DANCE INTEGRATION INTO A SIXTH-GRADE SCIENCE CURRICULUM

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DANCE INTEGRATION INTO A SIXTH-GRADE SCIENCE CURRICULUM

A Project

by

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Abstract

of

DANCE INTEGRATION INTO A SIXTH-GRADE SCIENCE CURRICULUM

by

Dimitri Masters

A sixth-grade science curriculum was developed for the California State Content standards 6.0 a-g, concerning the geologic processes responsible for the movement and features of the earth, all using dance integration as the primary teaching strategy. It was the aim of this project to use dance integration as an alternative to the text and worksheet model, previously the primary method for teaching science. Dance provided the author with another tool for expressing and meeting California’s science standards because it promoted embodied knowing. It allowed embodied knowing to occur through repetitive physical movement with an assigned meaning attached. As a result, this strategy provided students with the opportunity to make emotional connections to the scientific material they were learning, employ a unique study strategy, and gain conceptual understanding for the scientific phenomena about which they were learning. The author witnessed student achievement increase in the subject area of science, demonstrated by students’ proper use of academic language related to plate boundaries, their ability to infer and deduce what geologic process was occurring based on observable physical traits, and students excitedly providing the feedback that they “got” the concept. For one
student on the Autism spectrum, dance became the key to working through his verbal communication barriers.

__________________________________, Committee Chair
Elisa Michals, Ph. D.

__________________________________
Date
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Chapter 1

INTRODUCTION

Purpose

The purpose of this project was to provide educators with a user-friendly curriculum integrating dance with the California Earth Science Standards. Through dance integration, the educator met the needs of the diverse student population, particularly, the kinesthetic learner. The curriculum focused on the exploration of how body movement through dance can be used as a means to aid student retention, transference, and synthesis of new information, while also providing students with details of scientific phenomena. The 10 lessons in the chapter titled “Project” were formatted to be read and carried out like an actor’s script. Each lesson’s movement sequence started with the individual then built to group movement sequences that were more complex and detailed representations of the earth’s processes. Lessons built from individual to group so the instructor could monitor the students’ responses, degrees of comfort, and movement quality. This monitoring allowed the educator to adjust instruction to student readiness so student success in small groups could be increased. Moving from the individual movement to group also showed students what movements could be practiced in their free time, which increased their opportunity for retention. Each lesson satisfied a science content standard, identified in Appendix A.

The Problem

California’s current curriculum does not include material for the kinesthetic learner. Hutton (2006) described how “Oftentimes, kinesthetic learners feel their way of
learning is not as good because they just ‘can’t sit and do the work’” (para. 3).

Kinesthetic learners learn best through movement and touch. Jensen (2004) claimed, “many educators are reducing physical activity time at schools because of the time constraints and pressures related to the federal act No Child Left Behind” (p. 37). No Child Left Behind (NCLB) is the federal act effective 2001 making schools accountable for ensuring all students make substantial academic gains in relation to state and federal standards. Measurements of success are determined by annually testing students beginning in the second grade. NCLB requires the “National Assessment of Educational Progress (NAEP) reading and mathematics tests to be administered to a sample of fourth and eighth graders in each state every other year in order to make cross-state comparisons…Finally, states must issue annual report cards for schools and districts” (Greatschools.org, 2010, para. 2).

In response to NCLB, many school districts adopted a single curriculum to be employed by all instructors. Districts adopting a prefabricated curriculum have one goal, increasing test scores. The Academic Performance Index (API) “is the cornerstone of the state’s academic accountability requirements […]. A school's API is a composite number representing the results of these [CSTs, CMA, and CAPA] tests” (California Department of Education, 2010, pp. 1, 3). Since reading and mathematics are part of each testing cycle, what has emerged can be described as a “teach-to-the-test” scripted curriculum with the emphasis on reading and mathematics. “State and national testing has lead to a nation that is trying to ‘cover material for the test’ instead of making sure students understand before moving on” (Walker Tilestone, 2004, p. 7). Taught from the text and
measured by the completion of corresponding worksheets, students no longer experienced a rich and individualized curriculum designed to meet their specific learning needs.

Historically, the classroom has been structured for lecturing on the part of educators and listening on the part of students. Burrill (2005) expanded on this point in describing how the American Industrial Revolution permanently influenced and reshaped the American educational system by causing it to be:

- Designed to train the average child in the explicit skills of reading, writing, and arithmetic. [The educational system was] also meant to train behavior and bodies for long hours and of static and non-relational engagement with machines that was non-spontaneous, non-creative, and non-imaginative. (p. 32)

The educational system never broke from this ideological frame that holds the expectation of shaping individuals who can perform as productive and contributing members of society. Although the means of production and what it means to contribute has changed with the culture and advancements in technology, the expectation remains as reflected in NCLB, which requires testing students on reading, writing, and arithmetic.

To further complicate classroom learning, during the 1980s, California’s educational systems endured a series of budgets cuts. In part, this lead to increased class sizes causing student numbers to rise from the mid-20s to the mid-30s (O’Connell, 2009). The state-mandated minimum classroom size of 960 square feet is now crammed with desks, computers, reading centers, class libraries, and storage affording even less student space.
Environments are perceived by each individual and have both physiological and psychological impacts (Campbell, Campbell, & Dickinson, 2004).

When students were expected to sit and fill in blanks, they were not receiving the opportunity to acquire information in multiple modalities. Without the opportunity to move and receive lessons taught through movement, kinesthetic learners failed to see themselves in the curriculum. Over time, when they fail to see themselves in the curriculum, students disengage with the subject matter and the learning process (Belenky, Clinchy, Goldberger, & Tarule, 1986). The lack of connected knowing and seeing self in the curriculum demonstrates how kinesthetic learners are not having their educational, emotional, and developmental needs met. The classroom structure further exacerbates the exclusion of kinesthetic learners by literally not allowing movement. Because the kinesthetic learner has been pushed to the fringe of the classroom, the physiological and psychological message educators are sending them is that there is no room for them.

Most educators fail to meet the needs of kinesthetic learners because they lack pedagogical strategies and knowhow for educating this type of learner. Sinatra (1982) found:

While many conceptual models of the language arts clearly indicate that the oral and written language systems have their roots in nonverbal experience, few educators seem to acknowledge or capitalize on this implication in presenting nonverbal forms and structures to language-deficient students who could benefit from their use. (p. 204)
Often educators can identify that language learning has a nonverbal and physical aspect, but few understand what teaching strategies to employ or how students can use the body effectively to meet their needs. Many educators themselves were taught solely through strategies that met the needs of visual and auditory learners, such as lecture and written projects. For educators to buy into this integrated curriculum, we must address the specific needs of the adult learner before addressing those of the child learner.

Budget cuts to the California State University system have led prospective teachers, such as those at California State University, Sacramento (CSUS), to lose the opportunity to explore avenues of personal interest straying from the prescribed major graduation requirements. The 2006-2011 CSUS course catalogs offered no dance courses specifically geared at liberal studies majors or teacher credential candidates. The catalogs showed offerings for kinesiology courses aimed at educators with an emphasis on physical education standards; however, dance as presented in such a class is a means to meet physical education requirements. It was not presented as a teaching strategy that can be integrated into other core areas. For example, Kinesiology 172 was the only movement class required of liberal studies majors and the catalog description for that class was:

Examination of activities and theoretical concepts that relate to the physical, social, emotional and intellectual development of the individual. Content includes: health-related physical fitness, movement concepts, stability, locomotor and manipulative skills, rhythms and dance, gymnastics, games and sport activities. (California State University, Sacramento, 2010, para. 1)
Those in the field of education or entering the field of education were not afforded the opportunity to learn dance as a teaching strategy and, therefore, will probably not integrate it into their own lesson plans.

In the Two-Semester Credentialing Program, the arts requirement was met during a weekend seminar called the “Arts Fair” where vendors and guest speakers hosted workshops for teachers and teachers in training. Due to budget cuts at CSUS, this program was also eliminated, further showing the low priority of the arts in education. One weekend in the arts was not sufficient to build the body of knowledge for successful arts integration and movement integration, but at least it was something; now educators are even more unprepared.

Educators were not learning dance as a teaching strategy in their undergraduate work or as an arts medium in their credentialing programs. Campbell et al. (2004) observed in their study of three campuses trying to integrate the arts and theory of Multiple Intelligences, “often teachers are uncomfortable using movement in the classroom. This may be because they do not perceive the value of physical activity,[…] or they are simply unfamiliar with the process” (p. 73). To overcome the fears and negative perceptions of physical activity and dance in the classroom, educators need training in dance. Educators need a time in their teacher training programs when they can discuss their fears and explore their own movement; and they need time to ease into the development of their own use of dance techniques and strategies in their teaching with a supervisor who can provide meaningful feedback.
California’s students were also failing to perform in the area of academic language. Academic language is the language specific to a discipline and differs from spoken language in its formality. Kuehn (2003) found, “[m]any students who speak English well have trouble comprehending…academic language…Low academic language skills have been shown to be associated with low academic performance in a variety of educational settings” (para. 1). It is important to stress that the failure of academic language mastery occurs across classes and race and is not a limitation solely of second language learners. All students, including native English learners, are showing low-level performance in academic language. “No one is born with the ability to use academic language; it is a second language for everyone” (Mota-Altman, 2006, para. 6). The ramifications of a lack of academic language skills are most clearly demonstrated on standardized tests because the language of the test can inhibit students from correctly answering questions. Students who do not understand the language of the test or who lack the skills needed to break down words and phrases may fail to make the correct choice because they do not know what is being asked of them, or even if they do, because they lack language skills to find an appropriate response that represents their understanding.

The Significance

The significance of this project is that it used dance as a teaching strategy for science curriculum. In the past, dance was primarily integrated into history lessons through teaching the social dances specific to the period of study. Dance was used as an add-on to lessons, never as the means of teaching a new concept. Science lessons were
usually taught through text and worksheets and labs in districts that could afford them. Not every district or every classroom could teach science because of the reliance on costly materials. By reducing the need for outside materials through using the tool of the body, educators can increase their science teaching. The main element of this project was the exploration of how the body can be used as a means for grasping academic language and serve as a memory aid while also concretely providing students details of a scientific phenomenon.

Dance as a teaching strategy aids memory and process development because it allows students to rehearse and practice new material. As Wolfe (2001) stated, “without rehearsal or constant attention, information remains in working memory for only about 15-20 seconds” (p. 95) after which this information is discarded. Dance is choreographed steps with meaning attached; by having students repeat the physical movement, they are gaining a rehearsal method. Through repeated rehearsals, students created a neurological map for the learned information, thus committing it to their long-term memory. The 10 lessons found in Appendix A were crafted coupling academic language with specific movement that break down the scientific process the word or phrases describe. Each lesson provides a specific movement-meaning relationship by which students can rehearse and build memory.

