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Dancing Science: Using Dance and Movement as Culturally Responsive Teaching Strategies to Increase Motivation, Interest, and Understanding in Middle School Science Classes

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By

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CHAPTER ONE

Introduction

As our world becomes increasingly focused on technological advancement, science and math courses are emphasized while the arts are often cut out of curriculums, dance classes being a prime example. This focus on technology often leads to more time sitting in front of screens or at desks and less time being physically active in a classroom. At the same time, despite the emphasis on science, we have a scientific communication crisis. Science is not being taught and communicated in ways that the majority of people can understand. Science is taught as a static collection of facts, rather than dynamic exchange and experimentation. Students are rarely given the chance to construct the meaning of science for themselves. Nor are most students given enough time to move throughout their day. My Capstone aims to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?*

The Dancing Scientist

As a child, my life consisted predominantly of school and dance classes. Dance classes were where I felt the most alive, the most like myself. I often struggled to express myself verbally and dance gave me a physical place where I could express myself, or at least a space where my body could release everything it held inside. The dance studio was where I felt confident and motivated to improve. I was good at school, but I did not always love my science classes. I loved aspects of science and I loved learning, but the way science was taught in school was not effective for me. I was a diligent note taker but the emphasis on memorization did not encourage me to generate my own questions or

apply what I learned. In fourth grade I took a whale-watching trip with my family and came away wanting to be a marine biologist. I was so inspired by the scientists and naturalists who seemed to have neverending knowledge about their respective fields and who showed genuine interest in me as a young person. They made me feel like my thoughts were important and that I could do what they did. They encouraged me to lead nature walks and point out the plants I could identify. They asked me questions about what I envisioned for my future in ways and talked to me like I was an adult, capable of making decisions for myself. In this environment, I loved science and viewed myself as a scientist, two feelings I rarely if ever felt in my science classes in school.

Confusion About the Future

When I thought about my future, I thought I had two options. I could either pursue dance or I could pursue marine biology. I would have to give up one or the other, or if I wanted to do both, they could not happen concurrently. When I was in eighth grade, I learned about liberal arts colleges. My understanding of which was that I would not be forced to immediately choose what I wanted to study, that I could take my time exploring, and potentially study more than one thing.This knowledge helped me grow out of my binary mindset. It was revolutionary for my thirteen year old brain. I chose to attend a liberal arts college because I could study both of the things I loved at the same time. I still viewed science classes as a means necessary to get to where I wanted to go, but I was hopeful for college science classes.

Science in College

Once I got to college, things were more complicated. I loved my dance classes, both the physical and academic ones, and I really did not like my biology classes. I felt

lost and insignificant in the sciences. One shining moment came in an introductory biology class when the professor showed us a video of protein synthesis (miraclemart, 2006). The short film was created in 1971 for the Department of Chemistry of Stanford University. The video begins with a short narration of the protein synthesis process, the linking together of amino acids to form a protein. Then for the next ten minutes we see college students dancing around a field wearing costumes and performing specific movements and gestures as determined by the role they play. There is also a narrator who provides context, additional scientific explanations, and rhymes built along the Jabberwocky poem – fitting for how so many folks feel about scientific jargon. It seemed like my professor showed it partially for laughs, partially as another way to explain the information. I remember sitting in the back of the lecture hall thinking, *That is what I want to do.*

Finding My Voice

The semester before I had to declare my major I was still undecided. I did not feel like biology was the place for me but also did not know what else I would do. I was able to register for the only biology class that seemed interesting to me: Behavioral Ecology. Behavioral Ecology is the study of interactions between individuals within populations and communities, usually in terms of how these behaviors evolved. The professor allowed us some freedom with our final project. The assignment was a literature review of a specific animal behavior. We could choose to write a six page paper, but the professor encouraged us to think more creatively. She suggested we create board games, children's books, comics, videos, posters, anything we were interested in. At first I thought I might create a children’s book, but when I met with the professor we talked

about dance and she suggested I try that. She had a student create a dance in the past and said it had been a success. Thus began my first official scientific dance. The behavior I chose to represent was bubble-net feeding, a specific feeding strategy utilized by humpback whales. I first spent time dancing around the studio by myself and creating a musical score. Then I recruited dancers and found a short time window where we could practice and film the dance. In that time I was able to explain the feeding behavior, answer questions, assign roles, guide my dancers in improvised movement to the musical score, and film the resulting performance. Most of the participants were not biology majors, just friends who enjoyed dance and were excited to share in a passion of mine. I continue to be friends with many of them and they still talk about this dance and how much they learned and enjoyed it. In conjunction with the dance I created what would be the program notes in which I explained my artistic decisions and gave a description of the behavior in terms that non-scientists could understand.

I took Behavioral Ecology my sophomore year and did not have many other science classes that let me choose something I was interested in and demonstrate my knowledge in a way that was engaging and made sense to me. Despite taking interesting classes, I was not motivated by them. I found that my dance professors were often so much more open minded about merging dance and science than my science professors were. During a guided improvisation as part of a rehearsal for one of the dance companies on campus I remember thinking about what I was learning in my chemistry classes. I began to dance out the various paths that valence electrons travel in atoms. I was not able to exactly replicate them on the lateral plane I was confined to, but it helped me ingrain them into my brain. When I shared this with my dance professors their eyes

became wide, both ended up choreographing pieces focused on science topics the following year. This can be contrasted to when my biology advisor asked what I was interested in doing after graduation. I mentioned scientific communication and he admitted to not knowing much about the field or how to help me get there. When I told him I was interested in dancing science concepts, he laughed at me. It took a lot of vulnerability to share that desire with him. He was supposed to be the faculty member supporting me. His blatant dismissal of my interests solidified the feeling that I was not accepted in the academic science field.

You Should Be Our Teacher

After graduating from college, I spent a year in the marine conservation field before deciding that was not the best job for me at the time. A friend mentioned a position at the school she worked at, that she thought I would be perfect for. The position was as an AVID tutor working with students in seventh, eighth, and ninth grade. AVID, Advancement Via Individual Determination, is an international program that focuses on preparing students for college, career, and other postsecondary options. From there I added on a position as a paraprofessional working with English Language Learners (ELL). I loved it all. As the years went on, I received encouragement from the teachers I worked with to pursue my teaching license, and was even more encouraged when I frequently had students ask me *why aren't you our teacher* and others blatantly stating *you should be a teacher*. Working with middle school students does not always leave a person with many compliments, so this felt important to me. If the students thought I could do it, maybe I should try.

Neutral at best and negative at worst, my experience in science classes no doubt contributed to why I never envisioned myself as a science teacher. Even after working in schools for a few years as an AVID Tutor and ELL Paraprofessional and considering pursuing my teaching license, I still did not think about being a science teacher. I never thought I could be – or wanted to be – a science teacher because I did not see myself represented. It had not yet occurred to me that it was not me who needed to change to fit into science. Instead, the way that science was taught in schools needed to be changed so that more students feel like they belong. It took other teachers, friends, and even middle school students encouraging me to understand that my experiences could help me to be a better teacher than those I had. They helped me see that I could be a part of the change.

Recent Professional Experience

After four years working as a paraprofessional and taking education classes on the side, I was ready to get my teaching license. During the 2021-2022 school year I was a student teacher in a seventh grade life science class and then was a long term substitute teacher for an eighth grade physical science class. Both of these experiences solidified my love of the middle school years, particularly the earlier years. When a job opened up at the middle school I originally worked at, I jumped at the opportunity. For the 2022-2023 school year I taught ninth grade physical science and eighth grade product design at two different junior high schools in the same district. For the 2023-2024 school year I will be at another middle school teaching eighth grade physical science in collaboration with the design teacher. This school also offers a dance elective for students and there is a precedent for collaboration between the science and dance departments. I

am looking forward to being in a teaching environment where my interest in arts integration is encouraged.

