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MATHEMATICS IN MOTION:

A HANDBOOK OF KINESTHETIC TEACHING STRATEGIES

by

Janie Brown Salazar

A Research Project Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Education

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ABSTRACT

Howard Gardner first proposed his theory of Multiple Intelligences and the bodily-kinesthetic intelligence in 1983. Unfortunately, almost three decades later, teacher programs still do not train teachers about Bodily-Kinesthetic intelligence in depth; nor do they train teachers how to integrate Bodily-Kinesthetic intelligence into daily learning procedures and classroom environment. Schools focus very little on other factors that contribute to how successful a person might be in life, throughout life. Incorporating bodily-kinesthetic strategies in teaching can positively influence children's learning experience. The following research project investigates the research on the bodily-kinesthetic intelligence, bodily-kinesthetic teaching strategies, teaching strategies linked to student achievement, and mathematics textbooks. Lastly, the project culminates with a resource handbook that helps educators use the bodily-kinesthetic intelligence to improve classroom learning.

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Chapter 1

INTRODUCTION

Gardner's (2004) theory of Multiple Intelligences (MI) is widely accepted as a sound theory, yet the use of explicit traditional teaching strategies, such as a lecture, still seem to dominate how middle school mathematics teachers teach. The main idea of Gardner's theory is that individuals learn using a number of the intelligences but, primarily, tend to use one or two of them, and if teachers taught in a variety of ways, using all MI teaching strategies, students could learn more.

Statement of the Problem

Students' low mathematics scores nationwide are a concern for educators, as teachers are held accountable to increase student test scores. Members of the National Council of Teachers of Mathematics (NCTM, 2000), the largest mathematics education organization in the world, established standards to explicitly identify what mathematics content should be taught; however, the teaching methods and how to teach is left up to each teacher. A large percentage of what teachers do is guided by the textbook which was chosen for their school. Since textbooks are the primary guide for teachers and a first resource for students, it is important to understand what kinds of strategies are written in textbooks. Teachers need to acknowledge and address how each student learns. This can be done with the use of Gardner's (2004) MI to guide instruction. Use of the best

teaching strategies and methods can lead to improved student learning and higher test scores.

Purpose of the Project

The purpose of this project was to develop a resource handbook of under-utilized, yet effective teaching strategies that can be integrated with any mathematics textbook and with any lesson. This researcher examined five mathematics textbooks for MI (Gardner, 2004) teaching strategies in order to determine which ones are used the least. The use of MI teaching strategies can help targeted students' learning and can also help teachers make lessons more exciting and engaging for all students. To show how a teacher can practically use this handbook, a presentation of a mathematics lesson was presented with the use of traditional, direct teaching methods. The same lesson was shown again applying MI strategies from the handbook.

Chapter Summary

It is this researcher's position that every mathematics teacher must implement teaching strategies that are effective for each student. Chapter 2, Review of Literature, begins with a brief history of the teaching of mathematics over the last 200 years. In addition, this researcher presents research about: (a) textbooks in general, (b) five popular mathematics curricula used in Colorado, (c) MI, (d) Bodily-Kinesthetic teaching strategies, (e) differentiation, (f) best practices in teaching, and (g) the current methods that teachers use in middle school classrooms.

Chapter 2

REVIEW OF LITERATURE

The purpose of this project was to develop a handbook for mathematics teachers to use as a tool to incorporate the least used Multiple Intelligences (MI; Gardner, 2004), including musical and kinesthetic strategies into lessons. The major topics in the review include research on: (a) textbooks in general, (b) mathematics textbooks from five mathematics curricula used in Colorado, (c) MI and which teaching methods are linked with student achievement, (d) Bodily-Kinesthetic teaching strategies in detail, (e) differentiation, (f) best teaching practices, and (g) the methods teachers use in middle school classrooms today.

Brief History of Mathematics Teaching

Politics, research, and theories of child development in the 19th and 20th Centuries greatly influenced how mathematics is taught today (Gardner, 1993; Slavin, 2008). Changes based upon perceived needs were made in mathematics curricula which influenced what teachers did in their classrooms (Herrera & Owens, 2001).

Education was informal in the 1700s; teachers were considered Qualified if they could read, write, and stay out of trouble (National Education Association, n.d.). By the 1800s, people began to organize schooling more formally, and organizations were established in order to identify best teaching practices and to improve teachers‘ working conditions. In 1857, there were educational associations in 15 states when the National

Education Association (NEA) was founded. This was the first national, non-governmental, education committee formed by teachers to improve working conditions for all teachers in the United States. In 1920, the National Council of Teachers of Mathematics (NCTM; n.d.) was founded to be a public voice for mathematics education, and it has been a major influence in the development of mathematics curricula through their journals in which the most recent educational research findings are published.

As a reaction to the Soviets' launch of Sputnik in 1957, a new mathematics curriculum was written (Herrera & Owens, 2001). Sputnik resulted in the perception that the U.S. was behind in technology and that teachers did not teach the best way, which lead the U.S. to increase funding for education. The mathematics in the 1960s was known as the *new math* movement; however, it was popularly remembered as a pedagogical failure. The 1970s was termed, the *back to basics* era, and the new mathematics curriculum was abandoned.

Math wars is the term used to describe the debate between traditional and reform mathematics, the philosophies, and curricular teaching methods (Viadero, 2009). Traditional teaching methods, such as rote memorization, the study of algorithms, teacher lecture, and an authoritative learning atmosphere, characterized the teaching in the 1800s. In the 1900s, reform methods became popular which emphasized reasoning and the ability to communicate this understanding; in addition, cooperative learning groups (i.e., introduced by John Dewey in 1916), and student investigations were used. The debate about the math wars is not a new one. In 1938, people had conflicting views in regard to the U.S. education system: traditionalists clashed with the progressives who were similar

to current reformers (Stuckart & Glanz, 2007), and progressives favored methods that allowed for the free flow of ideas.

With the introduction of the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), the reform teaching methods began to replace the traditional teaching methods in textbooks. From 1989-1991, the National Science Foundation (NSF; as cited in Senk & Thompson, 2003) funded over 12 projects to develop new mathematics curricula in accord with the NCTM publication. In 2000, members of the NCTM wrote the Principles and Standards for School Mathematics (PSSM) in which standards for each grade were detailed. Hoff (1999) described a group called Mathematically Correct, which was formed in 1995, and it is a group of parents who are opposed to the NCTM reform changes.

The debate continues today in regard to traditional vs. reform teaching methods. Yet, some researchers (Byers, 2007; Hiebert & Grouws, 2007; National Mathematics Advisory Panel [NMAP], 2008; Wu, 1999) maintained that this may be a false dichotomy. Byers quoted one university mathematics professor, who said in regard to the nature of mathematics, "Many great mathematical ideas involve paradoxes. Zero, or the nothing that is, is a classic example. . . . Mathematics integrates the strictest logic criteria with the deepest creativity" (p. 3). In traditional teaching methods, there is a tendency to overlook the creativity building part of mathematics. Byers explained that teachers tend to focus on the logical or algorithmic dimension of mathematics because it is difficult for them to address the ambiguity that is the foundation of creative thinking. In 2008, staff of the NMAP, a government committee formed in 2006, published Foundations for

Success: The Final Report of the NMAP, and they stated that "research does not support the understanding that instruction should be entirely 'student-centered' or entirely 'teacher-directed,' but that best practices implies both" (p. 11). In spite of the math wars, Sood and Jitendra (2007) reported that 80% of textbooks used in schools today are still of the traditional type.

According to Slavin (1991), definitions of intelligence have driven people to make changes in teaching methods. It was not until the beginning of the 20th Century that Piaget's (1991, as cited in Slavin) theory of cognitive development replaced a continuous theory of development with the understanding that children go through a series of stages of development. Educators were influenced by Piaget's ideas of child development. Educators understood that children were capable of learning different things at different stages and taught accordingly. Also, in the early 20th Century, the intelligent quotient (IQ) test was introduced by Alfred Binet (as cited in Slavin, 1991) and used to identify children who had special needs beyond the regular classroom. These IQ tests were used to make placement decisions about students.

In 1983, Gardner introduced his theory of MI. Gardner expanded the general concept of intelligence which measures only two intelligences, linguistic and mathematical, to include five more intelligences. With this new view of intelligence, Gardner implied a need for a new kind of schooling, which he termed, *individual-centered* education. The belief, that IQ is an adequate measure of intelligence, aligns with the *uniform view* of schooling. Gardner explained that, in the uniform school, the staff have incorporated: (a) a core curriculum, (b) a set of facts that every student is

required to learn, (c) few electives, and (d) paper-pencil assessments. However, in 1984, as Gardner (1993) explained, Key School in Indianapolis was created to be a school where: (a) the educators honored all of the MI, (b) equal time was given to all subjects, (c) students were exposed to activities that nurtured each of the intelligences, and (d) each child was encouraged to develop in his or her area of strength.

Defining Intelligence: What Are Gardner's Multiple Intelligences?

Gardner (2004) lists seven intelligences in his MI theory. They are: (a) linguistic, (b) musical, (c) logical-mathematical, (d) spatial, (e) bodily-kinesthetic, (f) intrapersonal, and (g) interpersonal. Gardner makes clear that the seven intelligences are not the same as learning styles. The term, intelligence, could be replaced with the terms, ability or talent, but he equates these seven abilities with the same importance that is generally given to the linguistic and logic abilities as assessed by the IQ test, which is used to assess intelligence. Gardner gave intelligence a new definition, "The ability to solve problems, or to create products that are valued within one or more cultural settings" (p. xxiv). Gardner explained that all seven abilities are equally important factors of intelligence. Most people use a combination of the intelligences, and anyone can develop different intelligences at any time in many ways because this idea of intelligence is a process of the mind, not an ultimate measure. Gardner explained:

> I do not believe that it is possible to assess intelligences in pure form, and the kinds of assessment I favor are entirely different from those associated with IQ testing. . . Far from believing that intelligences are set in stone, I believe that they are subject to being considerably modified by changes in available resources. (p. xxxvi)

In general, the idea of MI theory is that all humans posses a set of intelligences, yet no two people possess exactly the same profile of intelligences because of genetic and experiential reasons that result in strengths and weakness in each intelligence. For an explanation of the seven MI, see Appendix A, Table 1.

In order for a talent or ability to be called an intelligence, Gardner (1983, as cited in Armstrong, 2000) defined certain criteria that had to be met first. There are eight factors included in that criteria.

1. Potential isolation by brain damage.
2. The existence of savants, prodigies, and other exceptional individuals.
3. A distinctive developmental history and a definable set of expert "end-state" performances.
4. An evolutionary history and evolutionary plausibility..
5. Support from psychometric findings [such as other assessment tests].
6. Support from experimental psychological tasks [that show the intelligence at work in isolation from other intelligences].
7. An identifiable core operation or set of operations [that drive activities specific to the intelligence].
8. Susceptibility to encoding in a symbol system. (pp. 3, 7, & 8)

Gardner's theory of MI immediately challenged how people thought about IQ, that is, as the only way to define and measure a person's intelligence.