The lessons also take into consideration the learning needs of educators who may be apprehensive of embarking on the journey of relearning scientific topics through the dance integrated approach. The lessons are followed by assessments and rubrics (see Appendix B). Because most educators lack formal training in dance integration, they too
need to be taught how to use their bodies to relate abstract scientific phenomena. For the educator, each lesson is accompanied by a chapter of the DVD (see Appendix C) showing the author demonstrating the movement and breaking down its importance to understanding the scientific process. Thus, each lesson is structured to meet the unique needs of the adult learner, the educator, by applying the basic principles of androgogy:

Adults need to know why they need to learn something, adults need to learn experientially, adults approach learning as problem-solving, and adults learn best when the topic is of immediate value. (Knowles, Elwood, & Swanson, 2005, p. 79)

If educators are to adopt the provided lessons into their curriculum, they need to understand how to use dance themselves. Dance integration is foreign to many educators because they lack experience and formal training. They need more support and opportunities for experiential learning, thus, the video component.

The Limitations

Limitations to this project follow:

- The lessons were not piloted with a working sixth-grade class.
- No pre- or post-test was employed to evaluate whether dance integration enhanced comprehension and retention for students relating to California Earth science content standards.
- This curriculum came to fruition in a time when the arts were undervalued in schools and by policymakers.
• Educators are reluctant to stray from adopted curriculum for fear of backlash by administrators and decreased test scores.

• Scores reported as part of API force schools to prioritize increasing student test scores over the learning process.

• That which is not tested is ignored as part of the curriculum.

• Teachers lack confidence in their own ability to use and teach movement.

• There is an increased dependency on Physical Education Specialists to ensure students are getting the mandated minutes of physical education.

• The definition and application of the term “embodied knowing” differs amongst fields of study such as neuroscience and linguistics.

Definition of Terms and Phrases

Academic Language

Kuehn (2003) defined academic language as:

“Academic language is the language used in textbooks, in classrooms, and on tests. It is different in structure and vocabulary from the everyday spoken English of social interactions” (para. 1).

Dance

For the purpose of this project, dance is a choreographed sequence of movement with meaning attached.
Dance Integration

Incorporating dance into other areas of study such as English, History, and Mathematics.

Embodied knowing

To “personify something; to express or exemplify something abstract in bodily form” (embodied knowing, 2010).

Learning Styles

Refers to the style or mode in which the brain “works most efficiently to learn new information” (Jester & Miller, 2000, para. 1). Learning styles fall into four broad categories: the Visual/Verbal Learning Style, the Visual/Nonverbal Learning Style, the Tactile/Kinesthetic Learning Style, and the Auditory/Verbal Learning Style.

Study Behaviors

Behaviors the student can do to eliminate distraction and increase focus on the material being covered, such as pacing, breathing, setting up a study routine, or defining a set study space.

Study Strategies

Methods allowing for concise and purposeful studying, such as the use of mnemonics, summarizing, pre-testing, etc.
Three (3) cues

The pedagogical strategy in teaching physical education that breaks a movement down into three basic parts; attaching short verbal phrases to each of the three parts.

Organization of the Project

The literature review, found in Chapter 2, is broken into sections. Section one entitled “Embodied Knowing” concerns why we as a people dance, the function dance serves, and how meaning is constructed through dance. Section two titled “Teaching That Promotes Optimum Learning Opportunities for All” is a brief overview of the learning brain and how memory is formed in response to external stimuli. Section two also includes information on “Multiple Intelligences” describing how their influence aids learning and memory. The third and final section of the literature review is “Dance and Science,” which describes the concept and benefit of dance-integrated learning, specifically in the realm of science.

Chapter 3 on the methodology used in the development of the project lesson plans details the parts of the lesson plans, including how they meet the needs of learners, aid memory, and detail scientific phenomena. Chapter 4 presents the recommendations made by the author. Lesson plans are in Appendix A and specifically target California content standards for the sixth-grade science curriculum. Each lesson has one key concept or physical phenomenon represented by dance movement and provides instructional cues such as when to introduce a movement. Each lesson coincides with a chapter on the accompanying DVD (see Appendix C) in which the author demonstrates the full
movement and verbal cue breakdown. Throughout the literature review and the lesson plans, the needs of juvenile and adult learners are addressed in pedagogy and androgogy.
Embodied knowing is to “personify something; to express or exemplify something abstract in bodily form” (embodied knowing, 2010). Embodied knowing is using the body as the vessel for obtaining and storing information and creating knowledge. As a people, we use our bodies to move and dance. Dance is expressed in secular and non-secular forms and occurs in a myriad of cultural settings from the bedroom to the ballroom. “Dance has been called the oldest of the arts[…] [t]he human body making patterns in time and space is what makes dance unique among the arts and perhaps explains its antiquity and universality” (Peterson Royce, 2002, p. 3). In its most organic form, dance, is not limited to an elite few on point shoes; dance is for all. It “[s]imply defined,…is the human body rhythmically moving through space and time with energy or effort” (Kassing & Jay, 2003, p. 4). In order to dance, one needs nothing more than the body.

Free of outside technologies, dance can be created at any time, thus making dance the most achievable of the arts because it relies on so little to produce. It has been observed in social interactions of non-humans, such as lesser apes and bees, demonstrating the universality of the medium to express meaning to an audience and participants (Gil & De Marco, 2010). Dance springs forth when individuals have messages needing to be conveyed; it allows expression of thoughts and feelings where words may not readily be found. Consider the two-year-old who, in frustration, begins
stomping her foot and waving her arms and alternately pacing. She sets the rhythm with her stomps and though she may not be able to say with words she is upset, the message is clearly received by onlookers. Through her rhythmic movement, she states, “I am angry!” She dances.

“There is no known culture or time in history in which the pairing of music and movement was not central to social bonding and to child rearing, in routine and monumental life events” (Phillips-Silver, 2009, p. 294). Dance could have developed for early humans at the same time they were creating their initial systems for symbolic representation. Dance is a form of communication and was developed to meet the needs of the people employing it. Freeman (1999) argued that communication developed rapidly, specifically in human primates, because it promoted species survival. Communication developed through speech and gesture in an attempt to closely relate to the emotion it conveyed. For example, when danger was presented to early humans, it was necessary to react with immediacy representing the emotion of fear, and it was meant for communicating the impending danger to others. Early humans may have communicated the fear they felt through some vocalization, gesturing to others to leave, or showing a grimace on their face. Emotional expression thus emerged as a means of communication (Freeman, 1999; McNeil, 2009). From these early gestures and vocalizations, dance emerged as a more developed means of using the body to create understanding and communicate messages.

Historically and cross-culturally, dance is a means to communicate information; it is a storytelling device. Oring (1986) described narrative (storytelling) as having the
ability to capture its audience and engage them intellectually and emotionally. Dance shares narrative qualities of storytelling by communicating messages that stimulate thought and stir emotional reactions for both the viewer and dancer. Dance allows for an emotional connection linked to movement. Dunham (1947) first explored dance as a storytelling device while studying Haitian dance and the dance of other cultures comprising the West Indies. From her studies, she developed the theory of form and function, which legitimized the technique and style of African Caribbean dance in the process.

According to Dunham, dance comes in a form and serves a function to the culture employing it. In a speech, Dunham (1972) described her understanding of dance being an expression of rhythm and choreography that fulfilled a range of needs for participants that were both personal and societal. The form of dance is the literal steps, or the how of the storytelling. The function of dance occurs when the cultural and social context are applied to the dance experience (the dancing and the viewing of dance). When Dunham referred to variety she also described the function or the message of the dance story being told.

Dance functions are diverse and can occur simultaneously within a single dance, such as providing social, educational, and spiritual support and information within a single piece. Ferraro (2004) provided examples of the functions of dance within a society such as aiding in diffusing conflict; politically, by showing fidelity to leaders and a governing system; religiously, by serving as the mechanism to link with higher powers; and educationally, by transmitting information.
We gather or interpret meaning from dance depending on the cultural and social context of the dancer and the audience member. The function (meaning) is determined based on interpretations of regalia, steps, emotion, lighting, music, and all the elements of the dance. We must look at dance from the perspective of the dancer in the culture from which he/she is dancing if we are to gather the specific function of that dance performance. Peterson Royce (2002) countered that in addition to looking at the cultural context, that the dance must be evaluated for its own merits. Beyond understanding the dance from within the culture, the dance must be broken down for what it is in that moment so the meaning of dance and the story can be understood.

To clarify these explanations for reaching the intended meaning of a dance, examples from different cultures are used. The dance “Las Canacuas” is employed by the Purépecha people located in the highlands of the Mexican state of Michoacán. This dance functions in the societal realm for the Purépecha who use it to teach and symbolize their hospitality to visitors. During this dance, 12 Purépechan girls dance in parallel lines enacting an exchange of hospitality. The oldest girl leads the others through a weaving exchange of large baskets filled with flowers and fruit. By the end of the dance, the contents of each basket must be emptied symbolizing the generosity of the hosts. Through this dance, Purépechan girls are taught what should be offered to visitors, the proper way to greet and welcome visitors, and who is expected to welcome visitors (Johnston, 1935). The Purépechan societal value for hospitality is expressed and passed down by means of the dance “Las Canacuas.”
Through the theory of form and function, dance emerged as a way of achieving embodied knowing. As mentioned previously, embodied knowing is to “personify something; to express or exemplify something abstract in bodily form” (embodied knowing, 2010, para. 1). Embodied knowing is using the body as the vessel for obtaining and storing information and creating knowledge. “Knowledge is felt kinesthetically and can be accessed by listening to the body and by moving to learn” (Campbell et al., 2004, p. 73). Purépechans embody the societal value for hospitality as they dance distributing the contents of their baskets. Through the dance, Purépechan girls practice the proper way to greet and welcome visitors. Using their bodies, bowing and curtseying, they take in the abstract concept of hospitality and transmit that information to others.

For anthropologists, the concept of embodied knowing emerged when participant observation allowed them to cast aside ethnocentric views to see the knowledge of non-literate cultures demonstrated and passed down through oral and physical traditions, such as dance. Comstock (1974) explained:

Dance functions in some cultures, the non-literate cultures, with as broad a spectrum of functions as the written word includes for others…dance, in the ritual setting is a literature of the non-literate cultures. (pp. 213-214)

Dance allows for embodied knowing to occur because “movement can help…internalize what they are learning, imprinting upon their bodies the social and academic lessons of the day” (Crawford, 2004, p. 56). Through dance and the process of learning and performing the dance, students gain societal information that is then transmitted to others,
thus communicating what that culture values as worthy of passing on and preserving for future generations.

Mead (1928), in her groundbreaking ethnography *Coming of Age in Samoa*, discussed how Samoan children define their individuality through their synthesis of the messages taught to them through dance. Dance for Samoan children allowed a freedom of self-expression that was frequently denied them as a societal norm. Samoan children learned through dance to declare their expressiveness and distinguish themselves from others. Dance becomes a part of the rite of passage from childhood to adulthood as children learn through dance to show their individuality and demonstrate skill and technique. For Samoans, dance is an educational strategy by which information is passed down, then synthesized into a new product – the dance – and finally performed communicating a new message.