The Value of Integrating Content Areas

Traditionally, school subjects are separated. We have specific content classes and they do not overlap. This has created generations of students who think they are *not good* at specific subjects. It has also contributed to misunderstandings of subjects and the inability to see how they actually interconnect in the world. In many ways, our school systems are working exactly as they were designed. The goal of the common school was not to create generations of critical thinkers, and in many cases our public school systems have not veered too far away from this model. Even in the 1950s when we started to see an emphasis on math and science instruction it was mainly viewed as the way to defeat communism and further American ideals (Mondale et al., 2004). Many schools still today emphasize STEM (Science, Technology, Engineering, Math), but we often focus on standardized test scores and the regurgitation of information. I think this is why I loved my English classes in school. Those were often the teachers who encouraged us to express our ideas in a variety of ways and encouraged us to connect them to the world around us. In my science classes I was good at sitting and taking notes, and I was pretty good at memorizing information, but I struggled to apply that information to new situations. I and countless other students were not and are not taught to do that. I hope to change that with a Capstone centered around the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?*

Importance of Science Education

Today we are seeing the effects of science not being communicated effectively and thus generations of people not understanding science. There are people who still believe the Earth is flat, who deny the climate crisis, who do not know how air molecules circulate and how that affects our air quality, who do not know how vaccines and virus immunity works. I do not claim to know everything about all of these subjects either, but I trust the processes of science that have led us to the currently accepted theories, because I understand the rigor of the scientific process. I do know that the very Nature of Science is that it is constantly evolving and even though that can be confusing, that is how we learn and grow.

There are generations of students who have copied down notes and facts about science. People who were never given the opportunity to construct that meaning for themselves—to create experiments that demonstrate various scientific principles. This allows powerful people to capitalize on the general public's lack of knowledge and exploit our collective resources. I believe that if we can increase student interest in and understanding of science we can create positive changes for the future. Our future as a species depends on humans understanding science.

Importance of Movement

Humans learn in a variety of ways yet traditional schools are designed to benefit those who learn best independently, aurally (verbal-linguistic, logical-mathematical), and to an extent visually (NRC, 2012). Middle school students have high energy, both emotionally and physically. They need outlets to be able to channel that intensity productively, such as classrooms that allow them to actively participate rather than

passively absorb information. It is easy for educators to become frustrated when students come into class with excess energy, incorporating movement into classroom instruction will give students an outlet for that energy while also enhancing their interest and understanding of content.

Many students also learn while moving. Research in embodied cognition shows us that the mind is best activated when the body is moving and interacting with the world (Hrach, 2021). Dance as an art form is the use of movement to create meaning. Students learn best when what they are learning is relevant to their lives. By dancing or moving through content they will create relevance for themselves.

All of my science classes in school consisted of me looking at a powerpoint and taking notes. Most of the time, the slides only contained words. Even when we were able to tap into kinesthetic learning in the form of labs, they were all prescribed. I could read the lab instructions and know what was supposed to happen without doing any of the work. It did not allow me to make the meaning in a format that was most intuitive to me.

Cultural Relevance of Dancing

Traditionally, schools in the United States were not designed for students of color (Mondale, 2004a; Mondale, 2004b; Mondale, 2004c). Thus, many students today come from cultures that are directly at odds with the dominant culture at school. Although dance and movement were generally discouraged by the colonizers of North America, these practices hold significance, educationally and otherwise, for students from a variety of other backgrounds (Wicks, 2022). Many students of color face policing of their bodies to an extent that their White counterparts do not; asking them to remain quiet and still for hours during the school day is an extension of that policing (Wicks, 2022). Allowing

students more opportunities to move throughout the day will allow them to bring their full selves to the classroom rather than requiring them to stifle part of their identity. Working with young people the past few years, it is clear how prevalent dance and movement is. Even students who might not normally consider themselves to be dancers often know movements to countless TikTok dances. Incorporating more movement into the classroom will make school more culturally relevant for students, which will lead to their increased interest and motivation in school.

Summary

To summarize, the research question I am exploring is: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* For students from non-White cultures, art, dance, and movement have often been incorporated into education. Even if they have not had those experiences for themselves, the cultural knowledge remains. Middle school students especially have excess energy. When movement is made a regular part of a classroom it will give them an opportunity to release some of that energy while also grounding them in their bodies and increasing their engagement in the content. Relying on my own experience of using dance and movement as a tool to help me understand and communicate science, I will explore how to provide similar experiences for middle school students.

Chapter Two provides a review of relevant literature related to the values of using dance and movement as an educational strategy and specifically the use of it in communicating science, the importance of movement for middle school students mind and body development, and the role of science in middle schools.

CHAPTER TWO

Introduction

The goal of this Capstone is to develop a unit plan that utilizes dance and movement in a middle school science classroom as a means to foster motivation, interest, and understanding. The Capstone investigates the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* The following literature review addresses meaningful middle school science curricula and the role that developmental levels of middle school aged brains play in the development of those curricula. It also highlights the importance of dance and movement as a teaching and learning method as well as the specific implications that has on science education. Finally the literature review highlights the importance of culturally responsive teaching and how dance and movement can be used in a classroom to best meet the needs of all students.

Middle School Science Education

Introduction

Traditional teaching often views students as blank slates or sponges, ready to absorb information. This is changing, with Braund (2015) suggesting that in science education it is believed that the science world of knowing often conflicts with the student's world of knowing; that rather than merely transmitting knowledge, teachers have to facilitate the construction or reconstruction of what students already know in order for genuine learning to occur. A few aspects of middle school science education are important to consider when answering the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and*

understanding for students in middle school science classes? One aspect is the shift to student centered teaching as encouraged by the Next Generation Science Standards (NGSS), along with the three dimensions of education under this model. Related is the Nature of Science and the science teaching technique of the learning cycle. Another final aspect is student's interest and motivation in school and science classes in particular.

Shift to NGSS from Traditional Science Classroom

In an effort to combat the growing disinterest in science, many middle school science curricula are turning to the Next Generation Science Standards (NGSS). These standards were designed to help students become life-long learners; to help them not only possess science knowledge and skills but also to appreciate science (NRC, 2012). Much of the recent emphasis on science education focuses on competition and the need for skilled science and engineering professionals to keep the United States on the international playing field (NRC, 2012). While NGSS will prepare students for that, it also emphasizes the importance of science understanding for general life.

Three Dimensions of NGSS.

The NGSS focuses on three dimensions: scientific and engineering practices, crosscutting concepts, and disciplinary core ideas. By integrating these dimensions rather than reducing science to a collection of facts, students engage with science in deeper ways rather than skimming the surface. NGSS focuses more on the Nature of Science, that it is tentative, empirical, creative, subjective, and embedded in culture, rather than a prescribed set of memorized facts. There is an emphasis on inquiry and hands-on learning. It allows students to practice doing science, and to see firsthand how science

knowledge develops. Actually doing science has been shown to pique student interest and motivate them to continue (NRC, 2012).

Nature of Science

As previously mentioned, the NGSS emphasizes the Nature of Science. The Nature of Science is that science is, first and foremost, tentative. It is reliable and durable, but it is not forever concrete. Often the scientific method is presented simplistically or as a linear process where scientists ask questions, test hypotheses, and make rational conclusions. Science is constantly changing and always will. By nature, science is empirical, based on observations and interpretations. Data and evidence are used to support claims. As scientists gain more evidence they make revisions. Science is also imaginative and creative. All observations have to be interpreted and how this happens is dependent on who is interpreting them. This leads to another tenet of the Nature of Science, that it is subjective and theory laden. All scientists will interpret information differently based on their prior knowledge, theoretical beliefs and experiences, cultural background, training, expectations, and biases. This is because science is socially and culturally embedded. No knowledge is created in a vacuum, it is all produced in society. As societies change so does science. Overall, the Nature of Science views science as a human, social experience (Najami et al., 2019).

