Makerspace Implementation in the General Education Classroom

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Abstract

An issue focused study discussing the relevance of art education in public schools including the status of art education funding and legislation in the United States. The author introduced the integration of art education into the general education classroom through a makerspace. The study investigated the implementation of the makerspace as a form of Science Technology Engineering Art and Math (STEAM) education. Students in a general education classroom were given access to a classroom makerspace for 26 school days. An average of 50% of students participated in the makerspace each day. The author's results support the use of a makerspace as one form of increasing access and opportunity for creative art exploration within the school day at a public elementary school without an art teacher.

Introduction

Art is essential for whole-child education (Wan, Ludwig, & Boyle, 2015). According to the United National Educational, Scientific, and Cultural Organization's (UNESCO) Universal Declarations of Human Rights (The United Nations, 1948, art. 8) and Convention of the Rights of the Child (The United Nations, 1989) art is a central part of the human experience. Access to the visual arts is considered a fundamental human right (McClure, Tarr, Thompson, & Eckhoff, 2017). McClure et al. (2017) stated that environments rich with art opportunities for young children is not solely an educational responsibility, but also an ethical necessity. Visual arts education continues to show educational advantages in other content areas and for the social-emotional well-being of students (Catterall & Peppler, 2007). This author explores a systematic way to integrate visual arts instruction in the elementary classroom.

For this issue focused study, the term *art* refers to the visual arts. According to the American Institute for Research (Wan et al., 2015), arts education refers to art lessons or classes that are standards-based and taught by certified art specialist teachers through a sequential arts curriculum. In 2011-12, an average of 2.5% of instructional time was allocated to art instruction for public school third graders (Hoyer, Sparks, & Ralph, 2017). The highest percentage of instruction was given to English Language Arts at 30.2%, and the second highest was mathematics at 17.6% (Hoyer et al., 2017), which demonstrates how much scope and sequence is occupied by curriculum and assessments in these core subjects. According to the United States Department of Education, 83% of all public elementary schools reported instruction designed specifically for visual arts in 2009-10 (Parsad & Spiegelman, 1999). Among those schools, principals indicated that a typical student received instruction in art at least once a week (Parsad & Spiegelman, 1999). Art specialists held employment at 84% of schools that reported art instruction throughout the year, and 68% had dedicated rooms with special equipment for art instruction (Parsad & Spiegelman, 1999).

According to the U.S. Department of Education (2019), there were nearly 23 million public school students in kindergarten through 5th grade in 2016. Of those students, more than four million did not attend a school with an art specialist employed to teach visual arts. These children experience art education only through the work of their general education teachers. General education elementary school teachers are required to balance their schedules and curriculum for maximum student outcomes in core subject areas. Subject areas, such as art, are often taught at the discretion of general education teachers based on their personal interest and available time in the classroom schedule. Time is a barrier to art education for general education teachers. When general education teachers are required to purchase their classroom materials, the cost of art supplies is another barrier. Integrating art into the general education classroom should not be a burden to teachers. Ideally, art intervention in the classroom should excite students without taking away from core subject time nor demand more from general education teachers.

The goal of this researcher is to explore one possible solution to art education in the general education classroom through a makerspace. A makerspace is a broad term to define an area to design, create, innovate, and explore using hands-on learning (Peppler & Bender, 2013). This author discusses the possibility of a classroom makerspace to extend art instruction into the general education classroom when a full-time art teacher is not present. The classroom makerspace is a location in the classroom where materials are available for creating and producing art. Makerspaces are often associated with Science, Technology, Engineering, Art, and Math (STEAM). A makerspace is an area for independent innovation and exploration, with a shared commitment to intrinsic interests and creativity (Peppler & Bender, 2013). Opening a classroom makerspace invites students to investigate art concepts in innovative ways through intentional exploration and builds deeper learning.

