rd	4th	5th	6th
Low level	1	2	2	2	0	5	2	0
	2	8	7	10	8	6	3	5
	3	1	4	5	4	3	1	1
	Total	11	13	17	12	14	6	6
Medium level	1	11	12	9	6	3	5	2
	2	3	10	7	4	2	4	2
	3	1	7	10	4	4	7	0
	Total	15	29	26	14	9	16	4
High level	1	4	2	3	3	2	3	1
	2	8	5	4	5	6	1	3
	3	2	4	3	3	3	2	0
	Total	14	11	10	11	11	6	4

3.2.2. Reliability studies

Several researchers investigated the reliability of the TCT-DP in different cultural contexts. Urban and Jellen (1996) reported a high interrater reliability for scoring ($r=.89-.97$). Hurrmann (1987; cited in Urban & Jellen, 1996) also rated the scoring reliability as very high ($r=.92$ and $.91$). Wolanska and Necka (1990; cited in Urban & Jellen, 1996) reported retest reliability after six weeks as a moderate significant correlation ($r=.46$). In a pre-post assessment of creativity training with gifted students, they found that control and experimental groups ($r=0.81$ and $r=.71$ respectively) showed high retest reliability.

3.2.3. Validity studies

The authors of the TCT-DP argued that the validity question was very difficult to answer for the TCT-DP because no comparable instrument exists. They discussed validity based on different sources of information, stating that discriminant validity was important because of the difference between the creativity construct as measured by the TCT-DP and intelligence as measured by IQ tests (Urban & Jellen, 1996). Their studies showed zero correlation between the TCT-DP scores of mathematically talented students and intelligence test scores on the Intelligence Structure Test (IST 70) (Urban & Jellen, 1996). However, Wolanska and Necka (1990; cited in Urban & Jellen, 1996) found significant correlations between the TCT-DP and the Raven Progressive Matrices ($r=.21-.41$) for different age groups. Another source of support for the validity of the TCT-DP cited by the authors was a study in which examinees' teachers were asked to rank their students from high to low on their creative abilities. Eight of fourteen rank correlation coefficients were statistically significant and ranged from .44 to .82. The moderate and high correlations showed partial evidence for the validity of the TCT-DP as a creativity test (cited in: Urban & Jellen, 1996).

Evidence for cross-cultural validity has been found in several studies. One study included 11 countries (Philippines, England, Germany, U.S.A., Nigeria, Republic of China, Zimbabwe, India, South Africa, Indonesia, and Cameroon) with a total sample of 569 children. The mean results of all groups were within the norm of the TCT-DP. The authors concluded that the test was sensitive and fair across cultures (Jellen & Urban, 1989). In a recent study, the TCT-DP was adapted for 1366 kindergarten children in South Korea (Chae, 2003). The author found results comparable to the original results reported by the TCT-DP authors. In a study of university students, Dollinger, Urban, and James (2004) found support for the convergent and discriminant concurrent validity of the TCT-DP in comparisons involving multiple measures of the creativity of college-age students, including storytelling, autobiographical photo-essays, and assessments of personality traits.

In sum, although a few studies of validity have been completed, not enough varied and long-term evidence exists for the validity of the TCT-DP as a measure of creativity in children. According to Nitko (2004), construct validity evidence should be gathered from multiple sources including studies of external structure evidence. Therefore, more studies need to be carried out to provide holistic evidence of the TCT-

DP's validity, especially predictive and concurrent validity evidence (Nitko). Despite the need for further study of the instrument's validity, it was chosen for the current study because of its applicability across diverse cultures (including many English Language Learners and bilingual students), its integrative nature, and its ease of administration.