Learning Cycle

The learning cycle is a theory of science teaching and learning where students discover and explore a concept on their own, then receive clarification from a teacher, and finally apply the concept to a new situation (Bybee, 2009; Karplus, 2003; Hick, 2017). This method is more effective in teaching the Nature of Science. It allows students

to learn science by engaging with the practices of science. Hick (2017) calls the three phases of the learning cycle *discover, clarify, apply*. Karplus (2003) describes the *discover* phase as allowing students to first gain experience with a topic or concept, and learn more about it through their actions and reactions to a new situation. *Clarify* is the time for social transmission, where the concept or principle is defined (Karplus, 2003). *Apply* is then perhaps the most obvious, where students apply their new learning, whether it is a concept or reasoning pattern to a new scenario or situation.

Student Interest & Motivation in Science

Science Interest. Students are losing interest in science and in science related careers as they finish middle school, so researchers are focusing on why this is happening and how to fix it (Bae and Lai, 2020; Britner and Pajares, 2006; Christidou, 2011; Kaya and Kaya, 2020; Lee et al., 2016). Science in elementary school is often rooted in play and creativity, whereas when students get to middle school there is a shift to rote memorization of facts. Thus, researchers speculate that the decline in student motivation and interest might be due to the failure of classroom activities to be meaningfully engaging (Bae and Lai, 2020).

According to Häussler and Hoffmann (2000), a student's interest in science involves three dimensions: interest in a particular context in studying science, interest in a particular content connected with that context, and interest in a particular activity in conjunction with that content. They go on to explain that, based on these three dimensions, the context in which students learn science can be used to predict student interest. Integrating dance and movement into the classroom is a method to increase

student interest. Because students enjoy the arts, they perform better when they are incorporated into their learning (Simpson Steele et al., 2016).

Science Motivation. Motivation is often divided in two overarching categories, intrinsic motivation and extrinsic motivation. In their studies on student motivation, Lee et al. (2016) divided four aspects of motivation into those two categories. Those aspects are mastery orientation, where students are interested in learning for understanding, or because they enjoy it; self efficacy, students' confidence in their own academic ability; performance approach, when students are interested in learning for a grade; and performance avoid, when students are interested in learning to avoid failure. Mastery orientation and self efficacy were categorized as intrinsic motivation, while performance approach and performance avoid were categorized under extrinsic motivation.

Conclusion

A crucial part of answering the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* is addressing why students are losing interest and motivation in science classes and what is currently being done to combat that. The Next Generation Science Standards are worded to emphasize the Nature of Science rather than specific content. The change was made to promote lifelong learning rather than memorization to pass an exam. The learning cycle is a method used by many science educators to have students practice making meaning for themselves and practice doing science. Students lose interest and motivation when the work is not engaging and when they cannot see the relevance of the information to their life.

Middle School Development

Introduction

Frameworks of educational psychology are important to keep in mind when answering the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* Where students are developmentally impacts what teaching strategies will most benefit them.

Cognitive Development

From Piaget's developmental psychology perspective, early middle school students are shifting from the concrete operational stage of cognitive development to the formal operational stage. By the end of the concrete operational thought, students have a mastery of logical thought and operations, but can only apply them to concrete or physical objects (Mcleod, 2021) In the formal operational stage middle school students are beginning to be able to think abstractly and develop their theoretical and abstract reasoning. They move away from needing concrete manipulation and are able to manipulate ideas in their head (McLeod, 2010). However, it is important to remember that not all students will be at the exact same point in their development (Karplus, 2003). Furthermore, the shift between concrete operational and formal operational is not a simple switch. As students gain the ability to think abstractly, some types of abstract thought might come more easily than others. Middle school teachers must actively identify student reasoning patterns and adjust their instruction to match their students (Karplus, 2003). Dancing and movement in general are strategies that can be used to turn abstract concepts into something tangible and concrete (Fattal and An, 2019).

Piaget also described two processes of acquiring knowledge: assimilation and accommodation. Assimilation happens when new information is perceived then placed into appropriate existing organizational structures in the brain. By contrast, accommodation is where existing organizational structures are changed or modified based on new information (Hoy, 2013). Assimilation and accommodation are often described as two sides of the same coin. Where accommodation is the reconstruction of knowledge and involves a reorganization of the categories students already established for themselves, and these processes happen in the context of their prior knowledge and experience (Posner, et al., 1982). In other words, accommodation happens within the context of what has been assimilated.

Social Constructivism

Constructivist theory is based on Vygotsky's approach to development. Vygotsky argued that learning is social and collaborative; that language and culture are the frameworks we use to understand the world around us (Hoy, 2013; *Social constructivism*, n.d.). Constructivists argue that knowledge is not passively received, but instead actively built or constructed based on experiences (Bautista, et al., 2016). Because of the emphasis on collaboration, Vygotsky asserted that students construct knowledge through social negotiation (McLeod, 2022). Vygotsky coined the term Zone of Proximal Development (ZPD) which is understood as the space between what a student can do without assistance and what they can accomplish with assistance from someone more knowledgeable or from their peers (Hoy, 2013). Students can be aided through the ZPD by social support and scaffolding. Because middle school students are actively constructing meaning in the world around them, they benefit from school experiences

that allow them to experiment, rediscover, and reconstruct knowledge (Valls et al., 2019). Even beyond that, students will benefit from experiences that allow them to do that in ways where they integrate information and perspectives from multiple disciplines (Bautista, et al., 2016).

Middle School Identity

A third aspect of middle school development comes from the eight stages of Erikson's psychosocial development theory (Hoy, 2013). Middle school students fall somewhere in between stage four and stage five. Stage four is characterized by the conflict between industry versus inferiority. This is where it is important for students to build competency and confidence. Students become able to tackle more complex tasks, and when they are encouraged to do so, they build confidence in themselves. If they are not encouraged to do so, they might doubt their ability to succeed. Stage five is characterized by the conflict between identity and confusion. This is often where students begin to question who they are and where they fit into the world. Students often grapple with what it means to be authentic. They want to learn, they have a thirst for knowledge, and they need guidance to grow into their places in society (Hart, 1992).

Characteristics of Teens

Thompson (1998) describes nine characteristics of teens, the descriptions of three are as follows. First, middle school students want to have fun. They need to be entertained and engaged. Often middle school is a time marked by a shift from play based learning to quiet, lecture based learning. This change comes too early for middle school students. Incorporating their interests into class is something they will enjoy and benefit from. As previously stated, students have high emotional energy (Thompson, 1998).

Middle school is a time where many students are feeling new emotions and having new experiences. They often struggle with how to process them. Having opportunities in class where they can be active and involved can help them regulate and channel their intensity into something into their learning. Middle school students want their learning to have a practical purpose. Because they are trying to figure out who they are and how they fit into the world, they want authentic experiences that provide them with skills applicable in the real world (Bautista, et al., 2016). Thus, it is crucial to ensure students understand how the content being taught connects to life outside of school and why it is important. The world is multidisciplinary. As students progress through the world they will need to be comfortable and able to apply ideas from one discipline to another, when we teach them to do this in school they will be more engaged and more prepared for the future (Bautista et al, 2016; Thompson, 1998).

Social-Emotional Learning (SEL)

Academics are important in a classroom, and what is equally if not more important is for students to have the social and emotional skills they need in order to be positive, present citizens of the world (Tantillo Philibert, 2016). This type of learning is called social-emotional learning (SEL) and is defined by the Collaborative for Academic, Social, and Emotional Learning (CASEL) as the processes through which we "acquire and apply the knowledge, skills, and attitudes to develop healthy identities, manage emotions and achieve personal and collective goals, feel and show empathy for others, establish and maintain supportive relationships, and make responsible and caring decisions" (*Fundamentals of SEL,* n.d., para.1*)*. Before students can engage at school, their basic needs need to be met. Students must first feel comfortable and

supported—their physical, mental, and emotional needs need to be met—before teachers can effectively teach other content. CASEL highlights five aspects of SEL: self-management, self-awareness, social awareness, relationship skills, and responsible decision making (Enloe, 2021). These aspects highlight that in school it is just as important that students have the skills to cope with stress and anxiety as it is that they know core content (Tantillo Philibert, 2016). One way to increase coping skills and student resilience is through incorporating movement into education strategies. This is because allowing students the opportunities to create movement gives them choice and autonomy over their body (Enloe, 2021). When students are given a choice, they are more motivated to engage with the work.