Textbooks: The Primary Guide

According to Raman (1998, as cited in Nathan, Long, & Alibali, 2002), the content of mathematics textbooks strongly influences the way mathematics is taught and learned. Similarly, Porter (1989, as cited in Witzel & Riccomini, 2007), reported that teachers use their textbooks as a guide for about 75% of their decisions in regard to: (a) instructional objectives and procedures, (b) content, and (c) classroom activities. In his review of literature, Johnsen (1993, as cited in Nathan et al.) reported that both novice

and expert teachers follow the textbook to write lesson plans. Also, for students in the upper grades, textbooks are vital because they replace teacher instruction as the primary source of information (Garner, 1992).

Mathematics Textbooks: Limited Research

In their review of research, the staff of the NMAP (2008) reported that research on effective mathematics textbooks is limited. They explained that "More research is needed that identifies effective instructional practices, materials and principles of instructional design, and mechanisms of learning" (p. xxvi). Also, Adams and Lowery (2007) observed that, ultimately, doing mathematics leads students to reading mathematics, yet Hall (2005) observed that few studies have been designed to increase students' comprehension in mathematics.

The limited research, which does exist, appears to be conflicting. According to Slavin (2008), who is an educational psychologist and currently Director of the Center for Research and Reform in Education at Johns Hopkins University in Baltimore:

> Throughout the history of education, the adoption of instructional programs and practices has been driven more by ideology, faddism, politics, and marketing than by evidence. For example, educators choose textbooks, computer software, and professional development programs with little regard for the extent of their research support. (p. 5)

Mathematics Textbooks: The Possible Problem

In 2005, only 2% of U.S. twelfth grade students attained advanced levels of mathematics achievement as reported by the staff of the National Assessment of Educational Progress (NAEP) in The Nation's Report Card (Witzel & Riccomini, 2007). Some researchers (Colorado Council of Teachers of Mathematics [CCTM], 2009; Sood &

Jitendra, 2007; Witzel & Riccomini) maintain that there are plausible reasons for low student scores in mathematics, such as poor curricular design and poorly designed instructional materials. Furthermore, Garner (1992) explained that many textbooks are hard to understand.

If there was an excellent mathematics textbook, would it be evident to researchers? There is no consensus about what constitues a good mathematics textbook. For example, according to Hoff (1999), the NSF funded mathematics curriculum, Connected Mathematics, was reviewed by the members of two mathematics organizations, the American Association for the Advancement of Science (AAAS) and Mathematically Correct. The staff of the AAAS rated this curriculum as excellent, yet the members of Mathematically Correct called the book "impossible to recommend" (p. 3). Viadero (2009) quoted the President of the NCTM, Kepneo, and stated, "We are not going to find a unique curriculum that all teachers can use with the same degree of effectiveness" (p. 3).

Furthermore, although it seems clear that textbooks are a notable resource for teachers and students, this researcher must acknowledge that, not only is the effect of textbooks on student achievement hard to prove (Reys, Reys, Lapan, Holliday, & Wasman, 2003), but other factors such as teacher effectiveness may have a greater impact on student achievement than curriculum (NMAP, 2008; Reys & Alajmi, 2006; Reys et al.; Sood & Jitendra, 2007). Wong and Wong (2009) wrote, "Research consistently shows that of all the factors schools can control, the effective teacher has the greatest impact on student achievement. Decade after decade of educational innovations and fads have not

increased student achievement" (p. 11). According to the members of the NMAP, "unfortunately, little is known from existing high quality research about what effective teachers do to generate greater gains in student learning" (p. xxi). Additionally, according to the staff of the NMAP,

> The delivery system in mathematics education. . . is broken and must be fixed. This is not a conclusion about any single element of the system. It is about how the many parts do not now work together to achieve a result worthy of this country's values and ambitions. (p. 11)

Colorado Middle School Mathematics Textbooks

Recently, the staff of the Colorado Department of Education (CDE; 2009) revised the Colorado Content Standards to be narrower and grade specific, and in Senate Bill 08-212, it is required that districts adopt all the revised standards by the end of 2011. With this detailed, time consuming attention on the mathematics content to be taught in schools, the concern, expressed by Austin-Martin of the CCTM (2009), is that educators have spent "very little time reflecting on how we teach mathematics" (p. 6). Further, he explained that the "poor state" of mathematics education is because many who are in mathematics education have "reduced the learning of mathematics to a set of rules, algorithms, and recipes to be followed. . . [students] are not learning how to think mathematically" (p. 6).

In general, there are two types of mathematics curricula that are used in Colorado public schools, traditional and reform. The views, presented by Austin-Martin in the CCTM (2009) journal, tend to favor reform methods for teaching and to be provided in textbooks. Austin-Martin explained that textbooks have missed the mark, because "Many

mathematics textbooks offer little more than a series of problems and activities that are both repetitive and routine, solved through the use of algorithms, memorization, and tricks" (p. 6). Yet there are educators who support traditional curricula such as the Core Knowledge Curriculum created by Hirsch (1996), who firmly believed that understanding comes after practice, not before.

Textbooks Review

This section of the review of literature investigates middle school mathematics textbooks that have been used recently in one or more of the following Colorado public school districts: (a) Littleton Public Schools (LPS), (b) Jefferson County (Jeffco), (c) Douglas County, (d) Denver (DPS), and (e) Colorado Springs (District 11). The following is a list of the textbooks: (a) Scott Foresman - Addison Wesley Middle School Math, Prentice Hall; (b) Mathematics in Context, Encyclopedia Britannica; (c) Connected Mathematics Project (CMP), Dale Seymour Publications; (d) Saxon Mathematics, Saxon Publishers; and (e) Math Thematics, McDougal Littell.

There are different organizations that review mathematic textbooks for different reasons. The three main reviewers this author found were the What Works Clearinghouse (WWC), the American Association for the Advancement of Science (AAAS), and a group called Mathematically Correct.

The WWC (WWC; n.d.) was established in 2002 by the United States Department of Education to report on different areas in educational research. One of the areas is the area of middle school mathematics research. The WWC publishes intervention reports that evaluate research on curricula and instructional strategies that

are designed to increase student achievement in mathematics for students in grades six through nine. The staff of the WWC are experts in the field of scientifically based evidence in education research. The purpose of the WWC is to be a resource for teachers for scientific evidence of what works in education and to understand and make use of effective teaching practices.

The AAAS (AAAS; n.d.), founded in 1848, is the largest international, professional, non-profit science organization that publishes the journal *Science* as well as many other resources with the mission to advance science and engineering worldwide. One program of the AAAS was Project 2061, a mathematics textbook evaluation, completed in 1999. As individual professionals from schools are most often unable to fully devote time to judge the claims by the textbook makers, the staff of the AAAS had the goal to evaluate instructional materials systematically. There were 24 criteria, consistent with the NCTM's 1998 mathematics standards, which the staff used to evaluate the quality of each textbook. Some of the criteria focus on explicit instructions for teachers, how to enhance the learning environment, instructional effectiveness, content depth, and student reflection that is important for student understanding. Twelve people evaluated each textbook. Dr. Kulm was the director of this textbook evaluation. He has given concise reports in regard to the outcome of this evaluation.

Mathematically Correct (1999) was founded in 1995 in California by parents concerned about the quality of American mathematic education. Support grew from more parents, educators, mathematicians, and other adults with the same concerns as the founders. The supporters of this organization are against constructivist methods of

teaching and believe that traditional teaching methods are best in order for children to learn the fundamentals in school. They support learning basic skills and direct instruction. The founders of Mathematically Correct conducted a mathematics textbook review for grades 2,5, and 7. This review was different from the previous two organizations' reviews. The staff of Mathematically Correct looked at the content area of each textbook, such as fractions and graphing, gave a summary of the structure of each program, reported on the depth of content, quality of presentation, and quality of student work to assess the depth of student learning likely to occur with each program, then an overall rating was awarded. Although this review was conducted much earlier than the WWC review and the AAAS review, it is important because it expresses the view of a different teaching philosophy.

Scott Foresman - Addison Wesley Middle School Math

The authors (Bolster et al., 2002) of Scott Foresman - Addison Wesley Middle School Math (SFAW) wrote a general letter to all students at the beginning of this text. They explained that students will: (a) develop problem solving techniques for everyday use, (b) find interesting themes in the book, (c) understand how mathematics is useful, (d) make conjectures, and (e) use links to the World Wide Web. Although this textbook is not labeled as either traditional nor reform, the members of Mathematically Correct (1999), the group opposed to reform oriented textbooks, reviewed an earlier edition of SFAW, and gave the program a B+ grade. Also, Kulm (1999) reported that when the members of the AAAS reviewed an earlier edition, they gave it a rating of Unsatisfactory. No additional research nor reports in regard to this textbook were found.

Mathematics in Context

Mathematics in Context (MiC) was a project funded by the NSF and developed by the scholars at the School of Education, University of Wisconsin. The staff of the What Works Clearinghouse (WWC; 2008a) stated that MiC:

> was developed to align with the 1989 NCTM Curriculum and Evaluation Standards. It is also based on the Dutch Realistic Mathematics Education approach of first engaging students in understanding real problems and then gradually moving to abstract concepts. Rather than focusing on one mathematical domain at a time, *Mathematics in Context* teaches students to explore the relationships among different domains of mathematics (such as algebra and geometry) and to develop strategies for reasoning through problems mathematically. *Mathematics in Context* also encourages students to collaborate on problem solving. (p. 1)

The staff of the WWC did not make any conclusions about the effectiveness nor ineffectiveness due to the lack of research in regard to this textbook. However, Kulm (1999) reported that the staff of the AAAS evaluated MiC as one of only four texts, which were rated as Satisfactory.

Connected Mathematics Project

The Connected Mathematics Project (CMP) was funded by the NSF as was MiC. It was developed in 1991 by scholars at Michigan State University. According to Sanchez (2007), this curriculum is inquiry based, and reform teaching methods are utilized in order for mathematics to be meaningful for students, with the idea that the teaching must not be focused on how to do mathematical procedures but must be focused on why mathematics works. The staff of Mathematically Correct (1999) explained that this book was impossible to recommend because of the limited content and inefficient instructional method. They assigned the textbook the grade of F in their review.

However, Kulm reported that the staff of the AAAS rated this textbook as their top choice. Most recently, the staff of the WWC (2010) reported that use of this textbook had no discernible effects on the mathematics achievement of students.

Saxon Mathematics

The members of Mathematically Correct (1999) gave Saxon Math 87 (i.e., eighth grade mathematics) a C+, and gave Saxon Math 65 (i.e., sixth grade mathematics) a B+. Kulm (1999) reported that the staff of the AAAS (1999) ranked this curriculum Unsatisfactory, partially because it did not present a purpose for learning mathematics and did not promote student thinking. However, the staff of the WWC (2007) found Saxon Mathematics to have positive effects on mathematics achievement. Chaddock (2000) reported that people avoid or embrace this program because of the traditional approach of learning through practice, which does not align with current reform practices. Wang quoted Saxon (as cited in Chaddock) who said, "Understanding more often than not follows doing rather than precedes it" (p. 2). Resendez and Azin (2007) explained the philosophy of the Saxon program.