3.3. Teacher implementation levels

The four schools included in this study, all in impoverished areas, participated in the DISCOVER V Project. The purpose of this project was to assist teachers in a) identifying gifted students needing special services or special provisions, b) identifying the strengths of all children, and c) implementing the DISCOVER curriculum/teaching model in their classrooms to meet the needs of all children. Some schools had special programs for gifted students, while in others, all instruction was provided within the general classroom. All teachers were given equal opportunities to participate in a variety of staff development opportunities: (a) workshops of varying length presented at the school (sometimes at the request of teachers, sometimes based on observations of site coordinators, sometimes at the request of administrators), (b) a summer institute on the university campus, (c) expert assistance within the classroom, (d) demonstration teaching and cooperative teaching with an expert teacher, and (e) general support when requested. Because all schools were in impoverished areas and all administrators wished to improve instruction for students with talents and gifts, all teachers were encouraged to implement the DISCOVER model. However, clearly some were able to do so at a high level and others at a much lower level. To distinguish these differences, two methods were employed to determine levels of implementation of the model.

3.3.1. Classroom observation

Teachers were observed in their classrooms by multiple observers on several occasions. Observations took place at least once a year by the DISCOVER personnel and each observation lasted for at least one h. A standard form completed by observers included specific information about instructional activities, multiple intelligences, use of the DISCOVER model, and a blank space to report a detailed description of the learning activities. Observers were encouraged to collect artifacts and required to take photographs of classroom environments to supplement their written observations (Maker et al., 1996). At the end of each observation observers interviewed the teacher to gather information about the intended purpose of each activity.

3.4. Teacher interviews

Teachers were interviewed each year about their beliefs about teaching, giftedness, and how teaching methods related to the development of student strengths, especially those the teacher believed were gifted. Information from these interviews was combined with data from teacher observations to provide an overall picture of the teacher's level of implementation of the DISCOVER model.

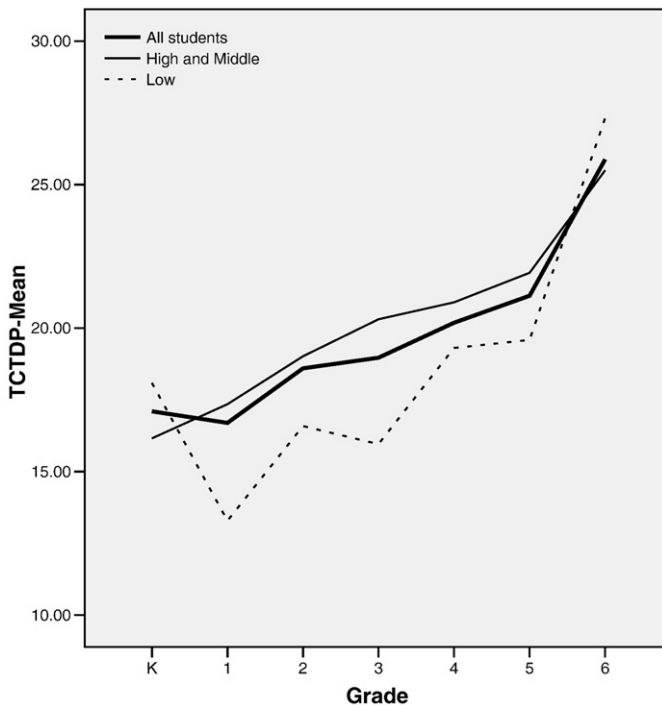


Fig. 1. Patterns of creativity development across all students, students in classrooms of high/middle implementers, and in classrooms of low implementers.

3.5. Teacher ratings

Based on the information from observations, teacher interviews, level of participation in staff development and length of participation in the project, two raters familiar with each teacher, and who had observed in most classrooms in the school, independently rated each teacher on a 5-point scale of the degree to which he/she implemented each of the six DISCOVER curriculum implementation principles presented in the section in which DISCOVER is described (Section 2.2, line 473–486). The same standard was applied across all schools.

In general, high implementers (levels 4 and 5) and medium implementers (level 3) in varying ways included multiple intelligences in their teaching strategies, and encouraged students to engage actively in problem-solving either individually or in small groups. Low implementers (levels 1 and 2) usually provided direct instruction instead of active, engaged learning experiences; and students, often working individually at desks, were not given many opportunities to pursue the solution of open-ended problems through multiple intelligences and self-selected products (Maker et al., 1996). The scores for the two raters were combined across all six criteria, and then inter-rater reliability was calculated. A third rater was asked to provide a rating if the two raters did not reach 85% agreement.