Educational theorists for over a century have focused on the importance of play for learning. Montessori (1967) argued that children learned best through work done by the hands, playing with materials that foster the natural desire to create. According to Wohlwend and Peppler (2015), play is losing the battle for curriculum time in schools. Engaging young students in meaningful learning moves beyond a singular focus on Common Core State Standards and requires the use of play (Wohlwend & Peppler, 2015). Bringing art to the classroom through a makerspace is an opportunity for play and a simultaneous chance to integrate core art education. The makerspace enables exploration of the core elements of art, art history, and art from around the world, bringing culture to students of all ages and backgrounds. Art learning should be experiential and hands-on, which is a core component of the makerspace activity, for example, mixing the colors yellow and red to create orange, which imprints on the child far more significantly than a verbal explanation of primary and secondary colors. The classroom makerspace is the area dedicated to the creative exploration of art through art materials, art history, and world culture. Purposefully presenting the core elements of art in the makerspace integrates visual arts access and exploration into core curriculum content.

Question

What measures can my school adopt to increase access and opportunity for creative art exploration during the school day?

Purpose

The purpose of this issue-focused study was to research the problem of limited access to art education in elementary schools that do not employ a dedicated art teacher. This author addressed the lack of art education in the general education classroom as defined by the visual arts standards set forth by the Washington State Office of Superintendent of Public Instruction. Limitations to art education can include a lack of resources, limited curriculum time, and monetary cost of supplies (Wan et al., 2015). Students in schools without an art education specialist only receive art in the general education classroom. Therefore, the level of art education is dependent on the general education teacher and their willingness to modify their schedule or curriculum to accommodate art education.

Rationale

Students in general education classrooms receive specifically designed instruction in core subject areas such as reading, writing, and math. The Every Student Succeeds Act (ESSA) explicitly included other subject areas, such as art, to constitute a well-rounded education (Zubrzycki, 2015). Section 8101(52) of ESSA (U.S. Department of Education, 2015) clarified that a well-rounded education includes the arts and music in addition to other academic subject areas. Title IV, Part F Section 4642 contains provisions requiring or encouraging that schools and districts seek to use federal funds available for art education (Wan et al., 2015). Researchers and teachers recognized the importance of art education for children, yet classroom curriculum time and district funding continue to limit access to art education (Cavanagh, 2017). Research highlighting the benefits of art education supported increased art education in classrooms (Wan et al., 2015). Art engagement leads to a wide range of positive outcomes, including a higher grade point average (GPA) and college aspirations (Catterall, Dumais, & Hampden-Thompson, 2012). Preschool art education shows promising effects on early literacy and school readiness (Phillips, Gorton, Pinciotti, & Sachdev, 2010). Researchers showed that art enrichment could promote social-emotional learning through emotional regulation (Brown & Sax, 2013; Peppler & Bender, 2013). Art education in early childhood education provides a creative outlet where children can acquire problem-solving and interpersonal skills (Kirby, 2018). Teachers play a critical role in exposing students to art. According to Ellis (2018), art education should be supported by the administration so that it is not a burden to general education teachers. The strategic intervention allows intentional exploration of art in the general education classroom.

In 2015, the National Coalition for Core Art Standards (NCCAS) developed visual art standards for kindergarten through twelfth grade. These standards cover art processes and anchor standards such as creating, performing, responding, and connecting, which apply to the use of art tools in a makerspace. The visual art standards apply new research to practical ways of educating students with art concepts in the classroom. The performance standard Cr1.1.K, engage in exploration and imaginative play with materials, is a central purpose of the classroom makerspace (Office of Superintendent of Public Instruction, 2017). Anchor standards 2.1.K, through experimentation, build skills in various media and approaches to art-making and 2.2.K, identify safe and non-toxic art materials, tools, and equipment, are other visual art standards used in the makerspace (Office of Superintendent of Public Instruction, 2017). The final art anchor standard that is directly applicable to the makerspace is anchor 3.1.K, explain the process of making art while creating (Office of Superintendent of Public Instruction, 2017).