> At the foundation of the Saxon program is the premise that students learn best if (a) instruction is incremental and explicit, (b) they can continually review previously learned concepts, and (c) assessment is frequent and cumulative. In Saxon Math, new increments of instruction are regularly introduced while, at the same time, students continually review previously introduced mathematics concepts. (p. 13)

Math Thematics

The members of Mathematically Correct (1999) gave Math Thematics a D+, while the staff of the AAAS (1999, as cited in Hoff) rated it Satisfactory; one of only four

textbooks to be given this top rating. The staff of the WWC (2008b) were unable to make any conclusions based upon research about the effectiveness of Math Thematics on student achievement. The staff of the Show-Me Center (n.d.) explained that Math Thematics was designed to provide students with "bridges to science and other mathematical fields. The materials are designed to integrate communication into mathematics by providing opportunities for students to use reading, writing, and speaking as tools for learning mathematics" (p. 1). The developers' goal was to have students learn in a variety of settings.

Teaching Strategies Linked to Student Achievement

According to Hiebert and Grouws (2007), "Documenting which instructional methods are most effective for students' learning continues to be one of the great challenges for educational research" (p. 1). There seems to be an untold number of factors that affect student achievement. The topic of teaching strategies is a large field, which includes: (a) management techniques (e.g., space, time, routines, attention, momentum and discipline); (b) motivation (e.g., personal relationship building, classroom climate, and expectations); and (c) instructional strategies. Also, these different areas of teaching are not mutually exclusive but, in fact, overlap. Take for example the strategy of immediate, specific feedback. According to some researchers (Marzano, Pickering, & Pollock, 2001; Shirvani, 2009; Sood & Jitendra, 2007), to give this kind of feedback is an excellent teaching strategy that improves academic achievement; however, Saphier and Gower (1997) explained that feedback given with *active listening* adds a feeling component which communicates a teacher's concern for

students' personal feelings, and this genuine active listening is a relationship building behavior which increases student learning.

There are two instructional strategies, which have received much support. First, teachers should not limit themselves to the use of only one teaching strategy but should vary instruction and use multiple representations in order for students to attain meaningful learning (Douglas et al., 2008; King, 2006; Lim, 2007; Marzano et al., 2001; NCTM, n.d.; NMAP, 2008; Sood & Jitendra, 2007; Tomlinson, 1999). Second, teachers should use MI teaching strategies (Douglas et al.; King; Tomlinson).

How to Vary Instruction: Differentiation

According to Tomlinson (1999), differentiated instruction is effective teaching in which the teacher takes into consideration the current understandings of how children learn. Also, according to Tomlinson and McTighe (2006), differentiation is not about individualization for each student, rather, it is a tool used to implement a variety of instructional strategies that serve multiple needs. Tomlinson described three principles of effective teaching and learning that educators have not always known: (a) intelligence is multifaceted, fluid; one thinks, learns, and creates in different ways, and vigorous learning changes the physiology of the brain; (b) because of progress in the field of medicine, it is known that the human brain seeks meaningful information, resists meaninglessness, and "the brain learns best when it can come to understand by making its own sense out of information rather than when information is imposed on it" (p. 19); and (c) humans learn best with moderate challenge, if a task is too difficult, the student feels threatened and shuts down into a self-protection mode, whereas if the task is too easy, the

student goes into relaxation mode. Gardner (1993) summed up the two choices a teacher can make, when faced with the wide range of student needs in his or her classroom, either write them off or find teaching strategies that are effective.

Tomlinson and McTighe (2006) explained that there are many factors which can inhibit a student from learning, such as: (a) past failures, (b) a personal crisis, (c) identity challenges, (d) learning problems, and (e) even kinesthetic learning needs. Tomlinson and McTighe described a real student situation where a teacher overheard a boy say out loud in class one day, as he paced around the room while he worked on an assignment, "I think I learn better when I move. That's cool to know, isn't it?" (p. 15). In fact, this boy was a highly kinesthetic learner and, for him, mental energy showed itself through physical energy.

According to Tomlinson and McTighe (2006), student learning will decrease when a teacher is not attentive to student needs, such as student interest and student learning profiles. Differentiation matters in teaching for numerous reasons including:

1. To increase student motivation to learn. Attending to student interest and "Positive teacher-student relationships are a segue to student motivation to learn. A learner's conviction that he or she is valued by a teacher becomes a potent invitation to take the risk implicit in the learning process." (p. 18)
2. "Enabling students to work in a preferred learning mode simply 'unencumbers' the learning process. When learning challenges are already substantial, it is sensible to allow students to work in ways that best suit them." (p. 19)

Tomlinson and McTighe suggested that teachers use multiple strategies to teach in order to provide students with more ways to demonstrate learning.

Differentiation: Learning Styles of Boys vs. Girls

In the last 30 years, the findings from brain-based research have given educators a reason to believe that boys and girls learn quite differently (Gurian, 2001). According to Gurian and Stevens (2006), every boy and girl is born with a degree of maleness or femaleness, and that gender is not completely a matter of the way in which one is nurtured. As a teacher, it is important to know how to address these differences and to vary teaching to include these differences.

Gurian (2001) explained the function of 35 parts of a brain and compared the similarities and differences in boys and girls. However, Gurian warned the reader to understand that, even though he labeled certain behaviors as male or female, any student may still fall anywhere between the extremes of the male brain and female brain definitions. In one comparison, the cerebral cortex which "contains neurons that promote higher intellectual functions and memory, and interprets sensory impulses" (p. 21), is thicker in males on the right side of their brain and thicker in females on the left side; thus, boys tend to be right-brain dominant (i.e., where spatial awareness is processed) and females tend to be left-brain dominant (i.e., where verbal skills are processed).

Gurian (2001) identified 10 ways for a teacher to vary instruction to address the brain based differences of boys and girls. The following are 3 ways to address movement and learning.

1. Boys get bored more easily; Girls are better at self-managing boredom.
2. Boys tend to use up more space; Girls use less space.
3. Boys need movement to help stimulate their brains, manage and relieve impulsive behavior; Girls do not generally need to move around as much while learning. (pp. 46-47)

To address movement issues, Gurian recommended the use of stretch breaks, movement breaks, or allow a student to play with an object in his or her hand. When boys are allowed to move in some way, their brains are stimulated, and they feel comfortable; both help the learning process. In regard specifically to the middle school mathematics classroom, Gurian explained that students, both boys and girls, learn best when a teacher uses a variety of instructional methods.

MI Teaching Strategies

According to Gardner (2004), when he first published the MI theory in 1983, his colleagues (i.e., psychologists) were not very interested in his new theory. However, professional educators were immediately interested in MI theory even though, initially, he did not intend for his MI theory to be used as an educational tool or a teaching guide. In 1988, a group of NEA members built Key Elementary School entirely around the MI theory (Sheehan, 1997). The essence of the theory is to respect the many ways people learn; also, people think very differently, and there are "almost an infinite number of ways in which they can leave a mark on the world" (Gardner, as quoted in Armstrong, 2000, p. vi). Since 1983, Gardner has worked on two main objectives in regard to individual-centered education: (a) how to enhance MI in children and (b) how to assess MI in children. Often, teachers use assessments to guide their instruction; therefore, it is important to find intellectually fair assessments just as it is important to find a variety of ways to use MI in teaching strategies.

It is important to understand the philosophy, which supports the use of MI strategies in teaching. Gardner (1993) believed that the purpose of school should be to

"develop intelligences and to help people reach vocational and avocational goals according to their particular spectrum of intelligences" (p. 9). However, in traditional, uniform schools, "paying attention to individual differences is at best a luxury, at worst a dangerous deviation from essential educational priorities" (p. 69). Gardner further explained that those, who are able to reach their potential through their strengths, "feel more engaged and competent, and therefore more inclined to serve the society in a constructive way" (p. 9). Gardner's school design is based on two assumptions: (a) not all people have the same interests and abilities; and (b) currently, it is impossible for most people to learn all the information available, and therefore, choice is inevitable.

According to Gardner (1993), "The choice of mode of presentation can in many cases spell the differences between a successful and an unsuccessful educational experience" (p. 73). Gardner suggested that any topic can be approached in at least five different ways that align with MI. "We might think of the topic as a room with at least five doors or entry points into it" (p. 203), and the effective teacher can, over time, cover a concept from these different points to help deepen student understanding, which is the goal of teaching. The five entry points are: (a) narrational, one presents a story about the topic; (b) logical-quantitative, one approaches the concept with deductive reasoning or numerical considerations; (c) foundational, explain the philosophy and terminology related to the concept; (d) esthetic, the topic is introduced with sensory appeal or surface features that will capture the students' attention; and (e) experiential, a hands-on approach, in which one works with materials that express the concept.

Armstrong (2000) identified many ways in which a teacher can incorporate MI into his or her lesson plans. There are four steps that a teacher can use to guide this process. First, a teacher should pick and choose activities that feel comfortable to him or her. Second, the learning objective should be stated clearly. Third, in order to address a certain intelligence, ask an appropriate question that is focused on that intelligence. As an example, a question to focus on the logical-mathematical intelligence would be to ask, "How can I bring in numbers, calculations, logic, classifications, or critical thinking skills?" (p. 45). Another example, for the musical intelligence, is, "How can I bring in music or environmental sounds, or set key points in a rhythmic or melodic framework?" (p. 45). Fourth, for each intelligence, Armstrong listed examples of: (a) teaching activities, (b) materials, (c) instructional strategies, (d) presentation ideas, and (e) a sample introduction activity. The use of these steps can help a teacher to brainstorm and list all possible teaching ideas that come to mind.

Teaching strategies can be extended to include the formation of the classroom environment that can be restructured to accommodate different kinds of learners. Armstrong (2000) explained that there are many questions teachers can ask themselves in regard to the type of classroom environment they create. For example, for the linguistic intelligence, "How are students exposed to the written word? Are words represented on the walls (through posters or quotations)?" (p. 67). For students with musical intelligence, would they like background music or silence? For students with spacial intelligence, does the room visually stimulate or deaden students' senses? Armstrong stated that teachers, who consider multiple intelligences in this way, "will enhance a

classroom environment to the point where even students who enter the room with significant academic, emotional, or cognitive difficulties will have an opportunity to feel stimulated toward making great strides in their learning" (p. 69).

Bodily-Kinesthetic Teaching Strategies

According to Armstrong (2000), students who are highly bodily-kinesthetic think through somatic sensations. Teaching ideas include: (a) any type of hands on learning; (b) the use of drama, sports, and physical games that teach or creative movement; and (c) use of kinesthetic imagery, cooking, gardening, tactile activities, and relaxation exercises. Also, these students love to dance, run, jump, build things, touch, and gesture. Teaching materials include "building tools, clay, sports equipment, manipulatives, and tactile learning resources" (p. 41). In addition, Armstrong listed instructional strategies as "build it, act it out, touch it, get a "gut feeling" of it, [and] dance it" (p. 41). A presentation skill could be as simple as the use of gestures or dramatic expressions. See Appendix A, Table 2, for the Eight Ways of Learning, and see Table 3, for the Summary of the Eight Ways of Teaching from Armstrong, (2000). Next, the question is how does a mathematics teacher incorporate these ideas into lesson plans?

Armstrong (2000) explained that one of the oldest and most frequently used bodily-kinesthetic teaching strategies is the use of *body answers*. To show understanding, students can raise hands or do a variation of this, such as use one finger to show very little understanding and use five fingers to show complete understanding. This researcher questions this as a teaching strategy, because it is a form of communication in regard to the level of comprehension about a concept and not a bodily-kinesthetic activity used in

order to understand the concept presented. It seems plausible that if body answers is a way for teachers to take into consideration the bodily-kinesthetic intelligence of students, then to chew gum in class, to squeeze a ball while taking notes, and to balance on an exercise ball instead of to sit in a chair, would target this intelligence as well.