3.6. Data collection and scoring

The TCT-DP was administered at the end of the spring semester of each of the three years of the project using standardized procedures described in the manual (Urban and Jellen, 1996). Although the authors of the test recommend

administration of both forms, because of the numbers of children being assessed and staff time available for scoring, only Form A was administered in three of the schools and both forms were administered in School C. Therefore, only the results for Form A were used in this analysis. DISCOVER Project team members who had received training from Klaus Urban administered and scored the TCT-DP the first and second years of the study. Random samples of scored tests were sent to Urban for reliability checks, and when scorers had questions about scoring, they sent these questionable booklets to the author as well. Team members who were considered experts provided training for others who administered and scored the test the third year. In all cases, training for each scorer continued until he or she had reached an agreement level of .90 or above when the scoring of a new individual was compared to the independent scoring of the team member who trained with Klaus Urban.

3.7. Data analysis procedures

Analysis of variance (ANOVA) was used to determine the mean differences between different grade levels and teacher levels of implementation on the TCT-DP for three years. The ANOVA, with an alpha level set at .05 and followed by a Post-hoc Holmes–Bonferroni procedure, was employed to determine which means differed from each other (Kirk, 1995). Effect sizes were computed to determine the extent of the differences.

4. Results

4.1. Does students' creativity as measured by the TCT-DP increase across grade levels, from Kindergarten to grade 6?

To answer this question, an omnibus *F* test was performed on the grade levels to determine whether a real difference existed between any two grade levels (Kirk, 1995). Only one score was included for each child, the score for the first time the child took the test.

The ANOVA revealed significant differences between different grade levels, $F(6, 1979) = 19.46, p = .000$. The proportion of variance accounted for by the grade levels was at approximately the medium level as indicated by Cohen's (1988) guideline ($\eta^2 = .056$). A post hoc analysis was performed to test the differences between means of different grade levels. The Holmes–Bonferroni procedure showed significant differences between means of students' creativity scores at various grade levels. Notably, in general, no significant differences were found between students' creativity scores between two consecutive grade levels with the exception of the difference between grades five and six. Students' scores increased across the grade levels, and no significant peaks or slumps were evident (See Fig. 1).

4.2. Is the development of children's creativity different in classrooms of teachers who are high, middle, or low level implementers of the DISCOVER curriculum model?

To answer this question, a univariate analysis was performed to determine if a real difference existed between different

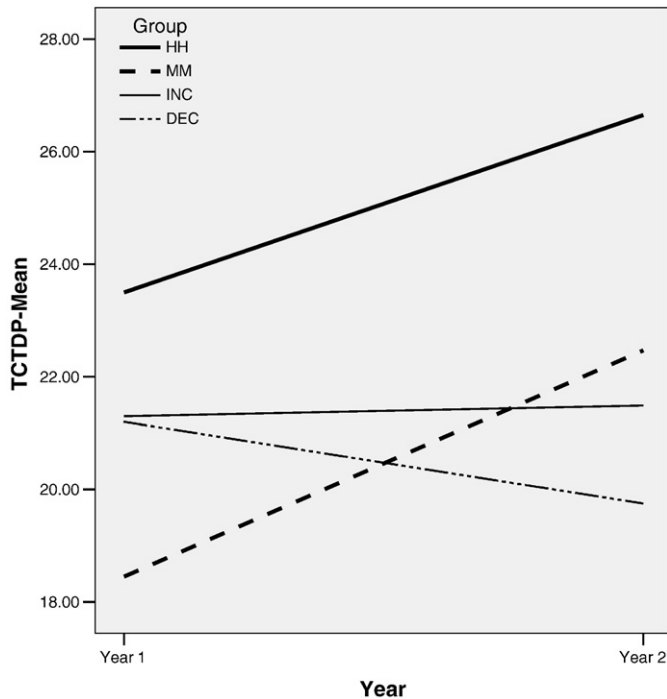


Fig. 2. Influence of levels of implementation of the DISCOVER curriculum on creativity development from year 1 to year 2.

implementation levels of the DISCOVER curriculum across grade levels (Kirk, 1995). Only one score for each child was included for this analysis, the score earned the first time the child was assessed.