Conclusion

Movement is often incorporated into elementary school curriculum and quickly dropped in the middle school years. Yet, while researching to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* we see that movement is just as important for middle school students as it is for the younger students. Students in middle school are in various phases of entering Piaget's formal operational stage of cognitive development. They are gaining the skills to be able to think abstractly, but still need support and scaffolding to be able to do so independently. Constructivist theory reminds us that learning is social, students will learn best when they are interacting with their peers in a variety of ways. Dancing and moving with others is one way to do this. Middle school students have high energy levels and often are not given opportunities to release that energy. By incorporating movement into class, we give

students a space to release the energy constructively, while also deepening their connection to themselves, others, and the world around them.

Dance and Movement in Education

Introduction

Traditional classrooms often feature a teacher standing at the front of the room and students sitting at desks. Students are expected to be still and to quietly absorb the information given to them. For some students –those who work well independently, who think and process in verbal-linguistic, logical-mathematical ways – this teaching method works (NRC, 2012). For those who work best in collaboration with others and who learn kinesthetically, these traditional methods are ineffective and frustrating. In order to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* thinking outside of the white dominant culture of the traditional school model is required. It is also important to remember that even students who might have assimilated to traditional school structure and more easily adapt to sedentary, passive learning structures will benefit from the increased oxygen to their brains when they move and the enriching of their own understanding (Fattal and An, 2019).

Learning through Dance and Movement

Embodied Cognition. Embodied cognition suggests that humans learn best when they are moving. This is because our sensory and motor systems are both used as we process and acquire knowledge. Students are less likely to dissociate when they are physically and creatively engaging with content material (Fattal and An, 2019). Hrach (2021) describes the scenario of humans using their hands as gestures and how that act "[connects] motor association with new conceptual language" (p. 116). When we dance or move, we are adding a kinesthetic anchor to the content (Fattal and An, 2019). In other words, we are able to embody and give concrete meaning to abstract ideas. In this way we can make abstract concepts more tangible (Fattal and An, 2019). Wicks (2022) describes *bodily learning* as "learning in the whole body, in the whole person, and between humans in social and material realities" (p.13). From this description, when we turn our attention to the body we learn about ourselves, our connections to others, and our connections to the world around us.

Dance to Deepen Understanding. Although dance and movement are some of the oldest tools of communication, they are often underappreciated (Hrach, 2021). While dance is often accepted as a form of expression, the role it plays in the education of children, specifically from many non-white cultures, is often ignored (Banks, 2010). In many ways, we forget that the movement expression of dance *is* communication. Dance provides both a communication tool and a teaching strategy, especially when it is integrated with other core content areas, (Fattal and Needle, 2022). Research combining cognitive psychology and dance shows that humans can interpret complex emotions through watching dance movements (Gervasio, 2012). Thus, when students engage in these dance practices themselves, they are merging cognition, emotion, and kinesthetic intelligence (Fattal and Needle, 2022). This merging makes it easier for students to grasp complex concepts than simply listening to a lecture and taking notes.

Movement can be used to deepen students' understanding of concepts they learned in other more traditional ways (Braund, 2015). This is because creating a dance or movement phrase is more interpretive than pantomiming or directly representing a concept (Cone and Cone, 2002). Pantomime can be a place to start if students are stuck. In some ways pantomiming is the physical representation of regurgitating what was told to them. In order to demonstrate their full understanding of a concept through movement, to go beyond simply responding to a task, students have to use critical thinking and imagination to explore possible interpretations of the content (Cone and Cone, 2002). When students engage in dancing their learning, not only are they deepening their understanding of the content, they are also increasing their creativity (Wicks, 2022)

Arts Integration Curriculum. While researching *How dance and movement can be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* it is helpful to consider the benefits of arts integrated curriculum. Generally speaking, integrated curriculum is student-centered and often focuses on a theme or real world problem that is drawn from many subject areas (Bautista et al., 2016). The emphasis is on the students as learners and the ideas themselves rather than on the disciplines (Bautista et al., 2016). Arts integrated curriculum is then a teaching method where content and processes of two or more subjects, at least one being arts related, are combined (Richard and Triechel, 2013).

Arts integration allows students to relate ideas from different content areas and create new interdisciplinary connections for themselves (Bautista et al., 2016) The real world is not divided into content areas. Anything that students might want to pursue after high school will require them to apply ideas and procedures from a variety of disciplines. In this way, arts integration in middle school gives students a space to practice this kind of authentic, multidisciplinary critical thinking and better understand the world. Not only will it give them the space to practice, it will also improve their higher level thinking and make knowledge transfer easier (Bautista et al., 2016).

Integrating arts with other subjects generates conditions deemed ideal for learning by cognitive science and education researchers (Rabkin et al., 2005). It provides them with authentic, challenging intellectual experiences in addition to teaching communication, fostering creativity, providing tools for critical assessment, and promoting a sense of civilization (Farrell, 1991).

Science through Dance and Movement

Science of Movement as Meaning Making. The greatest interest in the connection between dance and movement and the sciences comes from the dancers rather than the scientists. However, some recent advances in the scientific study of the brain and body might change that. In the late 1930s, John Martin, dance critic, proposed that "dance 'worked' by 'speaking' directly to the bodies of the audiences (Conroy et al., 2013). His work eventually gained new life in broader theoretical circles after discoveries of mirror neurons in the 1980s (Conroy et al., 2013).

Mirror neurons are neurons that fire when an observer witnesses actions of a performer that reflect those fired in the performer. Essentially, if the observer sees the performer raise their arm, the neurons associated with the action of raising an arm fire in the observer. It is theorized that mirror neurons could explain a variety of human capacities such as the ability to understand the intention of others, to learn through imitation, and emotional empathy (Conroy et al., 2013). Perhaps the most obvious connection to classrooms is learning through imitations. However a case can also be made for groups of students moving or creating dances around a topic and others learning both from actively performing and actively observing.

Making Meaning in Middle School Science. There can be a disconnect when learning science. Science plays a role in many aspects of our daily lives, often in ways we are not aware of. Yet at the same time, so much of science is not easily seen and relies on our conceptualizing invisible components such as energy, molecules, electrons, and cells (Braund, 2015). Symbolic language, equations, symbols, and graphs help students conceptualize the information, but when the symbols we teach do not align with students' own preconstructed ideas our symbols become just another piece to memorize and add to their jumbled puzzle (Braund, 2015).

Many terms used in science have different meanings in the world outside of science. An often confused example is *energy*. In daily life energy is spoken of as a consumable entity (Braund, 2015). It can be generated, saved, lost, or run out completely. In science, however, energy is transferred or transformed, it cannot be created or destroyed. Teachers often utilize analogies to draw comparisons between an unfamiliar science concept and something familiar in students' lives, but a problem with this approach is that not all students will fully understand the connection (Braund, 2015). Other teachers will use hands-on activities or practical applications to help teach concepts, but this can often lead to students performing rehearsed routines and procedures rather than understanding and applying them (Braund, 2015). Teachers utilize modeling both as part of the NGSS science practices and from what they know to be effective teaching. Inviting students to use their own bodies to create three dimensional models grounds students in the physical space around them and provides a kinesthetic anchor, turning abstract concepts into physical reality (Fattal and An, 2019; Fattal and Needle, 2022; Braund, 2015). The process of transferring a model discussed in class,

drawn on paper, or read about in a textbook to a three dimensional model on human bodies requires students to conceptualize their knowledge (Ødegaard, 2003; Najami et al., 2019). For the students who understand the model based on traditional teaching styles this will allow them to reconsider what they know, and for the student who did not understand from traditional methods alone, enacting the model is a crucial step in their understanding.