A more direct way to give students an opportunity to learn through the bodily-kinesthetic intelligence is through hands on learning activities. Armstrong (2000) recommended the use of Cuisenaire rods and Dienes blocks.

Also, Armstrong (2000) suggested the use of centers where students could deepen their knowledge of a topic through a specific activity based on one of the multiple intelligences. For bodily-kinesthetic, this activity could be to create something out of clay or to build a model out of paper.

Armstrong (2000) explained that, in order to create a classroom atmosphere that addressed students' bodily-kinesthetic intelligence, teachers should ask themselves the following three questions.

1. Do students spend most of their time sitting at their desks with little opportunity for movement, or do they have frequent opportunities to get up and move around (e.g., through exercise breaks and hands-on activities)?
2. Do students receive healthy snacks and a well-designed breakfast or lunch during the day to keep their bodies active and their minds alert, or do they eat junk food during recess and have mediocre cafeteria meals?
3. Are there materials in the classroom that allow students to manipulate, build, be tactile, or in other ways gain hands-on experience, or does a "don't touch" ethos pervade the room? (p. 68)

Student Motivation and Self-Efficacy

The staff of the NMAP (2008) reported teachers' comments about teaching and the single most challenging aspect reported in regard to teaching was unmotivated students. Ultimately, a student is responsible for his or her own learning. Bandura (1997) explained that self-efficacy is the belief in ones capabilities to perform given actions. Self-efficacy is a key factor in understanding self-motivation, and motivation is a key factor in understanding student academic behavior. Bandura stated, "Self-efficacy beliefs determine the goals people set for themselves, how much effort they expend, how long they persevere, and how resilient they are in the face of failures and setbacks" (p. 1). Then, the question for teachers is, so what increases student self-efficacy?

Numerous researchers have explained how different emotions or processes within a student can help or hinder the learning process.

1. Marzano et al. (2001) identified nine research-based strategies that are effective in the classroom. One strategy is a set of instructional techniques that addresses students' attitudes and beliefs: Reinforce effort and provide recognition. The correlation between effort and achievement is simple: The harder one tries, the more successful one can be. Another strategy listed was focused practice: to master a skill requires a fair amount of practice.
2. Gladwell (2008) explained how Schoenfeld (n.d., as cited in Gladwell), a researcher and a mathematics professor at Berkeley, concluded that for a student he was working with to learn mathematics, it was the student's

attitude not innate ability that was the major factor to determine how much was learned: Success was a function of persistence and willingness to work hard until the concept was fully understood.

3. Gardner (1993) stated, "The feeling of self-esteem that accrues from a job well done may encourage the child to take up challenges that might previously have been intimidating" (p. 206).
4. Gurian (2001) explained that the emotive response, "I can't do this, it's too hard" (p. 19), which is processed in the limbic system, can slow down or shut off most thinking in the top of the brain because the blood flow remains heavy in the middle of the brain.
5. Many researchers (Kress, Norris, Schoenholz, Elias, & Seigle, 2004; Norris, 2003; Weissberg, Resnik, Payton, & O Brien, 2003; all cited in Jones, Jones, & Vermette, 2009) believe that social and emotional factors are important variables for student academic advancement. They further explained that the teaching of social-emotional skills to secondary students has been linked to more positive student motivation and to higher student achievement (Elias & Arnold, 2006; Kress et al.; Weissburg et al.; all cited in Jones et al.).

It seems clear that self-efficacy, motivation, effort, hard work, and success are closely linked. Also, it seems highly plausible that, if teachers incorporated additional teaching strategies, such as kinesthetic learning strategies, in order to vary instruction, this might help with a plethora of common classroom problems that get in the way of learning, such

as: (a) discipline, (b) student focus and interest, (c) motivation, (d) expression, and (e) persistence.

Current Classroom Teaching Strategies

According to Tomlinson and McTighe (2006), most teachers agree that in order to attend to diverse student needs, one must vary teaching strategies to be effective. However, they also stated that "research. . . suggests to us that few teachers in fact translate that ideal into classroom practice" (p. 39). White-Clark et al. (2008) found that secondary mathematics teachers continue to teach with the use of traditional methods such as didactic, teacher-directed, "sage on the stage" (p. 41) methods, and few constructivist principles. McKinney and Frazier (2008) wrote about the instructional strategies utilized by many middle school mathematics teachers. "The results indicated that although the subjects are implementing a variety of practices, lecture, drill and practice, and teacher-directed instruction continue to dominate many high-poverty classrooms" (p. 201). The NMAP (2008) staff found in their research that Algebra teachers reported that only occasionally did they use manipulatives as a learning strategy. Armstrong (2000) stated that, "In most schools today, programs that concentrate on the neglected intelligences (musical, spatial, bodily-kinesthetic, naturalist, interpersonal, intrapersonal) tend to be considered 'frill' subjects or at least subjects peripheral to the 'core' academic courses" (p. 82). According to Gardner (1991), the fact is that educational reform, such as progressive education, is a very difficult transition to make in a traditional educational system because it requires teacher training, teacher dedication, and teacher belief in a new philosophy. Gardner stated, "if we wished to have education

of higher quality and more rigorous standards, education that took seriously the need to address individual differences and achieve widespread understanding, we could make enormous strides even with the present resources" (p. 258).

Chapter Summary

It seems clear that the teachers within the United States school system are heavily biased toward traditional modes of instruction. At the same time, researchers (Douglas et al., 2008; Gardner, 2004; Gurian, 2001; Marzano et al., 2001; Tomlinson, 1999) have indicated that people clearly learn in different ways, and that this is a widely accepted view that has not been incorporated into practical day to day teaching. Two instructional strategies that have received much support are to: (a) vary instruction and (b) use MI teaching strategies, including bodily-kinesthetic strategies. It seems true that teachers have yet to accept the challenge to learn how to expand their teaching strategies to include these research based strategies. Chapter 3 describes the method, target audience, organization, and peer assessment plan for the development of this project.

Chapter 3

METHOD

The purpose of this project was to create a teacher handbook of kinesthetic teaching strategies that can be used with any lesson, with specific examples from middle school mathematics lessons. In the review of literature, it was found that to vary instruction and use of Gardner's (1993) Multiple Intelligences (MI) teaching strategies, including bodily-kinesthetic teaching strategies, are teaching strategies that improve student learning. Also, it seems clear that few mathematics teachers go beyond traditional teaching styles of lecture, drill, and practice. Research (Johnsen, 1993; Roman, 1998; both cited in Nathan et al., 2002; Porter, 1989, as cited in Witzel & Riccomini, 2007) has indicated that teachers are guided by textbooks, most of which are reported to be of the traditional type that support traditional teaching strategies. Clearly, teachers need training in how to vary instruction, and especially with the least used MI strategies such as bodily-kinesthetic teaching strategies.

Target Audience

This handbook is intended for all levels of mathematics teachers and for teachers of all subjects, but with focus on and examples for how to enhance middle school mathematics lessons. Teachers who need ideas of ways to incorporate bodily-kinesthetic teaching strategies into lessons or need ways to engage the highly bodily-kinesthetic learners, should find this handbook helpful.

Organization of the Project

The goal of this project is to provide teachers with a resource to help incorporate bodily-kinesthetic teaching strategies into lesson plans. The handbook begins with an explanation of bodily-kinesthetic teaching strategies, reasons to use them, and a summary of bodily-kinesthetic teaching strategies used in five middle school mathematics textbooks. The handbook provides instruction on how to create a bodily-kinesthetic resource center for the classroom and how to incorporate these teaching strategies for individuals or for whole classroom instruction. Lastly, the handbook provides two sample math lessons that incorporate these strategies to show how they are practically applied.

Peer Assessment Plan

Assessment of the handbook was obtained from four colleagues through formal feedback and suggestions for further research. Each colleague was given a copy of the handbook and asked to review it for clarity, ease of use, and desirability to use the strategies listed. The reviewers provided formal feedback via a questionnaire designed specifically for this project.

Chapter Summary

According to Gardner (2004) and Gurian (2001), the use of bodily-kinesthetic teaching strategies can improve student learning; however, it appears this is not a common practice among United States teachers. Through this project, this author intends to provide teachers with ideas to easily incorporate in their day to day lessons. Chapter 4 provides ways for teachers to vary instruction through the use of bodily-kinesthetic

teaching strategies, and for teachers who desire to help students with bodily-kinesthetic learning needs.

Chapter 4

RESULTS

Gardner's (2004) theory of Multiple Intelligences (MI) is widely accepted as a sound theory, yet the use of explicit traditional teaching strategies, such as a lecture, still seem to dominate how middle school mathematics teachers teach. Teachers need to acknowledge and address how each student learns. This can be done with the use of Gardner's (2004) MI to guide instruction.

The purpose of this project was to develop a resource handbook of under-utilized, yet effective bodily-kinesthetic teaching strategies that can be integrated with any mathematics textbook and with any lesson. The use of MI teaching strategies can help targeted students' learning and can also help teachers make lessons more exciting and engaging for all students.

Project

The goal of this project is to provide teachers with a resource to help incorporate bodily-kinesthetic teaching strategies into lesson plans. The handbook is titled "Mathematics in Motion: A Handbook of Bodily-Kinesthetic Teaching Strategies." The handbook begins with an explanation of bodily-kinesthetic teaching strategies, reasons to use them, and a summary of bodily-kinesthetic teaching strategies used in five middle school mathematics textbooks. The handbook provides instruction on how to create a bodily-kinesthetic resource center for the classroom and how to incorporate these

teaching strategies for individuals or for whole classroom instruction. Lastly, the handbook provides two sample math lessons that incorporate these strategies to show how they are practically applied.

Mathematics in Motion:

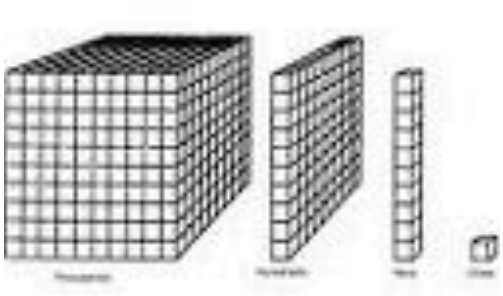
A Handbook of Bodily-Kinesthetic Teaching Strategies

by Janie Brown Salazar

Table of Contents

ONE

What are Bodily-Kinesthetic Teaching Strategies?



The Origin of Bodily-Kinesthetic Teaching Strategies

What is Smart?

It was a little over 100 years ago that Alfred Binet came up with a test that could predict which children would succeed and which would fail in the primary grade schools of the time (Gardner, 1993). Most know this as the famous IQ test, that measures the logical-mathematical and linguistic intelligences, which many rely on today as a measure of intelligence. Before this test was invented, the idea of intelligence was vague and depending on which culture you were from, intelligence meant different things. It is also interesting to note, that receiving successful grades in school has not been proven to be a predictor of success in life after the school years. Today, there is only one theory that challenges IQ as the way to measure human intelligence; the theory of Multiple Intelligences (MI). MI theory was first proposed by Howard Gardner in 1983. He painstakingly proved each of his multiple intelligences. In short, MI theory says that all human beings have at least seven different forms of intelligences which they use to differing degrees. The seven multiple intelligences are:

Linguistic, Logical-mathematical, Musical, Bodily-Kinesthetic Spacial-Visual, Interpersonal, and Intrapersonal (more recently added: Naturalistic, Moralistic, and Existential).