An ANOVA performed across groups showed significant differences between scores of students in classrooms of teachers at different levels of implementation $F(2, 1970) = 6.206$, $p = .002$. The Holmes–Bonferroni procedure showed that the differences between high and low ($p = .004$) and between middle and low implementers ($p = .012$) were statistically significant. However, no significant difference was found between middle and high implementers.

Because no significant difference was found between high and middle implementers, we collapsed the data for high and middle implementers into one group. Consequently, the same analysis was performed on two implementation levels: high and low implementers of DISCOVER. The two way factorial analysis revealed significant differences between: (a) different implementation levels, $F(1, 1941) = 9.335$, $p = .002$, (b) different grade levels $F(6, 1941) = 18.54$, $p = .000$, and (c) implementation by grade levels, $F(6, 1941) = 3.14$, $p = .005$. The proportion of variance accounted for by the implementation level, grade level, and the interaction between them was at low to medium levels as indicated by Cohen's guideline, $\eta^2 = .005, .054, .010$, respectively. Essentially, grade level explains a higher percentage of the variance than teacher level or the interaction between teacher level of implementation and grade level (see Fig. 1).

Students in the classrooms of high and middle implementer teachers performed better than those in classes of teachers who were low implementers of the DISCOVER curriculum principles. This result was consistent across all grade levels.

As depicted in Fig. 1, scores increased or remained stable in the classrooms of middle and high implementers, but showed a decrease from kindergarten to grade one and a slight decrease from grade 2 to grade 3 in the classrooms of low implementers.

4.3. What are the differences in creativity of students who are in classrooms of teachers who are a) high implementers for 2 years, b) middle implementers for 2 years, c) low implementers for 2 years, d) at mixed levels of implementation?

For this analysis, the scores for only the students who were assessed for two consecutive years were included; scores for students who were assessed for three consecutive years were excluded from this analysis. Students were separated into five groups: a) those who were in the classroom of a high implementer both years (HH, $n = 20$ for years 1 and 2, $n = 59$ for years 2 and 3), b) those who were in a classroom of a middle level implementer both years (MM, $n = 47$ for years 1 and 2, $n = 66$ for years 2 and 3), c) those who were in a classroom of a low implementer both years (LL, $n = 0$ for years 1 and 2, $n = 51$ for years 2 and 3), d) those who were in a classroom of a lower implementer the first year and a higher implementer the second year (i. e., the implementation level increased the second year) (INC, $n = 37$ for years 1 and 2, $n = 51$ for years 2 and 3), e) those who were in a classroom of a higher implementer the first year and a lower implementer the second year (i. e., the implementation level decreased the second year) (DEC, $n = 53$ for years 1 and 2, $n = 53$ for years 2 and 3).

The ANCOVA with year 1 scores as a covariable showed that the differences between groups the second year were marginally significant, $F(3, 152) = 2.63$, $p = .053$ (Fig. 2). The post-hoc