Creative Process and the Nature of Science. *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* While at first the connection between dance and science might seem tenuous, the creative process and the science process are actually quite similar. They both utilize creative problem solving which facilitates higher order thinking (Cornett, 2011, p. 5-6; Deasy, 2002). Nichols and Stephens (2013) extensively collate the scientific method and the creative process. When the principles of the Nature of Science, these being that science is empirically based, tentative, subjective, imaginative and creative, collaborative, and rooted in social and cultural influence, are substituted in for the scientific method, the connections become even more clear. Both processes are cyclical (Nichols et al., 2013; *The nature of science*, 1990). They begin with a question or problem to be explored. Experimentation ensues, the inquiry processes of which are determined by the methods of the particular creative or scientific discipline. Evidence or data is gathered, practitioners think imaginatively to interpret their work, then it is revised, adjusted, edited, or rehearsed as necessary and appropriate. By engaging with the creative process, students in science classes both learn the concepts and gain an appreciation for the Nature of Science and how science interacts with society (Ødegaard, 2001, as cited in Braund, 2015). When students are engaged, when they physically experience the content, they will retain more of it (Nichols et al., 2013). In this way, when students are given opportunities to dance and move in their science classes, they are more interested and gain deeper understanding.

Dancing the Learning Cycle. As previously mentioned, the learning cycle is a theory of science education where students *discover* and explore a concept on their own, then receive *clarification* from a teacher, and finally *apply* the concept to a new situation (Bybee, 2009; Karplus, 2003; Hick, 2017). Dance and movement can be involved at any part of the learning cycle. Choreography itself has a construction of a beginning, middle, and end (Fattal and An, 2019). It begins with a discovery, the discovery is clarified and elaborated on, then it can be applied. When dance is taught it can be used as a method to acquire, reinforce, or assess learning (Hanna, 2008 as cited in Fatal and Needle, 2022).

Kaya and Kaya (2020) explained a scenario of a lesson around the subatomic structure of an atom. In this example of a class of thirty students, a teacher gave eighteen students labeled cards. Six students received cards labeled *proton-positive*, six received cards labeled *neutron-neutral*, and six received cards labeled *electron-negative*. Students were not told what their relationship to each other was, but they were invited to explore and discuss based on their prior knowledge. This is the *discovery* stage of the learning cycle. After all students shared their thoughts, the teacher used the same activity but guided the students to represent the structure of an atom. The teacher *clarified* misconceptions and gave students space to talk through their preconceptions and how the clarification changed them. As the *application* portion of the learning cycle in this lesson, the teacher had students draw the atomic structure of an atom. In this example, movement was used in the first two phases of the learning cycle. Other scenarios could include concepts first being presented on paper or orally and then students apply what they learned by using their bodies.

Success of Dancing Science. Dance has been used both in and out of classrooms across the world to facilitate science education. Many scientific concepts are difficult to conceptualize because they are impossible or very difficult to see with the human eye. Dancing the concepts is a way to bring them to life. Whether it is principles of physics and chemistry such as energy, chemical bonds and reactions, atoms and subatomic particles, acids and bases, the periodic table; principles of earth science like weather, moon phases, astronomy, wind turbines, earthquakes; or even life science with cells, genetics, physiology, human body systems, photosynthesis, and DNA translation, moving the human body can turn abstract concepts into concrete understanding (Azevedo et al., 2018; Buono et al., 2022; Burke, 2009; Egan et al., 2015; Fattal and An, 2019; miraclemart, 2006; Najami et al., 2019; Simpson Steele et al., 2016; Solomon, 2022).

Dancing Physical Science. Physics and chemistry can be polarizing subjects, especially for middle school students. Even at its root, dance is an exercise in physics. Dance and movement are direct perceptions of force and motion—weight and force interacting with time and space (Stevens et al., 2005). Scientific meaning can be given to the movements themselves.

Dance has often been used to generate interest in physics and chemistry (Najami et al., 2019; Solomon, 2022). Solomon et al. (2022) explored how dance could be used to increase understanding of and interest in physics for Black girls. By using dance and a process of inquiry to explore concepts such as gravity and the characteristics of elements on the periodic table, students were able to discover new ways of thinking and increased interest in a subject that was previously inaccessible to them (Solomon et al., 2022). The students they worked with were dancers, so they had a knowledge base and movement

vocabulary they could use to draw parallels between the familiar movement and the unfamiliar content.

In another case, a chemistry teacher from a rural public high school collaborated with a professional dancer to explore chemical bonding and reactions (Burke, 2009). A student from the class emphasized their dislike of chemistry before art was incorporated into class. Another explained that because single atoms are invisible to the human eye, it was helpful to represent the atoms with the body and dance the reactions and relationships (Burke, 2009). In this case, students gained a deeper understanding of the content and were more interested than they were before dance was involved.

Dancing Earth Science. Although generally more well liked than physical science, earth science is still greatly enhanced by arts integration. Fattal and An (2019) explored choreographing the moon's changing phases through a month. In many ways the moon cycle is a dance all on its own. Their representation included four hula hoops with black and white paper on each side representing a different phase of the moon. Simpson Steele et al. (2016) created a unit to explore how energy is transformed. This multimodal approach included hands-on activities, field-based experiences, interviews with experts, the use of science notebooks, creative movement improvisation, dance choreography, engineering wind turbines, and social activism. The unit merged physics and earth science in that students improvised creative movement to express types of wind like gusts, zephyrs, whirlwinds, and crosswinds (Simpson Steele et al., 2016). Students developed a dance vocabulary to represent the science vocabulary. Then as they began to engineer a model wind turbine, they used dance to make shapes with their bodies to represent how the turbine blades catch different types of wind. They engaged with the creative process and the Nature of Science through trial and error, feedback, and revisions (Simpson Steele et al., 2016). Students declared that the science made the dance better and the dance made the science better.

Dancing Life Science. There are multiple examples of life science being explored through arts integration and specifically movement. One such experience mentioned in Chapter One is that of the short film exploring protein synthesis developed at Stanford University in 1971 (miraclemart, 2006). In the video college students performed specific movements and gestures to represent the linking together of amino acids to form proteins. A similar process could be used in middle school to make the abstract concepts concrete.

When exploring food webs, Braund (2015) described a physical simulation where students represent organisms in an ecosystem. They were connected by strings and could tangibly feel forces being transmitted between others in the web whenever changes were made to the web. This provides students with a plausible and accessible alternative to seeing a web drawn on paper.

An aspect of life science is often learning about body systems. Dance can be a way to explore the musculoskeletal system and physiology to help students better understand anatomy (Farrell, 1991). Students could gain new perspectives by drawing parallels between athletes of different sports (Farrell, 1991). In another example, Amplify Science's Metabolism Unit (n.d). includes a lesson where students move around a classroom representing protein, starch, amino acids, glucose, and oxygen in the respiratory, digestive, and circulatory systems.

Buono et al. (2022) described an educational opportunity for students to explore the topic of microbes. Students were invited into a space to view dancers enacting their own representations of microbes. Then they were asked to verbally identify the characteristics they witnessed. They worked with dancers to improvise movement and choreography and perform their own sequences representing microbial movement (Buono et al., 2022). Dancers and students used their whole bodies to make scientific concepts such as homeostasis and symbiosis physically tangible.

Conclusion

In order to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* it is important to understand

the relationship between dance and learning. Dance and movement have long been both tools for communication and tools for education (Hrach, 2021; Wicks, 2022). Dancing provides students with a way to deepen their understanding of content as well as a way to increase their creative thinking (Wicks, 2022). It provides them with a way to make abstract concepts concrete—a way to model the content with their body. This is especially important in science, which is a field riddled with symbols and abstract concepts (Braund, 2015). Dancing can even be incorporated into the three phases of the learning cycle as a way to discover a topic, clarify it, or apply what students learn to a new scenario. Finally, dance can be used as a way to integrate arts and science, as well as a way to integrate various scientific disciplines (Azevedo et al., 2018; Buono et al., 2022; Burke, 2009; Egan et al., 2015; Fattal and An, 2019; miraclemart, 2006; Najami et al., 2019; Simpson Steele et al., 2016; Solomon, 2022).