Many Americans do not consciously identify their use of embodied knowing or their “body’s knowing.” Unaware are they that they employ embodied knowing every day in, for example, their drive from work, which represents a great dance of motorized machinery on the stage of tar. Embodied knowing occurs as their ability to “auto pilot” and drive safely home without a conscious effort. Embodied knowing is how the body knows to ease the brake then gently accelerate out of a turn; it is the ability for the body to react and know what an appropriate response is. “Auto piloting” is an example of embodied knowing because the body had to be trained how to drive. Driving is not a skill humans have inherently such as breathing, yet, over time, the body is conditioned with practice to respond and know how to drive without much conscious effort. It is
through experience and practice, which is our body’s way of knowing, that Americans are able to intuit how to drive.

Teaching That Promotes Optimum Learning Opportunities for All

This researcher could list dozens of cultures and the dances they use to demonstrate, acquire, and retain detailed and interpreted information to illustrate the use and importance of dance. But that does not explain why dance is not being used as an educational teaching strategy in the United States. Holding to the perspective that dance is a valid means to communicate and carry knowledge, dance becomes a necessary teaching strategy. Researchers Riolama Lorenzo-Lasa, Roger I. Ideishi, and Siobhan K. Ideishi (2007), in their work with preschool aged students’ learning and movement through dance, found that “cultural arts programs that integrate motor, cognitive, social and emotional skills, provide children with layered learning experiences that deepen their repertoire of behavior and responses to the world” (Lorenzo-Lasa et al., 2007, p. 25). Teaching students with dance as the instructional strategy allowed the preschoolers in the study to have opportunities to problem solve and collaborate with each other in new and dynamic ways that differed from strictly verbally responding.

Through dance as an instructional strategy, “children connect movement, sensation, and action to self-awareness, emotional response, social interaction, and cognitive focusing and attention” (Lorenzo-Lasa et al., 2007, p. 27), which allows teaching for understanding. It encourages students to analyze, synthesize, and evaluate concepts and their work (Walker Tileston, 2004).
Teaching for understanding should be the ultimate goal of every educator, rather than just the memorization of facts, and can be achieved through dance. However, in mainstream western cultures, such as the United States and Great Britain, dance is not recognized as a valid body of knowledge and is treated as a form of entertainment (Brinson, 1991). Limiting dance to the realm of entertainment diminishes student opportunities to acquire information in a way that differed from visual and verbal strategies. The typical American classroom showcases the lack of embodied knowing in curriculum, which has primarily been reduced to textbook activities and worksheets (Crawford, 2004). California’s students and educators are faced with an educational system in which the concept of teaching for understanding includes only those lucky to be visual and verbal learners.

By stripping the educational experience of body knowing and opportunities for movement in the classroom, educators are isolating and marginalizing those who learn best through their body, kinesthetic learners. When sitting behind a desk, students are expected to be silent yet, “silent too [is] the language of the body, the world we know through our fingertips, the world we carry on weight-bearing joints, the world we hear in sudden hums and giggles” (Grumet, 1988, p. xv). Lack of opportunities for embodied knowing leads kinesthetic learners to no longer see their needs reflected in the material they are learning. When students do not connect or relate in meaningful ways with the material they are being taught, they become disenfranchised and may, over time, disengage with the subject matter and the learning process (Belenky et al., 1986). The lack of connected knowing and seeing self in the curriculum demonstrates how
kinesthetic learners are not having their educational, emotional, and developmental needs met.

Brain-based Education

Eric Jensen (2004) described brain-based education as the “engagement of strategies based on principles derived from an understanding of the brain” (p. 4). Through the brain-based perspective, educators develop an understanding of how to create conditions in which the brain works best. By building knowledge on how the brain learns best and the contributions to brain functioning that movement provides, educators will be able to facilitate and foster an educational community in which all learners are having their needs met. The brain is a sensory response system, meaning that through the five senses, stimuli are absorbed causing the brain to respond. According to Sousa (1995), the brain takes in 40,000 fragments of information per second through the senses. Information is acquired through the senses and sorted by its corresponding cortex (Walker Tileston, 2004). Regardless of environmental interaction, the brain is designed to react to outer stimuli for the purpose of processing and motor control (Wilson, 2002).

Each brain is unique. Though the basic parts and functions of the brain are the same, each person responds to stimuli in his/her unique way. Some people respond more to aural stimuli, some to tactile stimuli, and others to visual stimuli.

The brain learns first through the senses, the messages the body receives through touching, tasting, smelling, seeing, and listening. Educators deny students of these basic learning experiences when they rely on scripted curriculum that keeps students behind desks. “Intelligence in the abstract is a concept that arises from human experience, from
what we see, hear, and feel” (Itzkoff, 1987, p. 192). Students must be afforded experiences in the classroom that stimulate and engage the senses because that allows for optimum learning opportunities and the fostering of intelligence.

**Learning through the Senses**

Based on the types of stimuli to which an individual more strongly responds, that person is said to be auditory, kinesthetic, or visual. Kolb (1984) referred to learning style as the favored way in which a person takes in stimuli and discerns meaning from it. Learning theory is the umbrella for which explanations for how individuals best acquire new information can be found. Keefe (1982) continued that learning styles “are hypothetical constructs that help explain the learning (and teaching) process” (p. 44).

This theory proposes that new information is inputted by means of a preferred form of response to external stimuli. Based on learning theory, an individual is then identified as an auditory learner, visual learner, or kinesthetic learner. These are not mutually exclusive categories into which a person falls, but a way of understanding how each brain is different and responds via the senses to stimuli. Table 1 by Sprenger (2003) illustrates the relationships between different sensory perception patterns, sensory processing, and the characteristics these relationships can produce.
### Table 1

**Perceptual Patterns**

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Preference</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual-Auditory-Kinesthetic</td>
<td>1. Seeing &amp; Showing</td>
<td>Read &amp; tell stories; good eye contact; can sit still for long periods; shies away from sports</td>
</tr>
<tr>
<td>Auditory</td>
<td>2. Hearing &amp; Saying</td>
<td>Good eye contact; neat; speaks with hands; shies away from public speaking</td>
</tr>
<tr>
<td></td>
<td>3. Experiencing &amp; Doing</td>
<td></td>
</tr>
<tr>
<td>Auditory-Kinesthetic-Visual</td>
<td>1. Seeing &amp; Showing</td>
<td>Very verbal; high energy; good vocabulary; learns with language; learns with discussion &amp; lecture; often interrupts; little eye contact.</td>
</tr>
<tr>
<td></td>
<td>2. Experiencing &amp; Doing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Hearing &amp; Saying</td>
<td></td>
</tr>
<tr>
<td>Auditory-Visual-Kinesthetic</td>
<td>1. Hearing &amp; Saying</td>
<td>Very verbal; good vocabulary; learns through discussion &amp; lecture; may learn through reading; maintains eye contact</td>
</tr>
<tr>
<td></td>
<td>2. Seeing &amp; Showing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Experiencing &amp; Doing</td>
<td></td>
</tr>
</tbody>
</table>
The ways in which an individual responds to stimuli hold significance when that information arrives at the brain’s reticular activation system (RAS). RAS sifts through incoming stimuli and flags what information should be the focus. If an individual is receiving stimuli in a way to which they do not naturally respond, his/her RAS may discard a message that should have been kept. The consequences for preferring one form of stimuli is that the brain may sort out information that should be stored, never holding it so it can be committed to long-term memory (Walker Tileston, 2004). This impacts learning in that a teacher may conduct a lesson in a way that favors one type of stimuli, such as auditory, and miss the students more attuned to visual and kinesthetic stimuli.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Preference</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesthetic- Visual- Auditory</td>
<td>1. Experiencing &amp; Doing</td>
<td>Learns through hands-on; gives eye contact; good at sports;</td>
</tr>
<tr>
<td></td>
<td>2. Seeing &amp; Showing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Hearing &amp; Saying</td>
<td>difficulty with oral reading &amp; reports; difficulty with expressing feelings verbally</td>
</tr>
<tr>
<td>Kinesthetic- Auditory - Visual</td>
<td>1. Experiencing &amp; Doing</td>
<td>Learns physically, or through hands-on ; difficulty sitting still;</td>
</tr>
<tr>
<td></td>
<td>2. Hearing &amp; Saying</td>
<td>good at teaching activities; good at sports</td>
</tr>
</tbody>
</table>

(Sprenger, 2003, p. 39)
Educators understanding RAS could take the brain-based approach to their lessons and ensure the content was presented in auditory, visual, and kinesthetic modalities.

Dance invigorates the senses in all three preferred stimulus modalities: aurally to create the rhythm or chanting phrases of meaning; visually, in watching how peers use their bodies and how, as a class the sequence of movement comes together; and kinesthetically by using the whole body. This achieves embodied knowing because of the way the brain breaks down incoming information. When more areas of the brain are activated through sensory stimulus such as moving, singing, and viewing simultaneously, the RAS is rapidly sorting and coming across the same information in new forms, flagging the information with more frequency and holding it so it can then be committed to long-term memory.

“Movement is a sensory experience. Visual, auditory, and kinesthetic senses are key sensations in movement through dance. These sensory skills facilitate awareness of response and reactivity to different conditions for the participant” (Loenzo-Lasa et al., p. 28). Although an individual’s brain may favor a form of stimuli, the brain is not fixed nor can it reach a full capacity. The brain is said to have plasticity or is undergoing perpetual change due to its reaction to stimulus and use (McNeil, 2009). To create neurological connections and grooves on the surface of the brain, dynamic stimuli need to be in varying forms so information is keyed in on in new ways.

Dance as a teaching strategy promotes retention and process development because it allows students to rehearse and practice new material. Wolfe stated (2001), “without rehearsal or constant attention, information remains in working memory for only about
15-20 seconds” (p. 95) after which this information is discarded. By teaching choreographed steps with meaning attached, and having students repeat the steps, they are gaining a rehearsal method. Through repeated rehearsal, students create a neurological map for the learned information, thus committing it to their long-term memory.

*Physical Activity and Positive Emotions*

Jensen (2004) proposed at least four basic positive outcomes of physical activity on the brain:

1. Enhanced circulation
2. Increased production of nerve growth factor
3. Production of dopamine
4. Production of new brain cells

The significance of increasing dopamine levels is that dopamine signals brain processes that govern movement, emotional response, and the ability to register incoming stimuli as pleasurable or painful. When higher amounts of dopamine are being produced, the individual receives emotional responses that signal pleasure (Walker Tileston, 2004). When students find learning experiences pleasurable, they are going to want to repeat the experience because it makes them feel good. This benefits the educational experience as a whole by improving the very function of the students’ brains.