In addition to art standards, a classroom makerspace applies to other STEAM content areas and their corresponding standards. The Next Generation Science Standards specifically outline science and engineering practices for teachers to follow in science education

(Schwichow, Zimmerman, Croker, & Artig, 2016). The eight math practices outlined in Common Core are other examples of how the makerspace incorporates national standards into a practical hands-on learning environment (Common Core State Standards Initiative, 2018).

The author examined the history of art education while approaching current and future challenges to art education in elementary schools. The author concentrated on one tool of art exploration, the makerspace, to integrate art education into the classroom without the use of a specially hired art teacher. The author sought to explore the makerspace as one form of increasing access and opportunity for creative art exploration within the school day at a public elementary school without an art teacher.

Literature Review

Foundations of Art Education

Art education brings foundational concepts of design and culture into the classroom. Throughout history, art is a mode of expression and discovery (Sabol, 2017). At the launch of the public-school movement in the 1830s and 1840s, curriculum development included art (Raber, 2017). The United States adapted to war and industrial revolutions, and so did its view of art. Art became a means of social communication, free speech, and power.

Art education in the late 20th century developed through the J. Paul Getty Trust, which focused on Discipline-Based Art Education (DBAE) (Dobbs, 1992). The objective of DBEA was to make art education equivalent to other academic disciplines with a standardized assessment framework. The outcome of DBEA was a shift in thinking towards making art education available to all students, not just those who demonstrate an aptitude for art. Art education has evolved as the landscape of all academic disciplines changed in the 21st century. In 2014, the National Coalition for Core Art Standards (NCCAS) developed a national guideline for educators in visual art, music, media art, theater, and dance. The standards provide a unified quality arts education for students preschool through high school (National Coalition for Arts Standards, 2014). The NCCAS recognized the evolution of standards and the further refinement necessary to develop art education in the United States (National Coalition for Arts Standards, 2014).

In 2014, NCCAS also adopted its conceptual framework for art standards in the United States. The purpose of the standards is to provide a guiding document to embody key concepts, artistic processes, creative practices, anchor and performance standards, and assessments (National Coalition for Arts Standards, 2014). Arts education encompasses dance, media arts, music, theatre, and visual arts, the primary focus of this study. The National Art Education Association (2017) defined visual arts as traditional fine arts, media arts, architectural, environmental and industrial arts, and folk arts. The National Coalition for Core Arts Standards depicted arts education as a triad of resources for students: certified arts educators, certified non-arts educators, and community arts providers. In the *Arts Education for All Students* purpose statement, NCCAS (2014) defined the benefits of this triad to students as sequential, standards-based arts curriculum, deep expertise and professional experience, and standards-based connection between the arts and other content areas. Students benefit from the professional expertise of an art community. Purposefully engaging students in arts education develop creative thinkers and problem solvers (Ellis, 2018). According to NCCAS (2014), art serves as a distinctive vehicle for self-discovery.

In 2017 Washington State adopted Arts K-12, a set of learning standards for dance, media arts, music, theatre, and visual arts (Office of Superintendent of Public Instruction, 2017). Online grade-level standards and resources are available to educators and the community. The vision for art education in Washington State is to provide students with a well-rounded education that supports their unique skills and engagement with the world around them (Office of Superintendent of Public Instruction, 2017). The Arts K-12 standards developed in response to the NCCAS's 2014 national standards (National Coalition for Arts Standards, 2014). The standards serve as a tool of consistency for art education across the state.

Legislation and Research for Art Education

While the value of art education continues to be substantiated by developmental research, the level of art education in schools has decreased (Taylor, 2012). For states, the reduction in art funding is a matter of balancing a financial budget and focusing on the priority of core subject areas such as math (Knight, 2013). Looking to future educational strategies inclusive of art education requires an approach that integrates diverse subject areas. Art education has been a core subject area included in public schools since 2015 (National Association for Music Education, 2015). Americans for the Arts, the nation's leading nonprofit organization for advancing arts education, connects the legislation for art education, connecting academic excellence, innovation, and creativity to the study of the arts (Cohen, 2018).