The idea that humans have multiple intelligences and not just the popular two, quickly caught on in the educational world because this meant that teaching from these perspective intelligences could be an effective instructional model. Now, instead of only using linguistic and logical teaching strategies, there were several more teaching strategies that could benefit children.

The Bodily-Kinesthetic Intelligence

Gardner (1993) describes the bodily-kinesthetic intelligence as the ability to use one's body (whole body and hands) to express ideas and emotions, to solve problems, or to fashion products. People who exemplify this intelligence are:

dancers
athletes
surgeons
&
inventors.

Armstrong (2000) explained that bodily-kinesthetic learning takes place through somatic sensations, such as dancing, running, jumping, building things, touching, and gesturing. He explains that children do not leave their multiple intelligences behind once they have reached puberty and if anything, the intelligences become more intense, especially the bodily-kinesthetic intelligence.

BK Teaching Strategies

One of the oldest and most frequently used bodily-kinesthetic teaching strategies is the use of, what Armstrong (2000) calls, **body answers**. To show understanding, students can raise hands or do a variation of this, such as use one finger to show very little understanding and use five fingers to show compete understanding.

Bodily-Kinesthetic teaching strategies include the following physical experiences:

build it
act it out, drama
dance
creative movement
kinesthetic imagery
any type of hands-on learning
the use of Dienes blocks
the use of Cuisenaire rods
touch it, tactile activities
get a “gut feeling” of it
relaxation exercises
spacial-mechanical activities
sports that teach
ball throwing
use of body answers to show understanding
cooking
gardening
the use of physical skills
coordination
balance
dexterity
strength
flexibility
speed

The BK Classroom Atmosphere

To create a classroom atmosphere that addresses students' bodily-kinesthetic intelligence, Armstrong (2000) presents three questions that teachers should ask themselves:

QUESTION 1

Do students spend most of their time sitting at their desks with little opportunity for movement, or do they have frequent opportunities to get up and move around?

QUESTION 2

Do students receive healthy snacks and a well-designed breakfast or lunch during the day to keep their bodies active and their minds alert, or do they eat junk food during recess and have mediocre cafeteria meals?

QUESTION 3

Are there materials in the classroom that allow students to manipulate, build, be tactile, or in other ways gain hands-on experience, or does a "don't touch" ethos pervade the room? (p. 68)

In order to develop the bodily-kinesthetic intelligence, the opportunity must be available. Being exposed to certain experiences can have a great effect on our innate talents and abilities.

Above all,
for growth in any area, the learner must make his or her own personal commitment to develop in such a way.

TWO

Why Use Them?

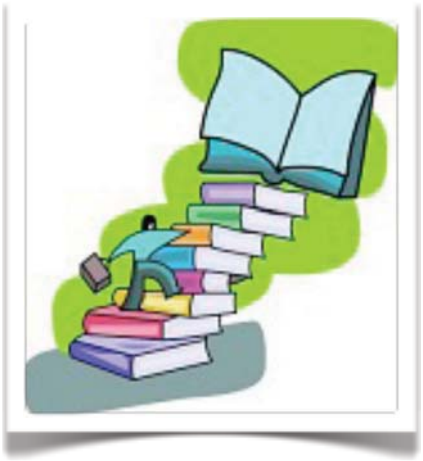
Reasons to use BK teaching strategies:

1. To increase student interest and awaken students' minds. **The brain is stimulated by novelty**.
2. To increase oxygen to the brain.
3. To increase glucose utilization.
4. To launch a unit in a different way.
5. A new way to review before a test.
6. Because school can be rigorous and enjoyable.
7. To increase the chance of reaching every brain.
8. Body answers can be a way for students to give immediate feedback to the teacher and can be minimally disruptive.
9. Hands-on materials can help provide opportunities for students to make connections between mathematical ideas and skills.
10. To appeal to students with kinesthetic learning needs.
11. In general, boys get bored more easily than girls and boys need movement to help stimulate their brains, and to manage and relieve impulsive behavior (Gurian , 2001).
12. To address movement issues, Gurian recommended the use of stretch breaks, movement breaks, or allow a student to play with an object in his or her hand. When boys are allowed to move in some way, their brains are stimulated, and they feel comfortable; both help the learning process. In regard specifically to the middle school mathematics classroom, Gurian explained that students, both boys and girls, learn best when a teacher uses a variety of instructional methods.
13. Boys account for 80% of the high school dropouts, 70% of the D and F grades earned, and 90% of the discipline referrals (Gurian, 2001). Could the use of BK teaching strategies help to lower these statistics?

14. Boys account for 2/3 of learning disability diagnoses and millions medicated for ADD and ADHD. Could the use of BK teaching strategies help lower these numbers?
15. To increase good attitudes toward mathematics.
16. To increase “feel good” neurotransmitters.
17. To increase adrenaline.
18. To increase student self-esteem.
19. To enhance learning, thinking, and creativity.
20. Research supports using a variety of teaching strategies.
21. To increase student motivation, the key to learning!
22. Help students be more active learners- Learning is not a passive activity!!
23. In traditional teaching methods, there is a tendency to overlook the creativity building part of mathematics
24. Students are not all the same. Adding a new approach could mean reaching every student, which is the goal.

THREE

BK Strategies In Math Textbooks



Bodily-Kinesthetic Teaching Strategies Summary

BK teaching strategies include activities where students use their body (hands or whole body) to express ideas or emotions, or to solve problems or fashion products. This can mean many things. Also, strategies can overlap into two or more categories, and for this reason each strategy found appears in only one category. The following list summarizes how the BK strategies have been organized.

1. Hands-On learning:
   a. hands-on games
   b. the use of manipulatives
   c. build a model
   d. drawing

2. Creative Movement learning:
   a. act it out/ demonstrate
   b. creative movement
   c. dancing

3. Sports:
   a. sports that teach
   b. physical Skills: Coordination, balance, dexterity, strength, flexibility, speed

4. Body Answers
5. Use a Calculator
6. Gather and record data
7. Using Intuition: Getting a "gut feeling"
8. Kinesthetic Imagery

The following charts show which strategies were found from approximately 30 lessons from each grade level of five mathematics curricula. The strategies have been taken from the main teaching manual, even though each curriculum did include extra resources, these were not investigated. The strategies recorded per lesson include both mere suggestions and main teaching strategies. For example, in the Saxon curriculum, the use of manipulatives is not the main teaching strategy, however, in almost every lesson there is a suggestion for how to incorporate manipulatives. Also, the strategies recorded are listed because the students are engaged in this way, not just the teacher doing something as an example. For example, drawing on an overhead would not be listed because only the teacher is doing the drawing.

The following curricula were viewed:

Connected Mathematics Program (CMP2)
Saxon Mathematics
Scott-Foresman Addison-Wesley Middle School Math
Mathematics in Context (MiC)
MathThematics

Connected Mathematics Program (CMP2)

BK STRATEGIES	6th grade	7th grade	8th grade
hand-on games	8	1	0
manipulatives	11	7	5
build a model	3	0	2
drawing	14	7	9
act it out/ demonstrate	2	3	4
sports	0	0	1
physical skills	0	0	1
body answers	0	0	0
calculator	4	1	2
gather/record data	12	10	5
intuition	2	5	5
kinesthetic imagery	2	2	2

TOTAL:	58	36	36
Number of Lessons:	30	28	25

Saxon Mathematics

BK STRATEGIES	6th grade	7th grade	8th grade
hand-on games	0	0	0
manipulatives	29	36	16
build a model	9	3	3
drawing	12	15	8
act it out/ demonstrate	11	9	5
sports	0	0	0
physical skills	0	0	0
body answers	0	0	0
calculator	2	11	6
gather/record data	17	3	12
intuition	9	3	3
kinesthetic imagery	8	3	2

TOTAL:	97	83	47
Number of lessons:	33	33	33

Scott Foresman–Addison Wesley Middle School Math

BK STRATEGIES	6th grade	7th grade	8th grade
hand-on games	4	3	3
manipulatives	13	14	11
build a model	5	5	8
drawing	10	11	8
act it out/ demonstrate	1	2	3
sports	0	0	1
physical skills	1	0	1
body answers	0	0	0
calculator	2	3	5
gather/record data	4	5	7
intuition	0	1	1
kinesthetic imagery	2	3	2

TOTAL:	42	47	50
Number of lessons:	30	30	30

Mathematics in Context (MiC)

BK STRATEGIES	6th grade	7th grade	8th grade
hand-on games	3	1	1
manipulatives	7	5	2
build a model	2	8	1
drawing	10	9	8
act it out/ demonstrate	9	0	4
sports	0	0	0
physical skills	0	0	0
body answers	1	0	0
calculator	0	0	0
gather/record data	10	7	7
intuition	3	0	1
kinesthetic imagery	5	1	2

TOTAL:	50	31	26
Number of lessons:	32	31	34

MathThematics

BK STRATEGIES	6th grade	7th grade	8th grade
hand-on games	1	8	3
manipulatives	9	10	6
build a model	7	10	7
drawing	9	6	9
act it out/ demonstrate	1	9	5
sports	0	0	0
physical skills	0	0	0
body answers	0	0	0
calculator	3	1	1
gather/record data	10	11	10
intuition	1	5	2
kinesthetic imagery	2	6	2

TOTAL:	43	66	45
Number of lessons:	30	30	30

I was intrigued to learn that there were so many bodily-kinesthetic strategies presented in these textbooks. The information really is in the books for teachers to use. But it is clear that using manipulatives, drawing, and recording data are by far the most used strategies. The following is a list of the total amount of each strategy that was found within these 459 lessons.

Hands-on games:	36
Manipulatives:	181
Build a model:	73
Drawing:	145
Act it out/ Demonstrate:	68
Sports:	2
Physical Skills:	3
Body-Answers:	1
Calculator:	41
Gather/Record Data:	125
Intuition:	41
Kinesthetic Imagery:	44

FOUR

BK Resource Center

Create A BK Resource Center For Your Classroom

Items for hands-on activities

Items for individual needs

Movement

More Resources

Items for Hands-On Activities

1. Laundry basket or large box (to store all items)
2. Extra basket (a target for ball games)
3. different size balls- tennis, sponge, rubber
4. alarm clock, stop watches
5. dice
6. glue
7. masking tape, scotch tape
8. paper: Plain white and colors, coordinate planes, graph, tracing, paper strips, origami paper
9. index cards
10. string, ribbon
11. scissors
12. spaghetti
13. rubik's cubes, plane cubes, colored cubes
14. Calculators
15. rulers, protractors, compasses
16. magazines
17. paints, colored pencils, markers, etc.
18. rocks
19. Geometry Shapes set
20. empty jars or plastic containers
21. Dienes blocks
22. Cuisenaire rods
23. small mirrors
24. straws
25. jump ropes
26. fake money
27. marbles
28. thermometer
29. stencils
30. staplers
31. tape recorders
32. Put up a display shelf/ clear a wall space for student work
33. List of Gardner's Seven Intelligences Described:

The Seven Intelligences Described

Intelligence	Description
Linguistic	The ability to use words effectively, whether orally or in writing. Exemplified in: T. S. Elliot
Musical	The ability to discriminate, transform, and express musical forms. Exemplified in: Mozart
Logical-Mathematical	Ability to perform mathematical calculations, think logically, use scientific thinking and deduction, problem solve, and detect patterns. Exemplified in: Winner of the Nobel Prize in Medicine
Spatial	The ability to perceive a mental model of a spatial world accurately and be able to operate using those perceptions. Examples: sailors, engineers, surgeons, sculptors, painters, athletes
Bodily-Kinesthetic	Ability to use one's body to express ideas and emotions, to solve problems or to fashion products. Examples: Dancers, athletes, surgeons, inventors
Interpersonal	The ability to understand and perceive other people, to notice distinctions among people in their moods, intentions, motivations, and feelings. Examples: Politicians, teachers, religious leaders, therapists, parents

Intelligence	Description
Intrapersonal	Self-knowledge, self-understanding, having an accurate picture of oneself (one's strengths and limitations), awareness of feelings and emotions, and able to use this information to understand and guide one's own behavior.