Wolfe (2001) continued, “the brain is biologically programmed to attend first to information that has a strong emotional content” (p. 87). The brain is biologically programmed to respond to emotion because the thalamus (receives incoming stimuli and
relays it to other areas of the brain for further sorting) and amygdala (located in the temporal lobe associated with emotional response) are linked by a single synapse, meaning that the path information must travel is very short (LeDoux, 1996). Information comes in and is emotionally reacted to before it goes to the cortex for further processing. Emotional expressions and the interpretation of those emotional expressions, impact learning as Damasio (1999) found because:

- Emotion is tied to reasoning and decision-making processes.
- One can learn to control the outward expression of emotions but cannot censor or stop emotional reaction; therefore, emotion is constantly influencing a person’s understanding of incoming messages.

Using dance to engage the body in gross repetitive movements and integrating dance into science lessons will allow students, through their increased levels of dopamine, to associate pleasurable feelings and a positive emotional response with learning science. Associating positive feelings with a subject leads to increased motivation to continue doing the activity that causes pleasure for the participant. “[I]ntrinsic motivation flourishes when people are able to satisfy their needs for competence and autonomy while doing interesting tasks” (Deci & Ryan, 2010, para. 15). If students feel practicing a physical movement that symbolically represents a scientific concept is fun or pleasurable, they are more likely to practice. Practicing helps students internalize the process and ultimately retain more information concerning the topic. Studies by Bugg, DeLosh, and McDaniel (2008) and Gurung, Weidert, and Jeske (2010) showed students need to be taught effective study strategies in order to study, and by
engaging the body, students will internalize what each motion means and relate it to a scientific phenomenon such as shifting plate boundaries.

Lorenza-Lasa et al. (2007) noted, “Children can attain a greater range of emotional feelings and cues through movement” (p. 25). Dance is loaded with emotional content because the mood the dance evokes, the style of the dance, and the physical expressiveness of the dancer’s body and face convey emotion and specific messages to the audience as they process the visual imagery they are receiving. Dance provides additional emotional connection for the student because they are the concept they are learning about. The student embodies the concept of sea floor spreading and tells the story of that process through the movement of her/his body. By being and becoming the scientific phenomena, there is an emotional connection to that scientific process. Dance is a physical, emotional, auditory, and visual process. It allows experiencing information in a way that breaks from the traditional model of lecture and note taking and improves the functioning of the brain and the experience of the learner.

Multiple Intelligences

An individual’s preferred intake of stimuli and the retention of that gathered information is only part of the puzzle to understanding how to create conditions in which the brain learns best. Educators must also have an understanding for the diverse ways in which individuals demonstrate their understanding and processing of information. The theory of multiple intelligences (Gardner, 1993) holds that intelligence is the way by which a person solves a problem. The individual develops and expresses that problem-solving strategy in a way that is of social and cultural relevance. The theory of multiple
intelligences differs from learning theory in that learning theory deals with the receiving and processing of incoming stimuli and multiple intelligence theory deals with the outward expression of how an individual has processed and created an understanding of that stimuli (Baum, Viens, & Slatin, 1999). These theories can be simplified to learning theory as the input of new information and multiple intelligence theory as the output of that information.

Gardner proposes there are seven ways of demonstrating intelligences that need to be considered in learning:

1. Linguistic intelligence (verbal);
2. Logical-mathematical intelligence (patterned, problem solving);
3. Musical intelligence (auditory);
4. Spatial intelligence (understanding space);
5. Bodily kinesthetic intelligence (learns through movement);
6. Interpersonal intelligence (learns through relating to others);

Individuals with kinesthetic intelligence produce and demonstrate their understanding best when they are able to use their body, whether it is manipulating something with their hands or acting a concept out. Those with the kinesthetic intelligence need to physically embody what they are learning in order to understand and effectively problem solve. When these individuals are limited to expressing their understanding in only verbal and auditory forms, they are not able to fully demonstrate their knowledge because those are not the mediums in which they are naturally as gifted
(Campbell et al., 2004). It is not to say that one possessing the kinesthetic intelligence is incapable of successfully writing a five-paragraph response to a question, but that the demonstration of that knowledge through the construction of a model may be met with greater ease.

Brinson (1991) outlined the spectrum of benefits for dance integration:

- Dance allows students to express themselves in unique and meaningful ways.
- Dance develops communication skills that are visual and movement-based.
- Dance is an alternative problem-solving skill and thought process.
- Dance contributes to the emotional and physical development of the student.

Using the whole body in dance allows kinesthetic learners and those with the kinesthetic intelligence to have success because they are able to function in their preferred modes of intelligence and learning style.

Dance Integration into Science Curriculum

According to the Visual and Performing Arts Standards (VAPA), beginning in kindergarten, students are to connect, apply, and integrate dance into other content areas (California Department of Education, 2001). Due to the expectation that students learn to integrate dance skills into other content areas, they must first be taught in a manner that integrates dance into curriculum. “[P]aired subjects engage the same cognitive processes: attentive observation, identification of meaningful detail, selection of appropriate representation strategies, and student and self-critique” (Rabkin & Redmond, 2006, p. 63). Pairing science and dance is effective because science should be taught through
hands-on experiential learning. With a lack of financial resources to buy labs and kits, teachers must create an alternative for students that allows for learning by doing.

Returning to the definition that dance “is the human body rhythmically moving through space and time with energy or effort” (Kassing & Jay, 2003, p. 4), the same can be said of a seismic wave. Dance and the physicality of the medium can be directly related to Earth science content standards. While speaking, humans unconsciously make small gestures and movements that relate to what they are saying (Holle & Gunter, 2007). This iconic gesturing can be exploited through the use of dance because students can say the name of the scientific process as they are dancing the movement to which it relates. Having students identify the scientific process and the term for the process through the movement of their body allows them to gain a study strategy and conceptual understanding as well as increase the likelihood they will retain the academic language associated with it.

Summary

Dance integration allows students to tell a story with their bodies describing complex concepts. Through dance, students respond to a new way of gaining external stimuli and messages that promotes the likelihood they will remember the messages they receive. This allows students to make an emotional connection to science curriculum, which can increase motivation and positive feelings in relation to science content. Dance promotes the successful incorporation of the kinesthetic learner and those with any kinesthetic intelligence by using the body to take in information and demonstrate knowledge. Retention and synthesis are key elements in determining if knowledge has
truly been attained because it requires the individual to move beyond regurgitation of facts to using that information in new and innovative ways. Students can use dance as a unique problem-solving device as well as a study strategy.
Chapter 3

METHODOLOGY

During her first semester student teaching, the author used dance integration in response to the needs of her sixth-grade students. Having worked for the CSUS Department of Theatre and Dance during her undergraduate work, as a paid and unpaid student assistant, hatter, cobbler, and costume designer, arts integration was a natural solution to many of the challenges the author faced. The class used for the project was comprised of 23 girls and four boys; two students were identified by the GATE program for academic giftedness and five students had individualized learning plans (IEP), including one student on the spectrum for autism. The students were highly verbal, interpersonal, and kinesthetic learners. The author and students bonded with one another through the extensive community building during a week-long overnight trip to science camp. All students had a great enthusiasm for learning, yet struggled with academic language as related to their science text. Students expressed a need for a more personal and direct link to their science text and for experiential learning.

Lacking the financial resources to buy kits to practice scientific concepts, the author experimented with different means of representation. Pulling upon her experience with dance and theatre, the author started to develop ways to represent concepts related to earth science through the body. When the author came to lessons covering fault lines, topographic maps were insufficient for students to memorize the academic language, specifically, the names for the processes causing geographic features about which they were learning. When students lined up in two parallel lines and did a roll off representing
sea floor spreading, the words of their text became real and relevant to them; they became
the sea floor as it spread. Through dance technique applied to science concepts, students
began to discover embodied knowing, or their body's way of knowing. As not only
phrases but movements with those phrases were repeated, the academic language that
once seemed so foreign became natural. As the students progressed through the unit
using their arms and full bodies to represent different scientific phenomena, their interest
and enthusiasm increased as did their retention of scientific academic language.

For one student, referred to as Jake, change in the method of instruction was a
source of anxiety. Jake was on the spectrum for Autism and needed routines to feel in
control because under high stress, he would shut down. Using dance to his advantage,
Jake began to employ his whole body to work through his anxiety. Instead of putting his
head down on his desk because he could not verbalize his questions, he would repeat the
physical movement of the scientific process compartmentalizing it into ways he could
verbally describe. As Jake's confidence grew with his ability to work through
communication barriers, he brought rocks from his backyard with the desire that the class
dance how they were formed. Through dance, Jake learned another way to communicate
and work through his stress.

The science period, once a source of dread, became a source of pleasure for most.
Gina, a student, would wave her arms and plead, "Ms. Masters, let’s skip to science!"
During recess, the students could be seen in small groups chanting the names of
processes and doing the accompanying dance sequences they were learning in class.
Through these experiences, the author saw a greater need for dance integration with other
content areas and a need for allowing more time during the school day for movement. Dance connected the students to the content of their science text. Spurred by students’ success and the benefit of communication gains they were able to achieve through dance, the author knew she needed to develop a curriculum for other educators to use. The author’s experience with dance integration during her student teaching left a lasting impression, inspiring her to want to explore why dance worked and how it could work for others. The author’s student teaching of dance-integrated science lessons informed the development of these lessons because it helped the author refine dance movement and expand on explanations and justifications for movement as well as when to introduce dance in relation to the scientific material.

Purpose

The project marries best practices in teaching language and science with that of dance instruction. This project is to serve as a user-friendly curriculum for educators with dance integration as the primary teaching strategy. It is the author’s intention the curriculum created for this project be used by educators, that it serve as a template for future lessons using dance as the primary teaching method, and that the learning and teaching of science is enriched and enjoyed through dance. This curriculum is attached in Appendix A.

Instruments

In developing the curriculum for this project, the author started with sixth-grade science textbooks. By reading through the progression of units in various middle school textbooks, the author gathered the similarities, noted differences, and was struck by the
lack of depth for coverage on plate tectonics. The author found that the language of the
textbooks was sterile and, though accurate, was phrased in a way that required an
understanding of the language of science. The texts were worded in a way that assumed
familiarity on the part of students to the scientific process and the language structure
specific to the academic sphere of science. The texts, without any input from the
educator, had an alienating quality that could stratify students by their language
readiness. The author felt students’ breadth of understanding would be limited if the
texts were the only resource teachers used and the prescribed pacing of a section day
followed. Fathman, Penick, Crowther, and Harris (2006) stated:

Learning science and language are cognitive processes that support each other.
The science process skills- including observing, predicting, communicating, and
analyzing- are almost the same as language learning skill- seeking information,
comparing, ordering synthesizing, and evaluating. These skills are truly the key to
integrating content instruction with language acquisition. (pp. 5-6)

While teaching science, educators must also teach the academic language of the
subject. For students to acquire a full understanding of the topics they are covering in
science, they must understand the language and phrasing specific to that of their science
text. The author designed lessons that integrate language development and academic
language acquisition with science objectives (based on the sixth-grade science content
standards for California) (CDE, 2001) to create the supports that promote student success.
Each lesson has a language objective and a science objective with an accompanying
language frame to aid students on how to effectively communicate about science.
After determining what was of importance to teach students in relation to the topic, the author needed to develop how students were to master these objectives. The included lessons are designed with a constructivist structure in that students are to construct their understanding through the use of their bodies.