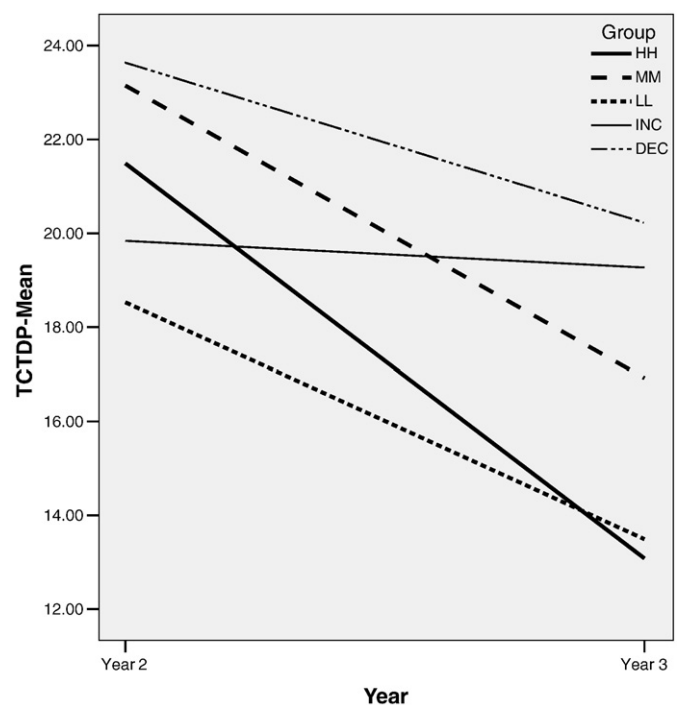


Fig. 3. Influence of level of implementation of the DISCOVER curriculum on creativity development from year 2 to year 3.

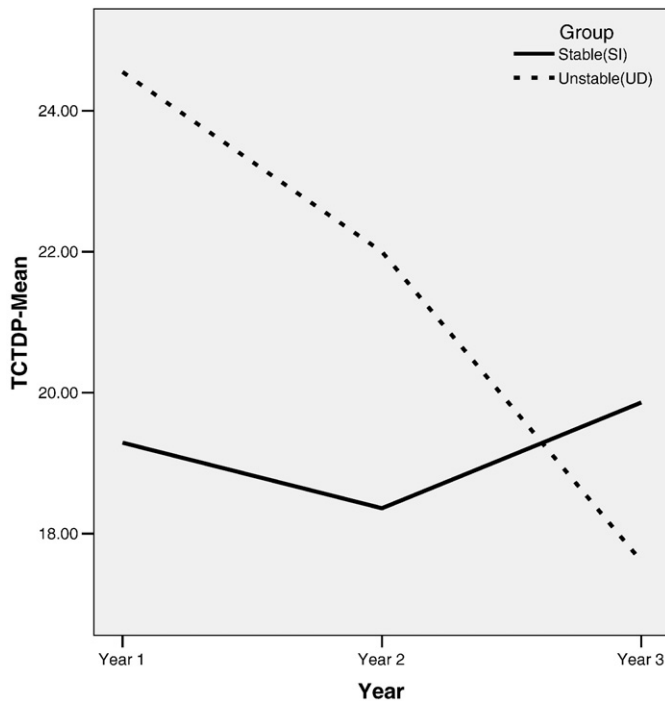


Fig. 4. Influence of stable/increased (SI) or unstable/decreased (UD) levels of implementation on creativity development across 3 years.

Holmes–Bonferroni procedure showed that the significant differences were between group HH and group DEC ($p=.035$). The proportion of variance accounted for by the pattern of implementation level for year 2 was at a medium level as indicated by Cohen’s guideline ($\eta^2=.049$).

In the analysis of scores of students assessed in years 2 and 3 (Fig. 3), the ANCOVA with year 2 scores as a covariable showed that the differences were significant $F(4,274)=11.19$, $p=.000$. The post-hoc Holmes–Bonferroni procedure showed significant differences between groups LL and DEC ($p=.000$), groups LL and INC ($p=.000$), groups HH and MM ($p=.024$), groups HH and INC ($p=.000$), and groups HH and DEC ($p=.000$). The proportion of variance accounted for by the pattern of implementation level was at a medium level as indicated by Cohen’s guideline ($\eta^2=.140$).

In summary (See Figs. 2 and 3), students’ creativity increased when they were in classrooms of teachers at high (HH) or middle levels (MM) during years 1 and 2 and was stable when the implementation level of their teacher increased from year 1 to year 2 (INC). In addition, during years 1 and 2, when the implementation level of their teacher decreased from year 1 to year 2 (DEC), their scores decreased. In years 2 and 3, the pattern was different. The scores of students in all groups (HH, MM, LL, DEC) except INC decreased. Scores of students who experienced increasing levels of implementation had stable scores even though the mean score of all students in the sample decreased during year 3 to a level below the mean for years 1 and 2 (year 1, $M=20.29$, year 2, $M=20.58$, year 3, $M=17.80$).