Note. From *Multiple Intelligences The Theory in Practice*, by H. Gardner, 1993, New York: Basic.

Eight Ways of Learning

Children who are highly:	THINK	LOVE	NEED
Linguistic	in words	reading, writing, telling stories, playing word games	books, tapes, writing tools, paper, diaries, dialogue, debate, stories
Musical	via rhythms and melodies	singing, whistling, humming, tapping feet and hands, listening	music playing at home and school, musical instruments
Logical-Mathematical	by reasoning	experimenting, questioning, figuring out logical puzzles, calculating	materials to experiment with, manipulatives, field trips
Spatial	in images and pictures	designing, drawing, visualizing, doodling	art, LEGOs, video, movies, mazes, imagination games
Bodily-Kinesthetic	through somatic sensations	dancing, running, jumping, building, touching, gesturing	role play, drama, movement, things to build, sports, hands-on learning

Children who are highly:	THINK	LOVE	NEED
Interpersonal	by bouncing ideas off other people	leading, organizing, relating, manipulating, mediating, partying	clubs, group games, friends, mentors, social gatherings
Intrapersonal	in relation to their needs, feeling, and goals	setting goals, dreaming, planning, reflecting, meditating	secret places, time alone, self-paced projects, choices
Naturalist	Through nature and natural forms	playing with pets, gardening investigating nature, raising animals, caring for planet earth	access to nature, opportunities for interacting with animals, tools for investigating nature (e.g., magnifying glass, binoculars)

Note. From *MultipleIntelligences in the Classroom*, 2nd ed., by T. Armstrong, 2000, p. 22. Alexandria, VA: ASCD. Copyright 2000 by Thomas Armstrong. Adapted with permission of the author. See Appendix C for permission.

Summary of the Eight Ways of Teaching

Intelligence	Teaching Activities (examples)	Instructional Strategies
Linguistic	lectures, discussions, word games, storytelling, choral reading, journal writing	read about it, write about it, talk about it, listen to it
Musical	rhythmic learnings, rapping, using songs that teach	sing it, rap it, listen to it
Logical-Mathematical	brain teasers, problem solving, science experiments, mental calculation, number games, critical thinking	quantify it, think critically about it, put it in a logical framework, experiment with it
Spatial	visual presentations, art activities, imagination games, mind-mapping, metaphor, visualization	see it, draw it, visualize it, color it, mind-map it
Bodily-Kinesthetic	hands-on learning, drama, dance, sports that teach, tactile activities, relaxation exercises	build it, act it out, touch it, get a “gut feeling” of it, dance it
Interpersonal	cooperative learning, peer tutoring, community involvement, simulations	teach it, collaborate on it, interact with respect to it
Intrapersonal	independent study, options in course of study, self-esteem building	connect it to your personal life, reflect on it

Intelligence	Teaching Activities (examples)	Instructional Strategies
Naturalistic	nature study, ecological awareness, care of animals	connect it to living things and natural phenomena

Note. From *MultipleIntelligences in the Classroom*, 2nd ed., by T. Armstrong, 2000, p. 41. Alexandria, VA: ASCD. Copyright 2000 by Thomas Armstrong. Adapted with permission of the author. See Appendix C for permission.

Items for Individual Needs

1. Exercise ball (2-3 per class, for students to sit on while taking notes)
2. Gum
3. healthy snacks
4. healthy drinks
5. squishy balls
6. music and headphones
7. tape recorders

Movement- Have a folder with a list of Movements:

1 minute version

(have everyone stand up, arms-width from each other, all movements count to 5)

* arms out stretch, arms perpendicular to body and extend fingers
* arm circles- big, 5 in both directions
* neck stretch, arms at side, look down, look up, move side to side
* toe risers, 5 slow or 10 faster, for a greater intensity, do not let you heel touch the ground completely when going down
* 3 deep breathes, let them out slowly
* touch toes: relax arms and shoulders
* 5 jumping jacks

* sit down, put head down on desk taking in one deep breath
* Lastly, **QUIET**, quietly count to five and prepare for next activity or lesson

* OR: Have students do as many push ups as they can in 40 seconds

* OR: Do 10 SUMO SQUATS- Place your feet wider than your shoulders, and turn toes out 45 degrees. Keeping your chest up and shoulders back, squat straight down, with knees over toes; then stand up and repeat. To increase intensity, hold hand weights at hips.

You will want to experiment before you lead the class. You can do only stretches, or just one exercise, like sit ups or push ups. Set a timer, and make sure you can lead a quick, refreshing, non-strenuous exercise. Also, you can ask your school's PE teacher for a list of exercises and he or she can show you how to do them properly before you lead your class.

Have fun!

More Resources

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FIVE

Strategies in Action

MATCHING

When it comes to differentiation,
the name of the game in teaching is called
"**matching**."

Matching is understanding your students, understanding all the possible teaching strategies, and then matching students with the strategies that will help them learn best. Sometimes, direct teaching is best. Sometimes a lecture is very efficient and productive for an entire class. But what about that struggling student? What might help him or her? What might help spark interest or awaken students' minds? What might help you enjoy teaching more? Repetitiveness can dull the mind, while novelty stimulates the brain. Might this be a good day to present the class a lesson in a novel way? Might some of these strategies be useful on a more consistent basis? You may only know through trial and error, but the key for teachers is to keep trying until they reach every student. Here are some ideas to try.

Individual Student Strategies

1. Exercise ball:
   while a student is taking notes, have him/her sit on the exercise ball. This keeps their inner core active, maintaining balance sitting, while writing notes.

2. Chewing gum:
   another idea for a student who is taking notes. This movement should follow an agreement of how to handle the gum respectfully.

3. Hand squishy-ball:
   and another idea for the note-taker. If it is possible with one hand to take notes and the other hand to squeeze the ball- student may want to rotate, only using the squishy ball when listening, in between note-taking.

4. Standing in the back of the room:
   final strategy for note-taking. This student is allowed to stand at his or her desk in the back of the room while taking notes. There should be no distraction to the other students.

5. Healthy snacks and drinks:
   for the student who has not had a good breakfast or lunch. Ideas could be worked out with the parents ahead of time. Times to eat and drink may include 1 minute before class begins, after a lesson is presented, or during individual work time.

6. Relaxation exercises or stretches:

   The one minute stretch list is given to a student to take outside the classroom. Set the timer for three minutes when she or he should be back in their seat working.

7. Manipulative Station:

   Set up a table with relevant manipulatives for each lesson as an extension for anyone who feels they could use this kind of help. Make clear directions for the hands-on activity, with clear objectives and outcomes.

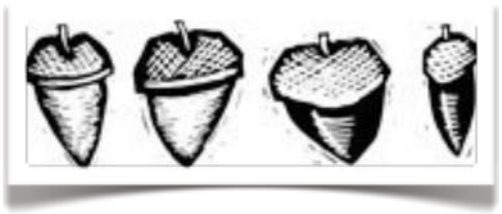
8. Tape Recorder Interview:

   Have one student interview another student using a tape recorder. Then to check for understanding, this can be played to the whole class (or a small group) and the rest of the students can check for errors. Students can also tape record a lesson as taught by the teacher and listen to it as a review.

9. Journal:

   Usually used for writing, this can also be a time to journal with pictures that represent math ideas or vocabulary words. This can be a reflective exercise too. Journaling can easily tap into all of the intelligences when thought is put into expressing what the objective is of the writing or drawing.

Whole Class Instructional Strategies



1. Manipulatives/ Build a Model/ Drawing:

In mathematics, many lessons, if not most, can be accompanied by some sort of manipulative, hands-on model or a drawing. Many educators have already provided hands-on opportunities such as Cuisenaire rods and Dienes blocks. Often teachers are the ones making the picture on the board, but having the students draw their own picture or representation of the math concept is one way to extend their thinking. Think of ways children can go beyond just listening and writing, such as:

TRACE, SHADE, CUT OUT SHAPES, FOLD, MEASURE, RECORD, MAKE A 1 or 2-DIMENSIONAL REPRESENTATION, PREPARE A RECIPE, STACK, MIX, MAKE, MODEL, MARK, CIRCLE,CREATE, DEMONSTRATE, INVENT, LIFT, LOCATE, FIND, COMPARE.

These are verbs that the teacher may already be doing. Have the students participate -and it does not have to be complicated or take lots of time. Just be prepared with the materials you will need and clear directions.

2. Hands-on Games:

If you go to a toy store, you can find hundreds of games that actually are teaching a mathematical concept. Also, it is easy to turn an idea into a game. For example, you can define rectangle, rhombus, and quadrilateral- then have children sort shapes. This can be done in pairs, dividing the class up into two groups, or as a station for individuals to visit as they wish. Games can be timed or not, competitive or not, done by taking turns, or even keeping score.

3. Math Basketball:

To review before a test.

Directions: The goal is to throw more basketballs through the hoop (or in a clean trash can or empty laundry basket) than the teacher. Here's how it works:

* **Write a problem** on the board.
* **Set a timer** for an appropriate amount of time for the students to complete the problem.
* **Randomly select** a student to share their answer (and if correct, to show how they arrived at their answer).
  --<u>If correct:</u> That student gets to try to shoot a basket for either 1,2 or 3 points, depending on what line they stand on.
  --<u>If incorrect:</u> The teacher gets to try to shoot a basket.
* **Keep score** on the board, TEACHER vs. STUDENTS

* If the teacher wins, set a consequence, such as, everyone has to do an extra problem in the book. If the students win, also set consequences, such as:
    -- students win by:
        1-2 points, get a piece of candy
        3-10 points, they get two pieces of candy
        11 or more points, they get 5 extra credit points in their homework grade.

Materials needed: list of problems/answers, a "hoop" or basket, a stop watch or timer, a ball, tape to mark the point line, a jar to put each student's name on a piece of paper in order to select them randomly.

4. Math Bingo:

Directions: The goal is to fill up a row, column, or diagonal on your Bingo card before anyone else, and yell "BINGO" when they do. Here's how it works:

* The teacher has a set of problems for the students to work, and the answers.
* Students are given a "BINGO" card which is a sheet with a 4x4, 5x5, or 6x6 grid that already has all the answers in random order in each square.
* Write each student's name on a piece of paper and put in a jar- to pick randomly.
* Write the first problem on the board and give the students enough time to work out the problem.
* Select a name from the jar- and if the student has the correct answer, allow them to work it through on the board to show the class.
* All students mark off the correct answer on their BINGO card.
* Keep working problems until someone gets a "BINGO"
* Whoever gets a BINGO, you may want to have some sort of prize for them. You may also want to have another reward that everyone receives for playing, given out at the end of class.