Culturally Responsive Teaching

Introduction

Curriculum should reflect the culture of the current students. Culturally responsive pedagogy is a term developed by Gloria Ladson-Billings, based on three theories about what contributes to success for all students. The first is that successful teachers focus on students' academic achievement; second, they develop students' cultural competence; and third, that they foster students' sense of sociopolitical consciousness (Ladson-Billings, 2001). The next two sections will expand on these principles to help answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?*

Culturally Responsive Pedagogy in Science

Culturally responsive pedagogy is especially important in science classes. Schools are places of cultural dissonance for many students of color, science classrooms especially so. This is due to the technical, authoritative, oppressive, depersonalized culture of science (Xu, Coats, & Davidson, 2012). In an effort to make science unbiased, we have created a discipline devoid of emotion. This replicates the policing of bodies that disproportionately impacts students of color and thus creates a racist discipline. Culturally responsive pedagogy creates an accepting, caring, and trusting atmosphere for all students. It is important for educators to teach based on social and cultural contexts. They must understand the learner and their past school experiences in order to be able to identify individual needs and link learning to that individual experience (Fraser-Abder, 2010). They need to understand the oppression that their students face every day in school and outside of school (Emdin, 2009).

Science and science education is rooted in Whiteness (Rivas Castro, 2022; Harding, 2015). Education has been designed to best serve White, middle-class and wealthy students. It was “not designed to celebrate minority culture” (Wicks, 2022). Because many students’ core cultural identity is at odds with White culture and thus school and science classroom culture, culturally relevant pedagogy is needed in order to meet the learning needs of students of color. When students of color enter schools they have to code-switch to fit the dominant school culture. When they enter science classrooms, they have to code-switch again to fit into traditional science culture. This makes learning science a cross cultural event, one teachers must guide students through (Aikenhead, 2001). Even beyond that, Freire (2000) emphasizes that students from

oppressed cultures are not people living “outside” society. Instead, they are living “inside” a system that has not been designed to serve them (Freire, 2000). The solution then, would not be to integrate them into the oppressive system, but rather to change the system so it can better serve all students (Friere, 2000; Wicks, 2022).

Black, Indigenous, and other students of color are increasingly encouraged to pursue careers or interests in Science, Technology, Engineering, and Math (STEM), however those spaces are not currently welcoming, accepting, or accessible. BIPOC students are asked to code-switch and to stifle their imagination and creative capacity because our schools and classrooms are not designed to be welcoming for their authentic selves (Sizemore Davis, 2022). When subjects are taught in culturally relevant manners, students will be intellectually, socially, emotionally, and politically empowered (Strachan, 2017). When teachers make and use connections to students’ cultural knowledge, skills, and attitudes they validate students’ culture and ways of knowing, leading students to feel seen, heard, and like they have agency in the field (Aikenhead, 2001; Emdin, 2010). It is important for students to have opportunities to be immersed in both their own culture and the science culture each day, where they are consciously aware of which culture they are participating in at any given time (Aikenhead, 2001). Opportunities to participate in their own culture should not only happen outside of school and class time.

Dance and Movement as Culturally Responsive Teaching

Students are bored and disinterested in classrooms where they only interact with information through a single medium. Utilizing a variety of techniques is important both when teaching a lesson as well as assessing how well the students understand the lesson. Historically, dance and movement have played a major role in the education of children

from a variety of non-white cultures (Wicks, 2022). Dance and movement give students autonomy over their bodies, a direct contrast to the way their bodies are often policed in schools that require them to be still and quiet for hours each day (Wicks, 2022). Furthermore, movement and arts integration have been linked to increased executive function in students of color in at-risk and urban situations (Gatz, 2019; Moss, 2018). Students who might not be comfortable reading, writing, or speaking might be more comfortable moving. It can encourage those students who normally do not feel like they have a voice to speak up and use their strengths to communicate (Simpson Steele et al., 2016).

Many BIPOC students feel they cannot bring their full selves to STEM fields. Often they work so hard to gain acceptance from a community that was not designed for them to succeed. They assimilate, code-switch, and try to "make [themselves] palatable and conform to the dominant science culture" (Baxter, 2022). Students of all kinds bring their own experiences to the classroom but it is often only students from the dominant culture, in the case of the United States, White culture, who see themselves represented in science. The voices and culture of urban and BIPOC youth need to be considered and amplified in science classrooms and beyond (Baxter, 2022).

Many students come to classrooms with bodily awareness from sports, dance, or other activities outside of school. Giving students space in class to do the activities they might do outside of class and connecting it to the content, will help them to engage in class. They will be more interested and they have a higher chance of understanding the content and staying motivated. When students are allowed to make their own connections, the teacher can use the student's knowledge as points of entry and focus on

filling in the gaps (Emdin, 2007b). As mentioned previously, Solomon et al. (2022) utilized this concept when working with Black dancers to explore physics principles. When physics was related to something the students knew and enjoyed, they gained interest in physics.

Although some students come to classrooms with some movement experience, others do not come with that level of comfort. Leonard et al. (2020) provide a framework for incorporating dance and movement into classes for teachers and students who might not be familiar with dancing or incorporating it into the classroom. Many examples use hip-hop as a way to connect with students, but it is also emphasized that students can be the best resource for determining what strategies a teacher can use to connect with them (Baxter, 2022; Leonard et al., 2020).

Conclusion

How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes? Culturally responsive teaching is teaching that responds to the needs and interests of students. As mentioned multiple times, dance has often been a part of education for people of many cultures (Wicks, 2022). It makes sense then, that it can be used as a strategy now to increase interest among students, especially those underrepresented in science fields.

Summary

The goal of this literature review is to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* In order to

maximize students' interest and motivation in science it needs to be relevant and relatable. The emphasis on the Next Generation Science Standards and the Nature of Science reminds students that science is constantly changing and adapting with society. The learning cycle provides teachers with a way to best present science information so that students can learn science while actively participating in it.

Grounding the work in middle school development is a reminder to create curriculum for the appropriate age group. At this age the content is important, but almost more important is building relationships, confidence, and critical thinking. It is important for middle school students to be active and engaged and for them to develop social emotional skills that will help them grow into well adjusted adults. Additionally, because students are still developing their ability to think abstractly, having multiple ways to make the abstract tangible is necessary for all students to understand.

There is growing research exploring the connections between dance and movement and cognition. Students are generally interested in art and culture so incorporating elements of art into core curriculum is a way to encourage them to be more interested in core content. Because so many scientific concepts are abstract, bringing them to life on the human body is a clear way to make them concrete for students.

Because schools have traditionally been designed to assimilate students into society, it is important to approach curriculum from a culturally responsive viewpoint. Many students come to school from cultures that have utilized kinesthetic knowledge, dance, and movement as part of their education. By including similar practices in schools we make classrooms more accessible and equitable.

Chapter Three explains the Capstone project in detail. The Capstone integrates the literature reviewed in Chapter Two and includes elements of the frameworks referenced. Chapter Three highlights the pedagogy that informs the structure of curriculum creature as well as the timeline for the project. It also includes a description of the setting and participants.

CHAPTER THREE

Introduction

This Capstone is based on my findings from the research question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* In response to my findings I created a project that applied the research to my classroom. I built a curriculum for students in my eighth grade physical science classes to help them foster motivation for, interest in, and understanding of physics and chemistry.

At the end of this class, my goal as a teacher is for my students to be critical thinkers and on their way to being lifelong learners. It is my hope that through this class they have learned something new, but more importantly that they have learned how to think critically and creatively. I strive to create a classroom where every student feels seen and that they can bring their full identity to class. Grounding them in their bodies as a part of class is the way I have chosen to achieve my goals.

This chapter describes the theoretical frameworks that guided the creation process for the curriculum. I discuss the learning cycle, understanding by design and backwards planning, arts integration pedagogy, and critically responsive pedagogy. Next, I describe the setting and audience for my project. Then I expound on the timeline of the project, including both how long it took to create and my proposed timeline for implementing it with students.