Setting

This unit of instruction is designed specifically to meet California’s sixth-grade science content standards, and, therefore, should be taught to sixth-grade science students. The lessons are designed with modification suggestions so they can be tailored by the educator to meet the needs specific to her/his class, be they a regular or special day class.

Participants

The content of the lessons, while specific to that of sixth-grade science, is not intended solely for sixth-grade teachers. It is anticipated that educators lack training or experience with integrating dance into their lessons and that students also lack experience with this teaching strategy. The layout of the lessons can be followed and adapted to any content area by the educator, thus making all educators the intended audience and participants for the use of the lessons.

Design/Procedure

Prior to teaching the lessons to students, the educator must familiarize her/himself with the content of the material and the movement to be used. It is a necessity the educator watches the accompanying video tutorial (see Appendix C) before the start of instruction. The video will allow the educator to practice the movement and determine
what modifications, if any, she/he will make for her/his class. The video is not intended to be put on and played for the educator's class. The design of the video is for the adult learner and would be inappropriate for the child learner based on language and content.

This unit of instruction is designed to be taught at the pacing choice of the educator. It would be ideal that at least one lesson be taught per week until the completion of the unit with additional practice time allotted. Each lesson should take at least 45 minutes, which includes the introduction of the topic, dance sequence, and rehearsal time. Lessons are to be taught in the order presented because the topics and dance sequences build upon one another in concept and difficulty.

Educators should evaluate and assess students at regular intervals and at the completion of each topic. Appendix B contains each lessons formal assessment plan and the culminating assessment plan and pertains to evaluation guidelines and rubrics. If it is required by the educator's district policy that textbook worksheets and test serve as the formal assessment, the educator should add this curriculum’s dance assessment to that. Fatham et al. (2006) advised, "With a focus on high-stakes assessment, teachers must have training in how to create a coherent plan to document students' understanding in language and in science" (p. 7). Though the district expectation of students might be the completion of worksheets, it cannot be stressed enough by the author that these are insufficient means for students to demonstrate knowledge because worksheets do not allow students to transfer and synthesize their unique understanding of the content of material covered.
Chapter 4

RECOMMENDATIONS

It is the intention of the author that the lessons provided in Appendix A be adopted by educators and extended to fit the needs specific to their class. Through the examples provided in planning and demonstration via the video, it is the author’s hope that educators are inspired to create similar lessons in their classrooms so the benefits of providing students a unique study strategy promoting retention, transference, and synthesis can occur. Many students will find dance integration an enjoyable alternative to lectures brimmed with note taking and filling in worksheets. At the end of the included lessons, students will be able to employ the appropriate academic language when discussing scientific processes related to plate tectonics and infer what process the earth was undergoing based on observable traits.

Students will be empowered through this instructional strategy because it will return them to embodied knowing, how learning first occurs. The lessons will help transform what it means for students to learn because it makes them become what they are learning about. Science will transcend the worksheet-driven subject, sterile and devoid of student interaction and connection, by becoming a lively, community building activity that demands the participation of all to create abstract representations. In a time when so much of our communication occurs indirectly through tweets, texts, and emails, providing students the opportunity to return to the basics of direct person-to-person communication through dance, the oldest of the arts, will allow them the added benefit of a new problem-solving device and communication strategy. Dance integration into
science also allows students to build memory and gain a study strategy, which will provide the added benefit of retention.

It is the author’s strong recommendation:

- The lessons of this project be used in the classroom.
- A pilot program be run in which a group of educators use these lessons with a pre, post, and post-post test conducted to evaluate whether an increase in understanding and memory occurred related to California Earth Science Standards, grade six.
- Educators use these lessons as a template to then create their own lesson plans that integrate dance into other core areas.
- More exploration of dance integration occurs with various age groups and curriculum content.
APPENDICES
APPENDIX A

Lessons

Lesson 1: Dancing through the Layers of the Earth DVD Scene: 1

Standards:

*Earth Science*

B) Students know Earth is composed of several layers: a cold, brittle lithosphere; a hot, convecting mantle; and a dense, metallic core.

*Dance*

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3) Understanding dance as a way to create and communicate meaning

**Objective:**

Students identify the three distinct layers of the earth; the core, mantle, and lithosphere by name, location, and at least one unique characteristic. Students demonstrate the characteristics of each layer through dance.

**Language Objective:**

Students apply the appropriate name core, mantle, lithosphere to its corresponding layer and characteristics.

**Using the language frame**

“_____ layer is located ___________(can provide depth from surface or relational distance) of the earth and can be described as ___________(give at least one descriptive characteristic).”

Example: The core layer is located in the center of the earth and can be described as dense.

*Bloom’s Level: Knowledge and synthesis (Bloom, Englehart, Furst, & Krathwohl, 1956)*
Social Objective: Students will discuss the value of sharing, particularly sharing space with their peers, and describe what that looks like, sounds like, and feels like.

Key Vocabulary:

<table>
<thead>
<tr>
<th>Lithosphere</th>
<th>Mantle</th>
<th>Metallic</th>
<th>Brittle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Dense</td>
<td>Conving</td>
<td>Hot</td>
</tr>
<tr>
<td>Cold</td>
<td>Solid</td>
<td>Liquid</td>
<td>Temperature</td>
</tr>
</tbody>
</table>

Materials:

<table>
<thead>
<tr>
<th>Music</th>
<th>feels/looks/sounds chart</th>
<th>language frame</th>
<th>Images of layers of the earth</th>
</tr>
</thead>
</table>

Hook:

(T) Get up and move in your personal space like the words I say. Big, butterfly, scissors, light bulb, egg, etc.

_Gauge the students’ enthusiasm and willingness to participate. Move with students to show this is a time to explore._

Have students sit before demo.

Demo 1: egg

(T) What is the core of an object

(S) Center

(T) What has a core? 

(S) Apples, our being, various responses

(T) Yes, the core does mean center. The earth has a core, too. As geologists, let’s travel to the center of the earth; the core. What do you think we will have to pass through to get there? What do you think we will encounter on the way?

(S) Various responses

(T) The earth is a lot like an egg with its thin outer shell, large liquid layer, and more dense and solid like core.

_Crack egg to demonstrate._
The first layer of the earth we will need to break through is called the Lithosphere, which literally means outer circle. The characteristics of this layer are that it is brittle and cold. What does brittle mean?

Breaks easily

What does cold mean?

Low temperature

In your personal space, I want you to move as if you were brittle. Say “brittle” as you make that movement.

Have students stand in personal space.

Various responses

Now I want you to move as if you were the word cold. Say “cold” as you make that movement.

Various student responses.

Now put it together making it a dance sequence “brittle and cold.” Move from one word movement to the next and repeat your movement while saying with me “Lithosphere; brittle and cold.” Now you are in the groove!

Repeat this sequence of movement several times.

Now that we have made our way through the cold and brittle lithosphere we make our way down to the mantle. Looking at our egg what might this layer be like?

Liquid, gooey, etc.

The mantle is hot liquid that is convecting. Does anyone remember what convection is from our weather unit? *

Student responses

Now move like you are hot liquid.

Various student responses.
(T) Now move like you are convecting liquid. Think high and low levels.

(S) Various student responses.

(T) Now put it together making it a dance sequence hot-convecting liquid. Move from one word movement to the next and repeat your movement while saying with me “Mantle; hot and convecting.” You sure look like the mantle to me!

Repeat this sequence of movement several times

*May use hot water with food coloring model to show movement of convection if students require refresher on this topic. Educators can follow with “How does convecting water move?”

(T) Now we have reached our final destination the core, but this layer is not that easy to get through because it is metallic and very dense. Can anyone tell me what metallic means?

(S) Metal

(T) Can anyone tell me what dense means?

(S) Thick.

(T) How can we use our bodies to represent metallic and dense?

(S) Various student responses.

(T) Now put it together making it a dance sequence dense-metallic. Move from one word movement to the next and repeat your movement while saying with me “Core; dense-metallic.” You are at the core of understanding!

Repeat this sequence of movement several times. Go through sequence and layers lithosphere to core and core to lithosphere.

Dance:

Have table groups partner. 1 with 2. 3 with 4. 5 with 6. Group A will be the core. Group B will be the mantle. Group C will be the lithosphere.

(T) Now we are going to circle up as groups and dance out the characteristics of each layer. Which group will be the outermost circle?
(T) What is C?

(S) Lithosphere

(T) Which group will be the innermost circle?

(S) A

(T) What is A?

(S) Core

(T) Which group will be between them?

(S) B

(T) What is B?

(S) Mantle

(T) Based on the diameters of these layers how far apart should the layers be from one another? How close should your group be from the next?

*Have student groups adjust distance between their circled group and neighboring groups.*

*Put on music and have the groups all dance like their layers.*

Opt out geologist, this is their time to help out peers and record observations.

**Closure:** Class summarizes findings

*Have one-half class demonstrate a layer and have second half of class identify by name and describe characteristics being danced.*

(T) How might understanding the layers of the earth be beneficial?

(S) Various student responses

(T) As a geologist how might this information be useful?
(S) Response

(T) Do you think the layers of the earth impact you as an individual?

(S) Response

Students will reflect anonymously on how they felt the class worked together and shared space as a whole using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self Reflection:

What went well?

What do students need from me that would have made them more successful?
Lesson 2  

Pangaea  

DVD Scene: 2

Earth Science Standards

1A) Students know evidence of plate tectonics is derived from the fit of continents; the location of earthquakes, volcanoes, and mid-ocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

Content Objective: Students will summarize Wegener's theory of continental drift and the order of how the landmass Pangaea split into the continents in present day positions.

Language Objective: Students will identify the large landmass as Pangaea, Wegener's two sub-landmasses as Laurasia and Gondwana, and the continents by name.

1. Pangaea  
   “Wegener called the large land mass Pangaea.”
2. Laurasia and Gondwana  
   “When Pangaea split it became two landmasses called Laurasia and Gondwana.”
3. North America, Europe, Asia, South America, Africa, Antarctica, and Australia  
   “Laurasia split into the continents North America, Europe, and Asia”  
   “Gondwana split into the continents South America, Africa, Antarctica, and Australia.”

Bloom's Level: Synthesis and analysis (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what that looks like, sounds like, and feels like.