5. Act It Out/ Charades/ Demonstrate:

These ideas are similar, yet can be very different. To act it out, students put on mini-skits with props. To demonstrate something, they act more like a teacher, and show how something works. Have props in the room and create ideas and ways to act out a math concept or vocabulary word. This can be done with or with out props- as in the game of charades and other people make great props! For example, if someone was trying to show 3-2 (3 minus 2), they could take 3 of their friends then make 2 of them sit down.

6. Kinesthetic Imagery:

This is when you hear or read about an activity and imagine putting yourself in that situation. More specifically, it's not just reading about body movement, but actually owning it and thinking about how you would do the action. This could be extended by having the students stand by their desks and do a movement that represents what is being read about.

7. Relaxation exercises or stretches:

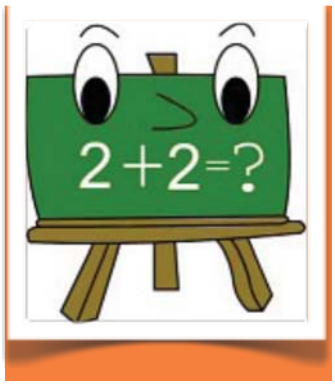
Use the minute the bell rings, before the lesson begins, or as a transition from a lecture to practice. Once this becomes a routine for the students, this activity can actually take two minutes and help focus students on the next task. Set rules such as, start with the tap of a bell, as soon as the bell is rung there is absolutely no talking, if you walk in late to class you must join in as soon as possible with no talking, after the last stretch you must sit down quietly with no talking. The consequences for talking must be set by the teacher or at the beginning of creating this routine, you may want to have a reward for the entire class participating with no distractions for the first week. This is not a widely used activity and you may find that the activity itself is a reward.

8. Physical Skills:

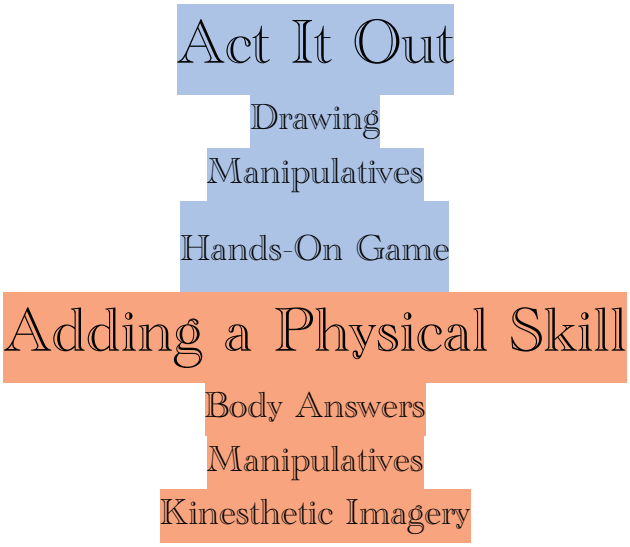
This could be as simple as flipping a drink coaster off a table and catching it- see how many you can do in a row. Physical skills includes coordination, balance, dexterity, strength, flexibility, and speed.

SIX

Strategies In A Math Class



Two Mathematics Lessons Using BK Teaching Strategies



Act It Out

Grade level: 7th
Subject: Mathematical Expressions, Equations, and Formulas
Title: Translating from English to Mathematics

Learning Objectives:
1. Learn how to translate verbal expressions into algebraic expressions and equations (formulas)
2. (**ACT IT OUT) Work in groups of 5-7 people and plan out a skit to show one equation or expression (your choice)

Teach:
*Review: Have students translate these words into mathematical symbols:
a. two plus an unknown equals the cost
b. the quotient of a number and 8
c. 3 increased by a number
d. twice a number subtracted from 6
e. The number of sides in T triangles

*Direct Teach: Expressions/ Equations can help figure out real-life situations. Example 1: To find the mean of four numbers, w,x,y,z, add the numbers and divide by 4. Turn this definition into an equation. Example 2: I don't really have a good idea what a temperature in Celsius feels like, so I need to change 20 degrees Celsius to Fahrenheit. Celsius temperature times 1.8 plus 32 equals the Fahrenheit temperature.
Written: 1.8 C + 32 = F
Question: Which is easier to remember, the words or the formula???

*Divide up into groups- set by the teacher: (** ACT IT OUT)
Pick one example or make one up of your own to act out any way you choose. One idea-- six people could act out the formula D = (R) (T), each person taking on one symbol or letter by physically making the shape. The people making the parenthesis could stand behind those making the R and the T with a curved arm on either side of them.

More Ideas:
**DRAWING/ VISUAL- Make a folder at the beginning of this unit with a decorated cover using one formula, writing out the formula in words and showing the formula mathematically. For example, D=RT could be represented on a triangle with the D at the top angle, the R at the bottom left angle, and the T at the bottom right angle with an equal sign in the middle of the R and T.

**MANIPULATIVES- On 3 by 5 cards, write a formula on one side and the words on the other side. These can be used as a self-quiz.

**HANDS-ON GAME- On 3 by 5 cards write a formula on one side and the words to A DIFFERENT formula on the other. These should be written in order so that as one student reads the English of the formula, another student has the mathematical formula on their card (which they read) then they flip their card over and read the English of another formula, to which someone else in the class has that mathematical formula.... and so on, until the entire class has gone through all their flashcards. This can be timed and the class can work toward a goal. Every student can have one or two cards depending on class size and number of cards.

Adding a Physical Skill

Grade level: 7th
Subject: MATH/ RATIO
Title: WHAT IS A RATIO?

Learning Objectives:

1. Express two quantities as a ratio
2. To understand that a ratio is a special kind of fraction, be able to define ratio. A **ratio** is a comparison of two quantities. Be able to state this definition. Be able to explain how a ratio is similar and different to a fraction. [Answer: Ratios can look like fractions when written with a numerator and denominator. Ratios cannot be written as decimals. Fractions show parts of a whole and ratios compare two different quantities.]
3. (**PHYSICAL SKILL) Give a ratio of the number of times you caught the paper coaster and the number of time you missed.

Teach:

*Review: write each fraction in lowest terms: 6/12, 4/10, 20/60

*Directly teach: A ratio is a comparison of two quantities. For example, (give the # of boys to the # of girls in the class) 5 boys to 10 girls is written: 5:10, 5 to 10, or 5/10.

*Let a volunteer think of another ratio. Have a different student write it on the board. Show of hands with thumbs up of who thinks the ratio was written correctly... then a show of hands with a thumbs down of who thinks it was written incorrectly. (**BODY ANSWERS)

*Give all students a cardboard coaster. Set the coaster on your desk, letting part of the coaster be off of the desk- enough of it on the desk so it does not fall to the floor. With the back of your fingers, come up under the coaster, flipping it and try to catch it in the air. Try this 10 times and write your attempts as the ratio of the number of times you caught the coaster to the number of times you missed the coaster. Have one student demonstrate 10 flips and then write the ratio on the board.

MORE IDEAS FOR THIS LESSON:
Ask-How can I involve the whole body/ hands-on learning/ drama/ dance/ sports/ tactile activities/drawing/ kinesthetic imagery/ body answers?

**MANIPULATIVES: Give groups of students (or individuals) two different quantities of colored items. Have each group (or individual) write as many ratios comparing the different colored objects as possible.

**KINESTHETIC IMAGERY: Suppose you run around a pond three and a half times. The only problem is, there is a log in the way on one side of the pond and a turtle on the other side, both of which will not move, so you have to jump over them. Write a ratio that expresses the number of times you have to jump over the turtle to the number of times you jump over the log. (Answer depends on where you start and which direction you go!) If it is helpful, draw a picture to show your path around the pond.

Chapter Summary

This chapter includes the teacher handbook of bodily-kinesthetic teaching strategies that can be used with any lesson. This handbook is intended for all levels of mathematics teachers and for teachers of all subjects, but with focus on and examples for how to enhance middle school mathematics lessons. Chapter 5 provides critiques from four colleagues through formal feedback and suggestions for further research. Each colleague was given a copy of the handbook and asked to review it for clarity, ease of use, and desirability to use the strategies listed. The reviewers provided formal feedback via a questionnaire designed specifically for this project.

Chapter 5

DISCUSSION

Since the time that the Alfred Binet IQ test was invented to identify students who may struggle in school, the idea of what makes a person smart has been defined by having a logical-mathematical intelligence and linguistic intelligence. Also, research indicates that teachers teach with the use of methods that cater to these two intelligences. However, research also indicates that there are many avenues to knowledge, such as kinesthetic ways. Teaching styles and methods have changed with the knowledge from research, the knowledge that the use of kinesthetic teaching methods can help some students learn better than the use of traditional teaching methods.

Schooling is suppose to prepare children for adult life. However, success in school is not a prerequisite to have a successful life. Nor would everyone who did poorly in school describe themselves as a failure in life. Traditional teaching methods are not ideal for every student. The purpose of this research project, the handbook of bodily-kinesthetic teaching strategies for mathematics teachers, is to give practical instructions about how to incorporate these strategies into daily lesson planning and classroom life, and more importantly, that teachers understand how to give students more options to avenues of learning. The handbook is not meant to replace all teaching practices. The handbook offers a plethora of ideas of how to incorporate strategies, some that take up no time at all, like to have a student sit on a ball during note-taking, to other strategies that

direct an entire lesson, such as math basketball. This author's hope is that the handbook offers realistic, research-based solutions, to problems such as high dropout rates, boredom, and low motivation in school.

Contribution of the Project

This author's hypothesis was wrong, that bodily-kinesthetic teaching strategies are left out of today's mathematics textbooks. However, research indicates that these strategies are not put to use regularly; that lecture, drill, and practice continue to be the main strategies used by mathematics teachers. Many teachers were taught with the use of traditional teaching strategies and therefore also use these strategies. Just because bodily-kinesthetic strategies are written in textbooks, does not ensure that teachers will use them or feel comfortable incorporating these ideas in their teaching. The handbook provides a concise list of ways to easily incorporate bodily-kinesthetic teaching strategies into any lesson, including a bodily-kinesthetic resource center, as well as ideas for individuals and whole classroom instruction.

Limitations

One limitation of this project has to do with textbooks. By looking at mathematics textbooks, page by page, it is verifiable that bodily-kinesthetic strategies have been a recent addition to both traditional and reform curricula. However, it is impossible to know the most used and most effective teaching strategies of every middle school mathematics teacher across America. The next question is, whatever strategies teachers use, do they work? Strategies are not used in isolation, so it is hard to verify why a student is successful. As schooling is an incredibly dynamic process over the

course of 12 years for children, with so many factors that effect the process, there are no clear answers. Lastly,many school districts decide which curriculum schools must use and have guidelines to be followed that make it impossible for a teacher to try these bodily-kinesthetic teaching strategies.

Peer Assessment Results

Experts in the field of education were asked to review the Chapter 4 handbook and provide feedback. The professionals included two middle school mathematics teachers, one professional development director, and one pediatric occupational therapist. The following is a summary of their comments.