4.4. What are the differences in creativity of students who are in stable levels of implementation or increased levels and those in classrooms in which the levels are unstable and also decrease?

For this analysis, we selected only those students who were assessed all 3 years of the project ($n=37$). We separated them into two groups: a) those who were in classrooms of teachers at high or middle (stable) levels of implementation, or in classrooms in which the level of implementation of the teacher increased across the 3 years ($n=14$), and b) in classrooms in which the level of teacher implementation was unstable (varied from year to year) and the level of teacher implementation decreased across the 3 years ($n=23$). The ANOVA with repeated measures showed no significant differences between the two groups, $F(1,35)=1.55$, $p=.221$. However, the pattern of scores is interesting (Fig. 4). Scores of students in stable or increasing levels increased while the scores of students in unstable or decreasing levels decreased.

5. Discussion

5.1. Limitations

Some important aspects of the study can limit its generalizability and usefulness, and should be acknowledged prior to discussing the results and how they may be used. First, and perhaps most obvious is the fact that only one outcome measure was analyzed in this study. Although the TCT-DP has been used extensively with a variety of cultural groups, it has been studied more extensively in European and Asian countries than in the US. Another concern related to its use in this study is that it is considered a domain-general measure of creativity—with the assumption that the most important aspects of creativity can be assessed through a particular type of task. The view of creativity promoted in the DISCOVER Project is one in which domain-relevant (Amabile, 1983, 1996; Lubart, 1994, 1999) skills are considered to be equal in importance to creativity-relevant skills. Students, especially those in high and middle implementers’ classrooms, were encouraged to engage with the “tools” or materials of varied domains, and to produce drawings, stories, poetry, 3-dimensional models, plays, and combinations of these products to demonstrate their ideas and knowledge related to academic content. Although the use of only one outcome measure is a definite limitation, the TCT-DP was a more appropriate measure of creativity in this population than a divergent thinking test. The emphasis on creating a drawing, along with scoring procedures that result in higher scores for those who produce an integrated picture with a recognizable theme may tap the creative strengths of children with more holistic thinking styles, as often found in Hispanic and Navajo children (c. f. Maker, 1993; Tharpe, 1989).

Another important limitation of the study is that it includes mostly students from low-income groups and students from culturally-diverse groups. Thus, caution must be exercised in generalizing these results to high-income groups and those of

predominantly Caucasian heritage. A related problem is the mobility of the population. Out of the 1986 children participating in the project, only 332 were present for the assessment 2 years in a row, and only 37 children were present for all three assessments. Although some of the children may have been absent when the assessment was administered, and some had moved to middle school, many of the children simply changed schools within the school districts or within the local area, and were no longer enrolled in the school.

Unfortunately, because of school policies, we were unable to place students in particular classrooms so the effect of particular patterns of implementation could not be studied in a systematic way. Separation of the groups during the analysis was the only way to study these patterns. An additional limitation is that only two schools included grade 6, which could have influenced the results showing a significant increase in scores at this grade level.

Finally, a factor that may have affected the results was that in the final year of the project, due to staff limitations, administration of the TCT-DP was done by the classroom teachers in some schools and by a graduate assistant in another school; and scoring was completed by two new assistants. Although training was provided in all cases, the impact of newly-trained individuals or teachers administering the assessments is unknown.

5.2. Conclusions and implications

In these four schools, we found that the creativity of students increased from year to year with no significant peaks or slumps. This result is similar to Urban's (1991) norming of the TCT-DP, except that he found a significant slump at entry to formal schooling. An important factor to consider is that all teachers, regardless of their level of implementation, had been exposed to the principles of the DISCOVER curriculum, and the climate of the school was one in which this kind of teaching was accepted and valued, which would contribute to a steady development of children's abilities. In addition, the impact of culture and language cannot be ignored, as these schools consisted mainly of children from Hispanic and American Indian heritage (Navajo and Yaqui), and many of them were either bilingual or English Language Learners. Although the population was different from that of Lopez et al. (1993), in that the students had not been specially selected, the school climate we were cultivating in the DISCOVER Project was similar to that of the Lopez et al. site. Interestingly, our results were similar—we found increases at all grade levels. Culture and language were not included as factors in this study, but should be examined in future analyses.