Project Description

Movement Based Physical Science Curriculum

For my project I designed a curriculum for dance and movement focused physical science classrooms. I began each unit with an overview of the purpose, knowledge and skills students will learn, key academic vocabulary, and the state standards met by the unit. The first unit is very specific to how I plan to begin my new school year with students. The focus is on building a safe, respectful community of learners and introducing students to the Next Generation Science Standards' principles of the Nature of Science. These being that science is empirically based, tentative, subjective, imaginative and creative, collaborative, and rooted in social and cultural influence.

Units 1: Atoms and the Periodic Table and Unit 3: Energy each contain a lesson outline that includes objectives, a materials list, a chronological description of lesson activities and the approximate time they will take to complete, and an assessment. At the end of all five units, I include Additional Movement Resources. These resources contain ideas for movement and mindfulness activities that can be used to start or end class, to transition between activities, or as brain breaks during longer lessons. Due to other differences in settings, teachers will likely need to adjust this curriculum to better fit the needs of their students and other curricular, assessment, or other constraints that may be in place at their place of work. Essentially, the core of this curriculum can be modified by teachers of any subject for students of all ages.

Theoretical Framework of Curriculum Development

Arts Integration Pedagogy. The curriculum I created for my Capstone project is essentially the definition of arts integration pedagogy. Richard and Triechel (2013) define it as a teaching method where the content and processes of two or more subjects, at least one being arts related, are merged. I created a curriculum where I teach science content and processes through the lens of dance, movement, and the creative process. I did this because arts integration allowed my students to draw on their kinesthetic knowledge and way of knowing as a way to understand abstract scientific concepts. This method enhances critical and creative thinking, both processes valuable both in science classes and out.

Culturally Responsive Pedagogy. The traditional classroom setting of a teacher presenting information to sponge-like students ready to absorb it is outdated and rooted in oppression and White supremacy. It teaches compliance rather than critical thinking. Culturally responsive pedagogy is teaching that utilizes a variety of techniques both to teach and assess students' understanding. Wicks (2022) reminds us that dance and movement have historically played a major role in the education of children from a variety of minority cultures (Wicks, 2022). Thus, incorporating dance into my classroom was a clear way to make my classroom more culturally responsive and relevant.

Understanding by Design / Backwards Planning. Understanding by design is a framework from Wiggins and McTighe (2011) that I relied on in the creation of my curriculum. This method places student understanding at the forefront, recognizing students are more likely to achieve in the long run if the focus in school is understanding concepts and the process of learning. Their approach is constructivist in that it emphasizes students actively constructing meaning rather than memorizing or absorbing. Using understanding by design, the first step was to determine my desired results. In accordance with my research question, h*ow can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* my desired results were for my students to be motivated and interested in science and for them to understand the concepts. Next I determined how I would gauge their motivation, interest, and understanding. Then I planned experiences and instruction that would help my students achieve my goal for them. By creating a movement based science curriculum, I created situations where students are active participants in the classroom. Students embody the science concepts, leading to deeper understanding.

Learning Cycle. In planning my curriculum I considered the learning cycle, the theory of science teaching and learning characterized by three phases: *discovery*, *clarification*, and *application* (Karplus, 2003; Hick, 2017). In this method, students have opportunities to discover a new concept and gain experience with it. There is then space for the concept to be clarified and defined. Then when students have had time to explore and refine, they have the opportunity to apply what they have learned in a new way. In the creation of this curriculum I chose to incorporate dance and movement in each of the three phases. I used dance and movement as a way to acquire, reinforce, and assess my students' learning (Hanna, 2008 as cited in Fatal and Needle, 2022). Some lessons began with students embodying their preconceived ideas about a topic, others culminated with students using movement to demonstrate their learning.

Setting and Audience

I planned this curriculum for middle school physical science students. Students came from a range of backgrounds including various races, religions, genders, home language and ability. The school I am teaching at for the 2023-2024 school year is 24% White, 54% Black/African American, 9% Hispanic/Latinx, 9% Asian or Asian Pacific Islander, 4% Native American/Indigenous. Students receiving ELL services comprise 13% of the population, 60% qualify for free or reduced lunch, and 20% receive special education services. Because approximately 76% of my students are students of color I need to ensure those students felt seen and heard in my class. Traditional models of teaching will not be successful models for these students. I have access to two different classrooms for my students. One is a traditional classroom space and the oher is our lab space. This makes it easier to implement movement focussed lessons in the classroom

because there is no fear of disrupting lab equipment. There is also a dance studio that I could use for collaboration with the dance teacher. On nice weather days there are multiple outside locations my students and I could use for extra movement space.

Timeline

I began the process of designing this curriculum during the summer of 2022 directly before I started a new job as a physical science teacher. I took this first year as a teacher to get to know my students and the content. The curriculum was designed in the summer of 2023 before my second year as a physical science teacher. I drew heavily from content created during the 2022-20223 school year and adapted it to include movement and dance. My second year as a physical science teacher is my first year in a new district at a new school. This school offers a dance elective and there is already a precedent for combining science and dance so I plan to implement my project during the 2023-2024 school year.

Assessment

The middle school I work at is an International Baccalaureate (IB) school so for each class, students are assessed based on four different rubrics. The rubrics emphasize skill building and critical thinking, where students have the ability to score higher on the rubric if they demonstrate deeper levels of critical thought such as applying information in unfamiliar situations and connecting to other content areas. With the implementation of my dance and movement focussed science curriculum I expected to see more students reaching mastery.

Summary

The creation of this curriculum has been informed by the research question: H*ow can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* I used arts integration pedagogy by using dance and movement as a tool for exploring science. By merging the two, students practice the creative process and the Nature of Science. The very act of incorporating movement and dance into a classroom disrupts the traditional schooling method and makes the curriculum more culturally responsive. I used understanding by design and backwards planning in that the curriculum was created with the goal of increasing motivation, interest, and understanding in middle school science classes. By incorporating the arts and movement, my curriculum increased these qualities. Finally, dance and movement were incorporated into various places in the learning cycle. My units and the individual lessons themselves are structured with the learning cycle in mind.

In Chapter Four I reflect on my research question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* I will more deeply consider the impacts the curriculum I created will have on students. I will describe limitations to my project as well as any changes I would like to implement in the future.

CHAPTER FOUR

Introduction

This Capstone aimed to answer the question: *How can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* This final chapter will address what I learned from creating a dance and movement focussed eighth grade physical science curriculum. I will discuss the challenges of creating this curriculum, and of teaching science content through dance and movement from both a conceptual and physical perspective. Next, I will briefly summarize the literature review, with a specific focus on what stands out to me now and on the elements that proved to be the most influential to my project. I will also discuss new connections and understandings after completing the curriculum design project itself. I will then describe implications of the project as well as limitations for implementation. Finally, I will address areas for further exploration and my recommendations for incorporating movement into classrooms. .

Challenges

The biggest challenge I faced is that I did not have a guide for what a dance and movement based science curriculum could look like. From what I can gather from the research, there are not many people creating dance based science curriculum. There are many stand alone lessons or lessons a teacher could incorporate into a larger science unit, but a dance and movement centered curriculum is new. This led to significant frustration and self-doubt which inhibited my creative process. All this said, the second round of research for this project did lead to one of my biggest inspirations and idealizations. This is the Learning Science through Dance model described by the CASE project (From

Delis and Ulveseth Lilletvedt, n.d.). Reflecting now, I can see how much like the scientific method it is. Both begin with asking questions, then finding and analyzing evidence. From there is a great deal of explaining, connecting, revising, communicating and reflecting until a temporary explanation is made.

A second challenge was feeling pressure to include all related science standards and to ensure I was covering *enough* science content. To me, this demonstrates how pervasive the mindset is that tells us art and creativity are *not enough*. I am so accustomed to scientists and academics condescending me and telling me that my interests are futile that I begin to believe this messaging myself. Through the curriculum creation process I had to remind myself that my students would be learning science content and applying scientific inquiry, just in a different way than is usually expected in science classes. What I learned is that just because the creation of a dance and movement based science curriculum is difficult does not mean it is not worthwhile and valuable.