Key Vocabulary:

Pangaea  
Laurasia  
Gondwana
Materials:

<table>
<thead>
<tr>
<th>Music</th>
<th>feels/looks/sounds</th>
<th>language frame</th>
<th>Earth chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jigsaw pieces</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Warm-up: have students dance through the layers of the earth.

Hook:
*Have puzzle pieces color coded 6 different colors, one different piece at each desk comprising a table group. These color-coded puzzle pieces are to be labeled a-f. These puzzles pieces will help identify the distribution of fossils in the following activities. Have map of earth displayed.*

T) While looking at a map of the earth have you ever noticed how much it looks like a jigsaw puzzle?

S) Various student responses

T) In the 1900s, Alfred Wegener (1880-1930) proposed the theory of continental drift to explain why the earth looks the way it does and how continents arrived at their present location. Wegener observed how the continents appeared like they would fit together much like a jigsaw puzzle. He stipulated that 250 million years ago the continents fit together as one large landmass. Wegener called this land mass Pangaea. Wegener believed that Pangaea broke into pieces that slowly drifted into their present locations. *Have table groups fit their individual puzzle pieces together.*

T) Wegener used fossil evidence, how the continents fit together, ancient climate records, in addition to the continuance of geographic features such as mountains and rocks to justify his claim.

T) Each puzzle piece represents an example of the type of evidence Wegener used to support his claim.

*Have students look at their puzzles pieces*

a) Fossils  
b) Continent fit  
c) Climate record  
d) Continuance of geographic features  
e) Mountains  
f) Rocks

T) Wegener believed the giant landmass broke in half about 135 million years ago. He called one half Laurasia. Laurasia was made of what is now North America, Europe and Asia.
Have students break their puzzle in half.

T) He called the second half Gondwana. Gondwana was made of what is now South America, Africa, Antarctica, and Australia.

T) Wegener believed these land groups then subdivided until they became the continents we see today.

Have students then break the puzzle back into individual pieces.

T) As table groups you are going to represent the continents.
Group 1 North America
Group 2 Europe
Group 3 Asia
Group 4 South America
Group 5 Africa
Group 6 you are going to break into two small groups of three.
Group 6a Antarctica
Group 6b Australia

Dance:

Have the class stand and form one large group. Have students determine how they want to use their bodies and spatial relations to represent their union as one large land mass, Pangaea.

T) Can anyone remember what Wegener thought happened 135 million years ago to Pangaea?

S) It split in half

T) What do you think your movement quality will be like if it took hundreds of millions of years for the earth's continents to arrive at their present location?

S) Slow

T) As you move from one another you will glide and move at a slow rate. To glide, brush one foot across the ground, one foot in front of the other in an even and continuous manner.

Teacher demonstrates gliding
Students split the joined group in half.
Students move at a slow even rate and glide into position.
T) How are you going to distinguish differences between the two land masses?

S) Students problem solve and determine a group formation and relationship to one another.

*Students move into their representations of Laurasia and Gondwana.*

T) What did Wegener think happened next to Laurasia and Gondwana?

S) It split into the continents

*Have students split into their assigned continent. Have students use their bodies and positioning in relationship to one another to represent their assigned continent.*

T) What was Wegener's evidence to support this split?

S) Fossils, continuance geographic features, etc.

T) How are you representing that evidence?

S) Jigsaw puzzle piece

*Students move into group position as a) individual continent and d) into the shape of that continent.*

T) Are groups 2 and 3 going to be far apart from one another?

S) No, they are going to be close together.

T) Teacher asks guiding questions while providing the verbal cues "Glide, Slow rate"

*Have students problem solve in their table groups until they represent their continent. Have students reconvene as the land mass Pangaea. Then have them split into Laurasia and Gondwana using their predetermined spatial formations and relations. Lastly, have the students move into their continent's present-day position. Have students move by gliding at a slow rate. Having students move in a fluid sequence comprises the dance of this lesson.*

Closure:

*Have students return to their seats.*

T) Do you think many scientists support Wegener's theory?

S) Various student responses.
T) Why or why not?

S) Various student responses.

T) Do you support Wegener's theory? Do you think that anything is missing from the case he makes?

S) Various student responses.

T) Wegener's theory was dismissed by many scientists because he could not identify the mechanism that caused the continents to drift into place. Wegener claimed the continents were moved through the seafloor by the same forces that caused ocean waves. Scientists rejected his explanation and his theory.

T) Why might it be important to know how the continents came into their present position? How might this impact you?

S) Various student responses.

_Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly._

Self-Reflection:

What went well?

What do students need from me that would have made them more successful?
Lesson 3: Sea Floor Spreading  

Standards:

Earth Science

1A) Students know evidence of plate tectonics is derived from the fit of the continents, the location of earthquakes, volcanoes, mid-ocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

Content Objective:
Students will be able to determine that one explanation for continental drift is sea floor spreading.
Students will demonstrate sea floor spreading through dance.

Language objective: Students will be able to define the term mid-ocean ridges and explain how they act as evidence for sea floor spreading.
“Mid-oceanic ridges are ________________ and are evidence for sea floor spreading because __________.”

Bloom's level: Synthesis, evaluation and comprehension (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what that looks like, sounds like, and feels like.

Key Vocabulary:

Mid-ocean ridges  Sea floor spreading  Magma
topography  Sonar

Materials:

| Music          | feels/looks/sounds | language frame |
Hook:

T) Has anyone ever line danced before?

S) Student responses.

T) Today we are going to do some line dancing as it relates to Wegener's theory of continental drift.

T) As you may recall, Wegener could not explain how continental drift occurred. Wegener could only explain the changes he observed to the surface of the earth. Starting in WWII, scientists began making many advances in terms of how they could study the ocean floor using Sonar, which is the bouncing of sound waves off the sea floor then measuring the waves return time. With the technology of sonar, scientists were able to map the features of the ocean floor by its depth.

T) What do you think scientists discovered about the depths of the ocean?

S) Not the same depth.

T) Yes, and they also found the longest mountain ranges on earth! These ocean mountain ranges are called mid-ocean ridges. At these mountain ranges, they recorded high temperatures.

T) How do you think these mountain ranges were formed?

S) Student response.

T) Geologist Harry Hess believed the high temperatures found at these boundaries occurred because lava erupted there and formed new sea floor. He called his hypothesis sea floor spreading. Sea floor spreading is the process by which new sea floor is constantly being formed at mid-ocean ridges.

Dance:

T) In our table groups, we are going to form 2 large groups. Groups 1-3 will be on the right. Groups 4-6 will be on the left. In our large groups, we are going to line up single file.

Have groups stand and line.

T) Group 1 and 4, you will start. Line up with your arms outstretched to the person in front of you. Link into partners. In unison, or all at the same time, you will step away from the other table group, and toward the outside walls of the room.
Have table groups 1 and 4 step away from each other.

T) Groups 1 and 4 have just represented old sea floor moving out and away from the ocean ridge. This allows new sea floor to come through. Table groups 2 and 5 can now come through. Standing single file, you will link with the person behind you form peaks with your outstretched hands. You will now step into the place groups 1 and 4 held. Now groups 1, 2, 4, and 5 step away from each other and toward the outside wall.

Have groups step away from each other.

T) Now it's time for the youngest sea floor to come out. Table groups 3 and 6 will now partner like groups 1 and 4 with their arms outstretched in front and linked to a partner. Now all groups will step away from each other and toward the outside wall.

Have students go through this sequence of stepping in the center and away from each other.

Explain to students that groups 1 and 4 have to go back down the center as new crust because the earth is not getting larger in size so seafloor is recycled back into the earth and forms new young seafloor.

Have students go through the entire sequence without your interference. Have students return to their desks.

T) Why might sea floor spreading be used to explain continental drift?

S) Student response.

T) Sea floor spreading can be used as an explanation for continental drift because as the sea floor spreads, the ocean becomes wider. As the ocean gets wider, continents drift apart.

T) If scientists in the time of Wegener knew of seafloor spreading, do you think they would have supported his theory? Why or why not? Justify your response.

S) Various student responses

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection: What went well? What do students need from me that would have made them more successful?
Lesson 4: How Plates Move

Standards:

**Earth Science**

1B) Students know the earth is composed of several layers; a cold brittle lithosphere; a hot convecting mantle; and a dense metallic core.

1C) Students know lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movement in the mantle.

4C) Student knows that heat from the Earth’s interior reaches the surface primarily through convection.

**Dance Standards**

1D) Students identify and demonstrate movement elements and skills in performing dance.

1G) Students demonstrate accurate memorization and reproduction of movement sequences.

3A) Understanding dance as a way to create and communicate meaning

**Content Objective:**

Students will be able explain how, according to some scientists, the process of sea floor spreading is a result of convection in the mantle. Students will demonstrate this process through dance.

**Language objective:** Students will be able to define slab pull.

**Bloom's level:** Synthesis and knowledge (Bloom et al., 1956)

**Social Objective:** Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

**Key Vocabulary:**

<table>
<thead>
<tr>
<th>Convection</th>
<th>Mantle</th>
<th>Magma</th>
<th>Seafloor spreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Ocean trench</td>
<td>slab</td>
<td>Mid-ocean ridge</td>
</tr>
</tbody>
</table>

**Materials:**

| Music | feels/looks/sounds |
Hook:

T) Convection currents in the mantle move plates from mid-oceanic ridges to oceanic trenches where they recycle back down becoming what is known as a slab.

Dance:

1. *Have students practice dancing the process of convection in their table groups using the cues, “Circle, rotate, levels (high-hot, low-cold)”*
2. *Have students join with another table group.*
   - Group 1 with 2, Group 3 with 4, and Group 5 with 6.
3. *In new groups, have table a (odd numbered table) dance the process of seafloor spreading in which they will create a trench or a ridge. Group b (even numbered table) will dance the process of convection.*

T) Not all scientists agree convection currents are the only means by which plates move.
- Some scientists believe gravity acts on a dense plate at the point of a ridge and causes it to go down.
- These same scientists believe lithospheric plates sink into the mantle, which is called a slab pull.

These scientists call the process for plate movement “ridge push and slab pull.”
T) Based on your experience in the last couple of lessons, what do you think causes the plates to move?

S) Various student responses.

T) All of the explanations made by scientists contribute to the movement of the plates. Scientists still have a lot more exploring and investigating to do before they know the whole complex story for plate movement.
T) Perhaps, someday when you are grownups, you may help make discoveries that lead to a better understanding for plate movement.

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection: What went well? What do students need from me that would have made them more successful?
Lesson 5: Plate Boundaries DVD Scene: 5

Standards:

**Earth Science**

1B) Students know the earth is composed of several layers; a cold brittle lithosphere; a hot convecting mantle; and a dense metallic core.
1C) Students know lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movement in the mantle.

**Dance Standards**

1D) Students Identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

**Content Objective:**
Students will be able to identify the three main plate boundaries. Students will demonstrate this process through dance.

**Language objective:** Students will be able identify the three main plate boundaries by name and describe their plate movement relationships.