In addition to the fact that no significant "slumps" were found in children's development, a significant increase was identified at grade 6. This finding is consistent with the results of many other studies, although the difference is that in the majority of studies in which decreases were found at grade 6, the domain of study was figural. In this case, however, because many children were bilingual, and many American Indian children demonstrate strengths in the spatial (figural) domain

(Begay & Maker, 2006; McCarty, Wallace, Lynch, & Benally, 1991; Yamauchi & Tharpe, 1995), they would be expected to perform better on non-verbal assessments than verbal assessments of all abilities, including creativity. Hispanic children also are considered to be holistic thinkers (Tharpe, 1989), so their performance on a test such as the TCT-DP might be superior to children from other cultures. Only two schools in the study (B and D) included grade 6; one was 98% Hispanic and the other was 99% Navajo; and both included high numbers of bilingual children. Perhaps the influence of culture and bilingualism on the results was greater at this level because our sixth grade sample included only those populations.

Another factor to consider, however, is that the influence of school climate, regardless of whether it is supportive or not, may not be as strong as it is at lower grade levels. Comparisons of numbers of low, medium, and high implementer teachers show that the average ratio of high or medium to low implementers at grades 1 to 5 was 26 to 12, while at grade 6, the ratio was 8 to 6. Thus, the significant increases in creativity occurred at grade 6 even though a much higher percentage of teachers were low implementers. This explanation is further supported by the results of our analysis to answer the second research question (Fig. 1).

Examination of Fig. 1 shows different patterns of development for students in the classrooms of high and middle implementers' classrooms and those in classrooms of low implementers. Differences between high and middle implementers were not significant. Interestingly, however, the significant increase in creativity from grade 5 to grade 6 was evident in the low implementers' classrooms, and in fact, their scores were somewhat higher than the scores of the sixth grade children in the middle and high implementers' classrooms. Developmentally, students may be more inclined to think in original and novel ways at ages 12 and 13. Perhaps Rosenblatt and Winner's (1988) work may provide the best way to integrate cultural, developmental, and environmental explanations for the observed increase in creativity as measured by the TCT-DP. Rosenblatt and Winner, who studied artistic creativity, described the early years as pre-conventional, the middle years as conventional, and the later years as post-conventional. At the post-conventional phase (beginning at around 12 years) children with a special interest and skill in visual art learn to violate the rules they worked hard to master during the conventional stage. Drawing is the medium for the TCT-DP, and the scoring procedures include an emphasis on unconventionality (four different scores for unconventionality and two for boundary-breaking). Therefore, students at this stage may perform very well because of their propensity and desire to break the boundaries of convention. A related factor is that artistic abilities are highly valued in the Navajo culture, and that many students demonstrate high potential in this area (Begay & Maker, 2006; Maker, 2004).

The overall finding of a difference in development of creativity in classrooms of students in high or middle implementers' classrooms and students in the classrooms of low implementers provides further evidence to support the use of the DISCOVER curriculum as a way to nurture children's

creative development. An overall approach in which the following strategies are used may be an important way to approach the teaching of academic content: (a) students are given choices, (b) students are provided with opportunities to set goals and design ways to meet these goals, (c) students are given opportunities to represent their knowledge through many and varied symbol systems and media, and (d) students are given many opportunities to experience the complexities inherent in identifying important problems to solve. In other words, teachers are not sacrificing the development of knowledge and academic skills by teaching creativity-relevant skills. They are adding depth and richness to the teaching of this academic knowledge by giving students opportunities to apply their knowledge in the development of unique products that are shared with other students and with supportive adults.