Through the creation process I allowed myself to dream and to not feel limited by physical classroom walls. It is possible that I will not have the space for my students and I to feel comfortable and free enough to dance and move in the ways I hope we can. In this case, we will have to pivot and either make small dances and movements, or find ways to branch outside of our classroom walls.

Literature Review Recap & New Connections

During the curriculum writing process, I kept returning to the research in embodied cognition which suggests that humans learn best when they are moving. When we are moving, multiple bodily systems are activated, in this case the sensory and motor systems. The more systems that are activated at once, the less likely we are to dissociate

and the more likely we are to actively and critically engage with, process, and acquire knowledge (Fattal and An, 2019). Dancing and moving adds a kinesthetic anchor to the content and allows abstract scientific principles to become concrete (Fattal and An, 2019). Wicks (2022) term *bodily learning* defined as "learning in the whole body, in the whole person, and between humans in social and material realities" (p.13), also continues to inspire me. The term is expansive in that it covers how we move in our own bodies, how to move with others, and how we move through space. It is my dream that through incorporating movement into my classrooms, students will learn about themselves, their classmates, their connections to the people around them, the science content, and the connections to the larger world.

Middle school students often come to school with plenty of physical and emotional energy. Rather than being forced to sit in a chair all day, they will benefit from classrooms that allow them to move. It leads me to wonder if this is why so many students like their Physical Education or Gym classes— because they have an abundance of energy and that is one of the few, if not the only, place they are allowed to move the energy through their bodies. Relatedly, middle school educational instruction traditionally focussed on quiet, still note taking and memorization rather than the play-based learning found in many elementary schools. Incorporating dance or movement into the classroom gives students the feeling of play, which they enjoy, even if they think they are too old to *play*. We know that when students enjoy what they are doing, they are more likely to both engage and perform better (Simpson Steele et al., 2016). In other words, they are more likely to be interested and motivated, and more likely to understand.

Most of the schools I have worked at in the past have been approximately 50% White and 50% non-white. The school I will be at for the 2023-2024 school year is 24% White and 76% non-White. Culturally Responsive pedagogy is important for students of

all racial, ethnic, socioeconomic, cultural backgrounds, and as a White teacher, I need to ensure I am meeting the needs of all of my students. The technical, oppressive, and depersonalized culture of Western science classes did not allow me to thrive and I am far closer to who the system is designed to serve than my students are. If it did not work for me, it certainly will not work for my students. For this reason, I turn to dance and movement. Firstly, as mentioned countless times, dance and movement have frequently and historically been a part of the education of children from non-white cultures (Wicks, 2022). It should then not be surprising that movement and arts integration have been documented increasing executive function in students of color in at-risk and urban situations (Gatz, 2019; Moss, 2018). For some, myself included, dancing allows students who might not be comfortable reading, writing, or speaking a way to engage and demonstrate what they know. When I felt stuck in my curriculum writing, I tried to remember these students. Although perhaps I will not have a class of students where they all want to dance their final unit assessment, I might have a few, and I want to give them the opportunity to do something they might not be encouraged to do otherwise.

I did not understand chemistry in middle school or high school, and only really began to grasp it in college after repeating a class and exploring concepts through movement. A large part of this for me was that I could not visualize the concepts. I could not understand the paths electrons took nor how to balance equations. Dance helped me with the former in college, and I know it would have helped me with the latter, in middle school. The reminder from Stevens et al. (2005) that scientific meaning can be given to and made from the very movements of our bodies and then the more detailed documentation by Solomon et al. (2002) and Burke (2009) that students gain deeper

understanding of and are more interested in physics and chemistry helped guide my curriculum development.

Limitations

Similarly to the challenges, this curriculum is limited in that it is designed specifically for a physical science classroom. I felt limited by trying to cover specific content and standards, while also allowing for creativity. I was inspired by the CASE project (From Delis and Ulveseth Lilletvedt, n.d.), and loved their method of allowing students to develop a question about the assigned topic. As mentioned, in many ways it parallels the scientific method. However I struggled to find the balance between ensuring students learned what I want them to and giving them the freedom to explore. The majority of the examples I encountered were in situations with a very low student to teacher ratio. These scenarios make it possible for each student to develop a question and for the teacher to be able to guide each of them effectively in answering that question. Although it is possible to have a low student to teacher ratio in public schools, it is not guaranteed. As a new teacher, I anticipate difficulty around effectively guiding thirty students who all have their own unique question, while also guaranteeing we cover the required standards. Practically, space and comfort levels might be limitations to this curriculum. It is my hope that Unit 0 and Unit 1 provide space for students to develop comfort with me and each other to feel safe enough to dance.

Implications

This curriculum will be implemented during the 2023-2024 school year. As mentioned, I hope the first units can help me gain comfort guiding students to move and dance while in a science classroom. I also hope that during the first few units students

gain comfort with each other in order to feel safe moving creatively. Because Unit 3, the most dance and movement heavy unit, is not taught until later in the year, I have time to incorporate smaller dance activities into earlier units. I also anticipate that as the year goes on, I can continue building a supportive, respectful environment where students feel comfortable being themselves and living in community with each other.It is encouraging that when I mentioned my project to the principal of my new school he said he did not think I would have any problem getting students at this school to dance.

Although this project is physical science specific, it can serve as an example of a dance integrated science curriculum and can be adapted for a variety of subjects and student ages.

Further Exploration/Recommendations

Practically, the school I will be working at for the 2023-2024 school year offers a dance elective and has a designated dance teacher, and I look forward to hearing about the dance/science collaboration that has occurred in the past and having a collaborative partner to work with in the future.

In the future, I will continue with a mindset of incorporating movement whenever possible. I have to remind myself that any movement and building a mind-body connection, however small it seems, is important and still progress towards my goal. This is where I would recommend anyone begin if they are interested in incorporating dance and movement into their classroom. Even something as simple as beginning class with a quick stretch can be a grounding tool to center students in their body as well as focus their energy for class. At this time, the smaller day-to-day movement activities seem

more manageable for me to incorporate the larger scale units, but hopefully that will change as I gain comfort instructing science through dance.

I would love to further explore what is suggested in the CASE project and incorporate dance into lab and experimentation work. For safety, clearly keeping the tangible lab work separate from the dancing, but for creativity, having students participate in a lab or see a demonstration and then responding with their bodies. Perhaps the dance becomes a hypothesis or perhaps the dance comes later in the lab as a conclusion summarizing all the pieces together. I would also love to do more with creating questions. Having a bank of guiding questions for students to choose from is more manageable than having every student come up with their own.

Summary

The creation of this curriculum was informed by the question: H*ow can dance and movement be used as a culturally responsive teaching strategy to increase motivation, interest, and understanding for students in middle school science classes?* Although I have yet to implement this curriculum to see the effects of it for myself, the very creation of the curriculum is a response to the question.

In this chapter I discussed the challenges in creating the curriculum, mainly that I did not find a clear model to use as a guide. There are stand alone lessons and strategies to incorporate, but it was more difficult to find a curriculum that integrated dance and science. Another challenge was the feeling of pressure to constantly meet all of the standards, as well as the pressure to have students moving or dancing at all times and how have them constantly be making meaning of science through dance. Neither of these are necessary, but the stress of them was a challenge.

Aspects of the literature that proved most helpful and that I kep returning to are Fattal and An's (2019) description of embodied cognition and Wick's (2022) definition of bodily learning. These provided a guiding force to keep pushing to create a dance focussed curriculum. Dance is a culturally responsive teaching strategy and I am grateful to have created this before entering my next year teaching. Physical science can be difficult to conceptualize and dancing provides teachers and students with a way to physically see the concepts or a model of them.

Limitations are that the curriculum I designed is specifically for middle school physical science. It is content heavy, but I hope the project can serve as a model for dance integration work. I am excited to begin implementing this curriculum in the upcoming school year and excited that there is already a precedent for the work at the school I am working at. I look forward to continuing to explore the connection between the creative process and the scientific inquiry process.

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