Mathematics teacher number one, has five years experience teaching middle school mathematics that followed his engineering career, and would describe his teaching philosophy as half essentialist and half perennialist. He believes that motivation on the part of the student and the teacher is vital, and that diagnosing poor student performance as categorized by the intelligences is probably one of the few ways a teacher can instill motivation in a student. The criticism this teacher had with the handbook was that it failed to identify what assessments would point a teacher toward bodily-kinesthetic methods. My response is that each teacher must decide what each student needs. When a child is put on an Individualized Education Plan (IEP), teams of teachers are a part of the process to decide what strategies to use. The handbook was not meant to assist in assessment, but perhaps a second handbook is needed that discusses behaviors and assessments that indicate when the use of bodily-kinesthetic strategies would be useful. It is this author's opinion that there is a wide range of answers to "when" to use these

strategies, from individual strategies to whole class, and to use as a change of pace in order to alleviate boredom, or to address actual diagnosed bodily-kinesthetic needs for certain students. He said he would recommend and use these strategies but was not specific about which ones. He said it was clear and easy to understand. Overall, he thought the handbook could be very useful for teachers.

Mathematics teacher number two, who has worked at a charter school for 12 years, firmly believes in direct teaching, drill, and practice. She thought this handbook could be useful in certain circumstances, but not daily in the mathematics classroom. She would consider using the math basketball game or the math bingo as a review method, and that she occasionally has a student that needs to stand in the back of the room. She felt that most of the other strategies would take up too much time and distract from learning. She believes that time in class for individual practice is the most beneficial use of class time.

The professional development director has been in her field for 18 years. Her convictions about education today are that students should not sit in the classroom passively, and that more kinesthetic learning strategies should be in classrooms, especially mathematics classrooms. Her personal journey through school was dominated by lecture in mathematics class; there were no hands-on options. She says that in her high school years, one teacher would hand out the test and say to her as she put the test on her desk, "Good night Mary Beth," as Mary Beth would then fall asleep until the period was over, obviously failing the test. This teacher simply lectured and did not offer another way for students to learn. Both the teacher and the student gave up. With more options, maybe less teachers and students would give up. This reviewer was intrigued as

she thought many of the ideas presented would have helped her in school. She would have welcomed any of the ideas as a young student. Her criticism about the handbook was the lack of a way to assess learning styles.

The last reviewer was Mrs. MacNeil, a pediatric occupational therapist of 10 years. Everyday in classrooms, she tries to convince teachers that movement is important for optimal learning. Though she focuses on children with autism, she says that sensory needs are real for everyone, even adults. "Some adults get tired and then get a coffee." However, in children, meeting sensory needs through motion, particularly the proprioception, vestibular, and somatosensory systems, provides an important foundation for learning and behavior. She says that children need to prepare their bodies for learning, that they often feel too excited or too sleepy and exercise can bring them back to a mid-level energy that leads to a higher level of cognitive functioning. Mrs. MacNeil said that chapter four, Bodily-Kinesthetic Resource Center, of the handbook could be very useful to teachers, except that most teachers do not believe that these resources really help students. In fact, some of these are the exact items Mrs. MacNeil uses with her autistic students and she explained that children without autism could also benefit from these strategies.

Recommendations for Further Development

Since Gardner's theory, teaching methods have changed and entire schools have been created around his new definition of intelligence. This author's recommendation for further development in the area of bodily-kinesthetic teaching strategies is to directly ask those who have been taught in this way. One way to understand the impact of different

teaching techniques would be to conduct interviews of college students, professionals, and adults who went through a K-12 education program that included bodily-kinesthetic teaching strategies. Through conversations with the adults who experienced bodily-kinesthetic teaching strategies, it is possible to find out first hand if their schooling was a pleasurable experience, successful experience, what career path they chose and why, and if they are happy and successful adults now.

Project Summary

The purpose of this project was to develop a resource handbook of under-utilized, yet effective bodily-kinesthetic teaching strategies that can be integrated with any mathematics textbook and with any lesson. The handbook lists many teaching strategy options in a clear, direct, practical and usable way for teachers to accommodate students who could benefit from a more active and engaging classroom.

We are in a unique time in history in that we are able to define which teaching strategies are most effective by the use of research. Research indicates that bodily-kinesthetic strategies are effective, and those who write mathematic curricula seem to agree as all five curricula, reviewed by this author, list hundreds of bodily-kinesthetic teaching strategies. How often teachers today use these strategies is still in question. If educators are to accept that the idea of intelligence is not limited to only linguistic and mathematical, then schooling and teaching practices must incorporate new, research-based ideas. Also, according to Gardner (1991), the fact is that educational reform is a very difficult transition to make because it requires teacher training, teacher dedication, and teacher belief in a new philosophy.

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APPENDIX A

Descriptions of Gardner's MI

Table 1
The Seven Intelligences Described

Intelligence	Description
Linguistic	The ability to use words effectively, whether orally or in writing. Exemplified in: T. S. Elliot
Musical	The ability to discriminate, transform, and express musical forms. Exemplified in: Mozart
Logical-Mathematical	Ability to perform mathematical calculations, think logically, use scientific thinking and deduction, problem solve, and detect patterns. Exemplified in: Winner of the Nobel Prize in Medicine
Spatial	The ability to perceive a mental model of a spatial world accurately and be able to operate using those perceptions. Examples: sailors, engineers, surgeons, sculptors, painters, athletes
Bodily-Kinesthetic	Ability to use one's body to express ideas and emotions, to solve problems or to fashion products. Examples: Dancers, athletes, surgeons, inventors
Interpersonal	The ability to understand and perceive other people, to notice distinctions among people in their moods, intentions, motivations, and feelings. Examples: Politicians, teachers, religious leaders, therapists, parents

Intelligence	Description
Intrapersonal	Self-knowledge, self-understanding, having an accurate picture of oneself (one's strengths and limitations), awareness of feelings and emotions, and able to use this information to understand and guide one's own behavior.

Note. From *Multiple Intelligences The Theory in Practice*, by H. Gardner, 1993, New York: Basic.

Table 2
Eight Ways of Learning

Children who are highly:	THINK	LOVE	NEED
Linguistic	in words	reading, writing, telling stories, playing word games	books, tapes, writing tools, paper, diaries, dialogue, debate, stories
Musical	via rhythms and melodies	singing, whistling, humming, tapping feet and hands, listening	music playing at home and school, musical instruments
Logical-Mathematical	by reasoning	experimenting, questioning, figuring out logical puzzles, calculating	materials to experiment with, manipulatives, field trips
Spatial	in images and pictures	designing, drawing, visualizing, doodling	art, LEGOs, video, movies, mazes, imagination games
Bodily-Kinesthetic	through somatic sensations	dancing, running, jumping, building, touching, gesturing	role play, drama, movement, things to build, sports, hands-on learning

Children who are highly:	THINK	LOVE	NEED
Interpersonal	by bouncing ideas off other people	leading, organizing, relating, manipulating, mediating, partying	clubs, group games, friends, mentors, social gatherings
Intrapersonal	in relation to their needs, feeling, and goals	setting goals, dreaming, planning, reflecting, meditating	secret places, time alone, self-paced projects, choices
Naturalist	Through nature and natural forms	playing with pets, gardening investigating nature, raising animals, caring for planet earth	access to nature, opportunities for interacting with animals, tools for investigating nature (e.g., magnifying glass, binoculars)

Note. From *MultipleIntelligences in the Classroom*, 2nd ed., by T. Armstrong, 2000, p. 22. Alexandria, VA: ASCD. Copyright 2000 by Thomas Armstrong. Adapted with permission of the author. See Appendix C for permission.

Table 3
Summary of the Eight Ways of Teaching

Intelligence	Teaching Activities (examples)	Instructional Strategies
Linguistic	lectures, discussions, word games, storytelling, choral reading, journal writing	read about it, write about it, talk about it, listen to it
Musical	rhythmic learnings, rapping, using songs that teach	sing it, rap it, listen to it
Logical-Mathematical	brain teasers, problem solving, science experiments, mental calculation, number games, critical thinking	quantify it, think critically about it, put it in a logical framework, experiment with it
Spatial	visual presentations, art activities, imagination games, mind-mapping, metaphor, visualization	see it, draw it, visualize it, color it, mind-map it
Bodily-Kinesthetic	hands-on learning, drama, dance, sports that teach, tactile activities, relaxation exercises	build it, act it out, touch it, get a "gut feeling" of it, dance it
Interpersonal	cooperative learning, peer tutoring, community involvement, simulations	teach it, collaborate on it, interact with respect to it
Intrapersonal	independent study, options in course of study, self-esteem building	connect it to your personal life, reflect on it

Intelligence	Teaching Activities (examples)	Instructional Strategies
Naturalistic	nature study, ecological awareness, care of animals	connect it to living things and natural phenomena

Note. From *MultipleIntelligences in the Classroom*, 2nd ed., by T. Armstrong, 2000, p. 41. Alexandria, VA: ASCD. Copyright 2000 by Thomas Armstrong. Adapted with permission of the author. See Appendix C for permission.

APPENDIX B

ASCD Permission

Permission to use Armstrong work in Thesis
Gleason, Janie

Sent:
Tuesday, April 27, 2010 9:52 AM
To:
permissions@ascd.org

Hello ASCD Permissions People,

I am a student at Regis University here in sunny Denver, Colorado. I am writing my thesis on Gardner's MI (the Bodily-Kinesthetic is highlighted) teaching strategies in middle school mathematics classrooms. I am requesting to use two of Armstrong's tables in his book, MultipleIntelligences in the Classroom, 2nd ed., 2000. One table is on page 41 called Eight ways of teaching, and the other is on page 22 - Eight ways of learning.

Thank you for the use of his tables. I believe they outline important information that all secondary school teachers should be exposed to and understand.

Thank you Thomas Armstrong!

Sincerely,
Janie Brown-Salazar

May 10, 2010

Dear Janie:

In response to your request below, ASCD is pleased to grant you permission to include the content from two of the tables from our publication *Multiple Intelligences in the Classroom, 2nd edition* in your forthcoming dissertation. Permission is limited to your use as described in your email of April 27th below, and does not include the right (a) to grant others permission to photocopy or otherwise reproduce the Material, nor (b) to reproduce the Material in digital, electronic, or any other media.

No fee is required for this use, however, permission is granted upon the condition that every copy of your work include a proper reference or citations with the excerpts.
We would appreciate your acknowledging the above by return email.
Once again, thank you for your interest in ASCD publications and good luck with your dissertation.

Sincerely yours,
Katy Wogec
ASCD Rights & Permissions Manager

Appendix C
Questionnaire for Evaluators

Date:
Name of Evaluator:
Occupation:

1. How many years of experience have you had in your occupation?
2. What are a couple of your main convictions in your philosophy of education?
3. What is your first impression of this handbook?
4. Would you consider using any of the ideas in your classroom?If so, Which ones?
5. Would you recommend any of the ideas in this handbook to others?If so, which ones?
6. Are the ideas and examples in this handbook clear and easy to understand?
7. Do you have any questions regarding this handbook?
8. What ways would you improve this handbook?
9. Is there any thing further you would like to say about this handbook?

Answering below, please use as much or as little space as you would like to answer these questions. Thank you so much for your time in reading my handbook and answering these questions. I welcome any comments you have. Your perspective and insight are appreciated. Once again, thank you for taking this time.