The fact that no significant differences were found in the development of creativity in classrooms of high and middle implementers in many ways can be encouraging to teachers. To support children's creativity development, they are not required to make radical changes in their teaching, nor must they give students total freedom to choose their projects and products. Teachers can provide a balance of teacher-directed and student-directed learning as children grow in their understanding of academic content, acquire domain-relevant skills, and learn to express themselves in unique and different ways. Essentially, the question is not whether to choose academics or creativity, but how to integrate them.

Further support for the value of a teaching approach such as DISCOVER comes from the answer to the third research question. Because students were not purposely placed in the classrooms of teachers at particular levels of implementation, varying patterns were observed. In this analysis, we found that the scores of the children were not significantly different the first year, which was expected because the teachers were beginning their practice of the new teaching methods. However, in year 2, we found significant differences between scores of students in classrooms of a high implementer for both years and those who experienced mixed levels of implementation, with the lower level of implementation in the second year. Although other differences were not significant, the patterns are interesting. In Fig. 2, one can see that the scores of children in high and middle implementers' classrooms increased from year 1 to year 2 while scores decreased for those whose teacher's level of implementation decreased. Children in classrooms in which the level of implementation increased had relatively stable scores from year 1 to year 2. The results for students who were present at the schools for years 2 and 3 are different, however. The only scores that did not decrease in year 3 were those of students whose teacher's level of implementation *increased* over the 3-year period. One of the most perplexing findings in the study is that the overall scores of students were lower in year 3 than in years 1 and 2. Perhaps the fact that some teachers and graduate assistants administered the assessment the third year, and some of the scorers were new, influenced the results. However, an alternative explanation comes from observation of children taking the test. Children, who were accustomed to having a variety of art supplies,

including many bright colored pens and markers, were disappointed when told they could use only a black pen to make their drawings. After participating in high and middle implementers' classrooms for more than a year, and having these exciting materials, children did not find the task interesting or exciting. Other task constraints that could have limited the motivation of students who had participated in many open-ended, domain-relevant problem solving experiences could be factors such as using only the fragments on the page, having only 15 min to complete the drawing, and being told they could not erase any lines. Many students from similar groups approached the senior author during the administration and pleaded for more time to complete the drawing they visualized in their minds.

Finally, although the scores of children in the two comparison groups who participated in the assessment all three years were not significantly different, the direction of the differences is important to note. Scores of children who were in classrooms of high or middle implementers or increasing levels of implementation increased while scores of children in low, unstable, or decreasing levels decreased (Fig. 4). This result is perhaps more striking in light of the fact that scores across schools and classrooms decreased in the third year of the project.

Perhaps the most important value of a teaching approach is consistency over several years, with support provided for children as they develop. If children experience an environment in which their unique ways of thinking are valued, and then encounter a teacher who does not provide this kind of support, they may become wary of expressing themselves. They may learn to attend more to the standards emphasized in the social atmosphere of the classroom than to their own internal standards for ideas and products, thus, they develop more conventional ways of responding.

Although more research is needed, results of this and other studies of the DISCOVER curriculum model suggest that administrators searching for an evidence-based curriculum model for enhancing both academic achievement and creative problem solving could consider DISCOVER. This and other studies (Maker, 2004; Maker et al., 2006; Maker et al., 1996; Taetle & Maker, 2005) have shown that it can be implemented school-wide, and that it can benefit many children who are considered "at-risk" with its emphasis on development of strengths in multiple domains. Staff development programs including a variety of models can be offered to assist teachers in acquiring the skills needed to change instructional patterns: workshops on the school campus, peer-to-peer teaching, demonstrations by teaching artists and master teachers from other schools, special institutes with emphasis on modeling the strategies teachers are learning, and financial support for grade-level groups of teachers wishing to design curricula or re-design their classrooms. Perhaps most importantly, administrators can foster a school climate in which openness to new ideas, acceptance of diversity, encouragement of independence in thinking and self-expression, and opportunities for creative problem solving are valued for both teachers and children.

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