**Bloom's level:** Synthesis and analysis (Bloom et al., 1956)

**Social Objective:** Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

**Key Vocabulary:**
- Convergent boundary
- Transform boundary
- Divergent boundary
- Subduction
- Fault
- dense
- fracture

**Materials:**

| Music | feels/looks/sounds |

**Hook:**
T) We’ve established that plates move, but based on the plates’ composition, they are all moving at different speeds and in different directions. Because plates are packed together
(think back to our eggshell), they run into each other and pull apart from one another. The pulling and pushing plates undergo causes the plates to be stressed and deformed.

T) Fractures are breaks and cracks in faults.
T) Faults are fractures where rocks on one side of the crack move relative to rocks on the other side. Faults form along plate boundaries. The three major plate boundaries are convergent, divergent, and transform.
T) At convergent boundaries, 2 plates collide into one another. The less dense plate subducts or goes below the more dense plate.

**Demo 1:**
Left hand plate a. Plate a is less dense.
Right hand plate b. Plate b is more dense.

1. Bring hands in toward center of body.
2. Hands collide.
3. Left hand goes below right hand. Plate a subducts below plate b.

*Have students practice hand motions.*

**Dance:**
1. Have students divide table group in half. One half plate a. Other half plate b.
   - Have students stand in two parallel lines facing in toward one another.
2. Plate a group kneels down.
3. Plate b lifts up on toes arcing arms over members of group a.

Teacher prompts using cues “Lines, levels”

T) At transform boundaries, two plates move past each other on a horizontal path.

**Demo 2:**
1. Left hand plate a. Right hand is plate b. Bring hands in toward center of body.
2. Hands move away from one another on horizontal path.

**Dance:**
1. Have students divide table group in half. One half plate a. Other half plate b.
   - Have students stand in two parallel lines facing in toward one another.
2. Plate a steps to their right.
3. Plate b steps to their right.

Teacher prompts using cues “Lines, step to right”

T) At divergent plate boundaries, the plates divide or move away from one another.
Demo 3:
1. Left hand plate a. Right hand is plate b. Bring hands in toward center of body.
2. Hands move away from one another, away from center of body.

Dance:
1. Have students divide table group in half. One half plate a. Other half plate b.
   Have students stand in two parallel lines facing in toward one another.
2. Plate a steps back.
3. Plate b steps back.

   Teacher prompts using cues “Lines, step back”

Closure:

T) What are the three different plate boundaries?

S) Divergent, convergent, and transform.

T) How are these boundaries different from one another?

S) Students list differences.

T) Can you infer or think of any consequences there might be for plates moving?

S) Student response

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection:

What went well? What do students need from me that would have made them more successful?
Lesson 6: What is an Earthquake  

Standards:

*Earth Science*

1D) Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.

1E) Students know major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motion.

*Dance Standards*

1D) Students identify and demonstrate movement elements and skills in performing dance.

1G) Students demonstrate accurate memorization and reproduction of movement sequences.

3A) Understanding dance as a way to create and communicate meaning

**Content Objective:**
Students will be able to determine the different causes of earthquakes.

**Language objective:** Students will be able identify the three main plate boundaries by name and describe how their movement causes earthquakes.

**Bloom's level:** Synthesis (Bloom et al., 1956)

**Social Objective:** Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

**Key Vocabulary:**

- Earthquake
- Elastic Strain

**Materials:**

| Music          | feels/looks/sounds |
Hook:
T) Recites
The Hanshin Awaji Earthquake Museum Experience
by Yuri Noh

Oh how I was excited,
entering the museum although predicting, that I'll be terrified.

Everyone shaking,
watching clocks breaking,
imAGING that the ground is shaking.

Minds filled with terror and sorrow,
feeling sorry for the one who died,
Oh I'm glad I'm alive.

T) Has anyone ever been in an earthquake?

S) Student response

T) What was it like? How did you feel?

S) Student response

T) Did anyone explain to you what was happening?

S) Student response

T) What is an earthquake?

S) Student response

T) An earthquake is a break or sudden movement of rocks along a fault.

T) When an earthquake occurs, it happens most often at a fault. At the fault, energy builds as the plates undergo elastic strain. Elastic strain is when the point of stored energy has a change in shape. This change in shape causes rocks to break, which releases the stored energy. When the stored energy is suddenly released is when the earthquake happens.

Dance:

T) Earthquakes can happen at transform boundaries.
1. The original position: Have students divide their table group in half and stand in two parallel lines facing in toward one another.

2. Elastic strain: Have lines lean to their right.

3. Rupture: Have lines step to their right.

4. Energy release: Stand back straight in line.

T) Earthquakes can happen at divergent boundaries.

1. The original position: Have students divide their table group in half and stand in two parallel lines facing in toward one another.

2. Elastic strain: Have lines reach across and join hands with a member of the line directly in front of them. Have them lean back.

3. Rupture: Have lines step to back until they can no longer hold hands with partner.

4. Energy release: Stand straight back in line further back from original position.

T) Earthquakes can happen at convergent boundaries.

1. The original position: Have students divide their table group in half and stand in two parallel lines facing in toward one another.

2. Students do level change representing subduction.

3. Elastic strain: Have lines lean toward one another.


5. Energy release: Stand straight back in line.

Closure:

T) Where do earthquakes occur?

S) They occur at faults. Faults occur at plate boundaries.

T) How are earthquakes different from one another?
S) They happen at different boundaries. They are made differently. Happen at different places.

_Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly._

Self-Reflection:

What went well? What do students need from me that would have made them more successful?
Lesson 7: Earthquake Seismic Waves  DVD Scene: 7

Standards:

Earth Science:

1G) Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, distance of the region from the epicenter, local geology, and the type of construction in the region.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

Content Objective:
Students will be able to identify the three main seismic waves.
Students will be able to dance the process of an earthquake’s seismic waves as they move from the epicenter.
Students will demonstrate seismic wave movement through dance.

Language objective: Students will be able to list the characteristics of the different seismic waves and use their proper names.

Bloom's level: Synthesis (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

Key Vocabulary:

<table>
<thead>
<tr>
<th>Primary wave</th>
<th>Secondary wave</th>
<th>Surface wave</th>
<th>Seismic wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault</td>
<td>Focus</td>
<td>Epicenter</td>
<td></td>
</tr>
</tbody>
</table>

Materials:

<table>
<thead>
<tr>
<th>Music</th>
<th>feels/looks/sounds</th>
<th>Jell-O</th>
<th>Toothpicks</th>
</tr>
</thead>
</table>
Hook:
Jell-O toothpick demo

T) As you do the demo identify focus and epicenter and define for students.
T) When an earthquake occurs, stored energy is released in the form of seismic waves. Seismic waves are the waves of energy made at the focus of an earthquake. These waves move away from the focus in all directions. They travel towards the earth’s surface and its core. Think of how water behaves when you drop a rock into a bowl of water. Ripples go out in all directions.

Demo: Drop a pebble into a bowl of water.

T) There are three main types of seismic waves. Primary waves, Secondary waves, and Surface waves.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Travel through</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary wave</td>
<td>Pulse, fastest wave, particles vibrate same direction</td>
<td>solids and liquids</td>
</tr>
<tr>
<td>Secondary wave</td>
<td>Snake or move perpendicular, slower than p wave</td>
<td>solids</td>
</tr>
<tr>
<td>Surface wave</td>
<td>Sways, particles move side to side, slowest seismic wave</td>
<td>Causes most damage</td>
</tr>
</tbody>
</table>

Have students
1. Hit bottom of palm with hand the…
2. Pulse hands in front like p waves
3. Snake hands in front like s waves
4. Sway hands in front like surface waves

Dance:
1. Circle; table groups form circle facing out backs in toward one another
2. In unison circle jumps up
3. 2 people are p waves they leave circle pulsing hands in front
4. 2 people are s waves they leave circle snaking arms in front
5. 2 people are surface waves and they leave circle swaying arms in front

Closure:

T) What do you think would happen if an earthquake happened in our town?

S) Student response

T) What waves do you think you feel most during an earthquake?
S) Student response

T) Do you think we would feel more waves if we were closer or farther away from the epicenter of the earthquake?

S) Student response

*Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.*

Self-Reflection:

What went well?

What do students need from me that would have made them more successful?
Lesson 8: What is a Volcano? DVD Scene: 8

Standards:

Earth Science:

1D) Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.
1E) Students know major geologic events such as earthquakes, volcanic eruptions, and mountain building result from plate motion.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

Content Objective:
Students will be able to describe the parts of a volcano.
Students will be able to dance the process of volcano forming.

Language objective: Students will be able to define volcano and lava.

Bloom's level: Synthesis (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

Key Vocabulary:

Volcano Hotspots Magma Vent
Fissure Eruption

Materials:

Music feels/looks/sounds
Hook:
T) Recites poem on volcano

Who could have predicted you
White cloud of ash
Full of beauty and of terror
A reminder to us
That we do not own
the universe surrounding us
—Gabriel Byrne 4/20/2010 Lincoln Center "Poetry & the Creative Mind,”

T) A volcano is a land or underwater geographic feature that forms when magma escapes through cracks and reaches the earth’s surface.

T) The opening of a volcano is called a vent. The path that magma travels to the surface by is called a pipe. The underground area in which magma gathers and builds in pressure is called the chamber.

Dance:

Have students form a circle with 4 members of their table groups.

The remaining two members of their table group stand on the inside.

Outside group

1. Circles
2. Links hands
3. Lifts hands up

T) The members of the group in the middle represent magma in the chamber that rises up through the pipe and erupts as lava out the vent.

Magma group
1. Kneel to stand < build pressure
2. Lift arms up < travel up pipe
3. Wave arms < erupt

T) Volcanoes occur at convergent and divergent plate boundaries.
Convergent boundary:

1. Less dense plate subducts
2. As it goes down plate melts and forms magma
3. Magma less dense than rocks, so it is forced upward

Dance:

1. Levels
2. Magma rises
3. Circle
4. Link
5. Lift

Divergent boundary

1. As plates divide, magma builds and is released

Dance:

1. Parallel
2. Step away
3. Magma rises
4. Circle
5. Link
6. Lift

Closure:

T) What do you think would happen if a volcano erupted in our town?

S) Student response

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection:

What went well?
What do students need from me that would have made them more successful?
Lesson 9: Volcanic Features and Eruptions

Standards:

Earth Science:

1D) Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.

1F) Students know how to explain major features of California geology in terms of plate tectonics.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.

1G) Students demonstrate accurate memorization and reproduction of movement sequences.

3A) Understanding dance as a way to create and communicate meaning

Content Objective:

Students will be able to identify the three main volcanic formations, cinder, shield, and composite volcanoes.

Students will be able to dance the process of the three main volcanic formations

Language objective: Students will be able to list the characteristics of the different volcanoes and use their proper names.

Bloom's level: Synthesis and knowledge (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

Key Vocabulary:

Viscosity      Shield Volcano      Tephra      Composite Volcano
Shield Volcano

Materials:

Music | feels/looks/sounds
Hook: Play the song: *It's a Volcano Teaching the Characteristics of Volcanoes* by Ron Brown

http://www.songsforteaching.com/earthsciencegeology/volcanoes.htm

T) Not all volcanoes are created equally. Volcanoes differ by the type of eruption that occurs, what is erupted, and how the lava flows.

T) There are different types of magma, which differ in composition and viscosity or resistance to flow.

1. Basaltic magma – low silica, low viscosity (flows easily), quiet flow
2. Granitic magma – high silica, high viscosity (flows slowly), sticky, high in gas, explosive eruption

Dance:

*Have students dance like granitic and basaltic magma in their personal space.*

*In table groups have students form generic volcanoes and erupt as the two types of magma.*

Basaltic:

1. Circle
2. Link
3. Lift
4. Flow soft

Granitic:

1. Circle
2. Link
3. Lift
4. Jump <Explode

T) *Can anyone remember from the song what the 3 different types of volcanoes are?*

S) Student response cinder, shield and composite
T) Shield volcanoes are made of basaltic lava eruptions that create smooth, even, sloping layers.

Dance:

1. Circle
2. Link
3. Lift
4. Flow
5. Curve arms over members of outer circle arc over with magma group members.

T) Cinder cone volcanoes are made of tephra. Tephra is any solid erupted from a volcano. Cinder cones form from explosive eruptions that shoot up high. As the lava cools it forms solids that fall near the vent of the volcano creating steep sides.

Dance:

1. Circle
2. Link
3. Lift
4. Jump < explode
5. Make circle with arms and arc over with magma group members.
6. Step closer in < make circle smaller

T) Composite volcanoes are made of lava and tephra layers. They form from alternating explosive and quiet eruptions.

Dance:

1. Circle
2. Link
3. Lift
4. Flow
5. Curve arms over members of outer circle arc over with magma group members.
6. Explode
7. Make circle with arms and arc over with members of flow group

Closure:

T) What do you think the personalities of the three different volcanoes would be like? Could you see them as your friends? Justify your response.
S) Student response

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection: What went well? What do students need from me that would have made them more successful?
Lesson 10: Hazards DVD Scene: 10

Standards:

Earth Science:

2D) Students know how earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

Dance Standards

1D) Students identify and demonstrate movement elements and skills in performing dance.
1G) Students demonstrate accurate memorization and reproduction of movement sequences.
3A) Understanding dance as a way to create and communicate meaning

Content Objective:
Students will be able to identify two hazards caused by earthquakes and volcanoes.

Language objective: Students will describe the characteristics of a tsunami and pyroclastic flow and their impacts on humans, wildlife, and their habitats.

Bloom's level: Knowledge, Synthesis, Analysis, Evaluation (Bloom et al., 1956)

Social Objective: Students will work cooperatively with their peers and describe what cooperation looks like, sounds like, and feels like.

Key Vocabulary:

Pyroclastic flows  Tsunamis  Gas  Ash
Solids

Materials:

<table>
<thead>
<tr>
<th>Music</th>
<th>feels/looks/sounds</th>
<th>YouTube video access</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing utensils</td>
<td>Props</td>
<td>Library access</td>
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</tbody>
</table>

Hook: Play YouTube video of tsunami and pyroclastic flows.
Japan Earthquake: Helicopter aerial view video of giant tsunami waves
Pyroclastic flows on Mt Merapi Java Indonesia
T) There are many consequences for plate movement including the devastation you witnessed in the YouTube videos.

T) One hazard caused by earthquakes is the creation of large walls of water called tsunamis. These walls of water are generated by the seismic waves that travel from the epicenter of the earthquake through the water and cause the most damage when they hit the shoreline.

Dance:

Tsunamis:

1. Plate transform, divergent, or convergent
2. Jump
3. Pulse, snake, sway
4. Form line
5. High level
6. Arm arms
7. Step forward l,r,l,r
8. Lower level

T) One hazard caused by volcanoes is the creation of pyroclastic flows. Pyroclastic Flows are made of a mixture of volcanic ash, hot gases, and solids that move rapidly down the sides of the volcano destroying everything in its path.

Pyroclastic flows:

1. Pick volcano
2. Erupt
3. Gas-quick steps
4. Ash-floating motion
5. Solid-stiff
6. Move forward l,r,l,r
7. Increase speed

Closure:

T) What do you think would cause more damage, a tsunami or a pyroclastic flow?

S) Student response

T) Can you think of any examples of tsunamis and pyroclastic flows in history?
S) Student response * Japan and Pompeii

T) How would you feel if you were a victim of a tsunami or pyroclastic flow?

S) Student response

Students will reflect anonymously on how they felt the class worked together cooperatively using thumbs up = great, thumbs sideways = ok, thumbs down = poorly.

Self-Reflection:

What went well? What do students need from me?
APPENDIX B

Assessments and Rubrics

Assessment: 1

Lesson 1: Layers of the earth

1. Students will create a poem with an illustration about the layers of the earth.

   Project Requirements:
   1. Student uses the proper name for each layer
   2. Students uses relative location of each layer
   3. Student describes the characteristics of each layer

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<th>Good (7 pts)</th>
<th>Needs Improvement (6 pts)</th>
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</table>
Lesson 2: Pangaea

1. Students will summarize Alfred Wegener’s theory of continental drift in one paragraph.

Paragraph Requirements:

a) Students use the proper names of Wegener’s landmasses and the seven continents they divided into.

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</table>

2. Students will create a travel brochure selling the features of Pangaea, Laurasia, and Gondwana.

Project Requirements:

1. Title with Slogan
2. Color and Illustrations
3. At least 3 examples of evidence for continental drift
4. Use of the land mass names Pangaea, Laurasia, and Gondwana
5. Name and table number
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Assessment: 3

Lesson 3: Sea Floor Spreading

1. Fill in the language frame.

“Mid-oceanic ridges are ___________________ and are evidence for sea floor spreading because____________.”

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. If scientists during Wegener’s time knew of seafloor spreading, do you think they would have supported his theory? Why or why not? Justify your response.

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### Evaluation of Assessment 3

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Assessment: 4

Lesson 4: How Plates Move

Name________________________ Table Number_____

1. Draw and label a diagram of convection currents in the mantle.

2. Explain how process of sea floor spreading is a result of convection in the mantle.

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3. Define slab pull

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Evaluation of Assessment 4

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<td>Q3 Accuracy</td>
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</table>
Lesson 5: Plate Boundaries

1. Identify the three main plate boundaries and describe their plate movement.
   a) ________________________________________________________________
      ________________________________________________________________
   b) ________________________________________________________________
   c) ________________________________________________________________
      ________________________________________________________________

2. Which fault would you most like to live on? How might your life change due to this fault?
   Justify your response.
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

3. How fast do plates move per year?
   a) Millimeters per year
   b) Centimeters per year
   c) Miles per year
### Evaluation of Assessment 5

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</table>

X- Either correct or incorrect
Checkpoint assessment:

1. Students will investigate
   a) What plate boundaries comprise California?
   b) What faults are in California and how are they made?
   c) How was California’s Cascade Range formed?
2. Students will produce a model or poster in their table groups of California’s geographic features
   a) Posters must have questions answered

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</table>
Assessment: 6

Lesson 6: What is an earthquake?

Name________________________ Table Number_____

1. What is an earthquake?

2. Identify the three main plate boundaries by name and describe how their movement causes earthquakes.
### Evaluation Assessment

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</table>
Assessment: 7

Lesson 7: Earthquake seismic waves

1. Students will invent a game to help teach children about earthquakes.

Game will include:

a) Rules and procedure to how game is played
b) Summary of what students will learn by playing game
c) Information on at least one major earthquake that occurred in California’s history
d) Information on the three different seismic waves
e) Safety tips for earthquakes

<table>
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<tr>
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<th>Good 7 pts</th>
<th>Needs Improvement 6 pts</th>
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</tbody>
</table>
Lesson 8: What is a volcano?

Name________________________ Table Number_____

Draw a diagram of a volcano and label its parts

Define:
volcano

lava
Assessment: 9
Lesson 9: Volcanic features and eruptions

1. Students will create a puppet representing the volcano of their choice; shield, cone or composite.
2. Students will create a character profile of their volcano based on how their volcano is created and the type of eruption it has.
3. Students will then pick at least one of the following options:
   a) Student creates a myth for their volcano that is performed with puppet
   b) Student writes an educational scene to perform with their puppet
   c) Student researches a volcano that is the same type as the one she/he selected and shares information about that volcano and its formation with her/his puppet for the class.
   d) Student researches a volcano in California and shares its formation and properties with her/his puppet for the class

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Comments:
Assessment: 10

Lesson 10: Hazards

1. Students will simulate a news broadcast reporting on the hazards caused by earthquakes and volcanoes, tsunamis and pyroclastic flows.
2. Students will describe the characteristics of a tsunami and pyroclastic flow and their impacts on humans, wildlife, and their habitats.

Procedure:
Divide the class in half by table groups. Groups 1-3 will report on tsunamis. Group 4-6 will report on pyroclastic flows. Students will be assigned roles.

<table>
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<th>Role</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>Anchor person</td>
<td>Research role + interview</td>
</tr>
<tr>
<td>3</td>
<td>Tsunami</td>
<td>Dance tsunami + interview</td>
</tr>
<tr>
<td>2</td>
<td>Farmer</td>
<td>Research role + interview</td>
</tr>
<tr>
<td>2</td>
<td>Fisherman/woman</td>
<td>Research role + interview</td>
</tr>
<tr>
<td>2</td>
<td>Animals</td>
<td>Research role + interview</td>
</tr>
<tr>
<td>2</td>
<td>Children</td>
<td>Research role + interview</td>
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<tr>
<td>2</td>
<td>Buildings</td>
<td>Research role + interview</td>
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<tr>
<td>1</td>
<td>Government Leader</td>
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<tr>
<td>2</td>
<td>Safety Workers</td>
<td>Research role + interview</td>
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<tr>
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<td>Research role + interview</td>
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<td>Pyroclastic Flow</td>
<td>Dance tsunami + interview</td>
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<tr>
<td>2</td>
<td>Safety workers</td>
<td>Research role + interview</td>
</tr>
</tbody>
</table>

Day 1:

a) research character
b) write anticipated questions and response
c) gather/ build props
d) gather costumes
e) rehearse

Day 2: Tsunami broadcast 45 minutes

Day 3: Pyroclastic Flow Broadcast 45 minutes
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Student Individual Evaluation Form

Students should try to get into the hearts and minds of their character. Students should consider how their characters’ lives would be impacted and/or devastated by the experience of a tsunami or pyroclastic flow. Students should take their role seriously and approach it with respect.
APPENDIX C

DVD
REFERENCES