Unfortunately, funding for art education is inversely proportionate to the research that supports its implementation in schools (Mazzocchi & Mazzocchi, 2015). The federal and state financial allocations for public school art education programs are not mandated and instead are often funneled to other content areas by districts and administrators (Mazzocchi & Mazzocchi, 2015). Funding cuts and loss of arts educators will continue to diminish the value of art education for our students (Ellis, 2018). The current status of art education is affected at the highest legislative and executive levels (Bolton, 2017). A 2018 presidential budget proposal prepared to cut federal funding to eliminate the National Endowment for the Arts (Bolton, 2017).

In the 2020 proposed budget, President Trump continues the administration's course of action to eliminate the National Endowment for the Arts within the next two years (Cascone, 2020). At the state level, departments of education are focused on quantitative data from test scores. In a study of 547 Virginia elementary schools, researchers found no data to support the reduction of time spent in art, music, and physical education in relational to increase standardized test scores (Graham et al., 2003). State and federal laws traditionally assign music education as a core subject area, while art education is considered an afterthought in student learning (Ellis, 2018). The young brain is most adept at refining artistic skills during elementary and middle schools, yet children have experienced a decrease in arts education and funding (Sousa & Pilecki, 2013).

According to the National Center for Educational Statistics (U.S. Department of Education, 2019), instruction accounted for an average of 80 percent of annual funding. Instruction can include salaries, benefits, teacher aides, and instructional materials. Funding for art education varies by state. Individual state plans for the implementation of art education and funding is broken down by the Grantmakers in the Arts organization (Grantmakers in the Arts, 2019). In 2015, Congress enacted the Every Student Succeeds Act (ESSA), which explicitly included art education as part of a well-rounded education (Zubrzycki, 2015). The law ensures that arts education programs and teachers are eligible to receive federal funds. The ESSA was created to replace the No Child Left Behind Act, which focused on core subjects and test scores (Zubrzycki, 2015). The focus on a well-rounded education, inclusive of the arts, showed a dramatic shift in education funding.

Funding continues to be a component of education at the district, state, and federal levels. According to ESSA, states are responsible for choosing what constitutes a well-rounded education and how to fund that education. Regardless of funding, Ellis (2018) suggested that school leaders should share in the responsibility to ensure art education occurs with classroom teachers. The integration of art education should be supported by the administration so that it is not a burden on general education teachers (Ellis, 2018). Zubrzycki's (2015) interview with an advocate from the Educational Theatre Association how important it is for administrators to understand the role arts can play in a well-rounded curriculum and how to obtain funding.

Research in art education has shown a clear connection between art and positive outcomes in neurological development. In 2012, the National Endowment for the Arts conducted a study on the effects of art on the achievement of at-risk students. Researchers found a strong correlation between art participation and a wide range of positive outcomes (Catterall et al., 2012). The main conclusive results showed that students engaged in arts had more positive outcomes in a variety of school-related areas compared to their peers, including a significantly higher GPA and college enrollment rates (Catterall et al., 2012). On a 4.0 GPA scale, students who had art-enrichment experiences had a mean GPA of 2.94, compared to 2.55 of students with low art-enrichment (Catterall et al., 2012). In the study, both 8th graders and high school students who were highly engaged in art were more likely to aspire to go to college. Catterall et al. (2012) found that 96% of students with high art engagement graduated from high school, compared to only 78% with low art engagement.

Preschool education, which integrates the arts, shows promising effects on literacy and school readiness skills of high-risk students nearing kindergarten entry (Phillips et al., 2010). Arts-integrated education readies even the youngest child for other curriculum content areas. Teacher-rated behaviors also showed significant improvements (Phillips et al., 2010). Children enrolled in a preschool enrichment program were found to display more happiness, interest, and pride in their music, dance, and visual arts classes, compared to the traditional learning subjects

(Brown & Sax, 2013). The researchers demonstrated that arts enrichment could promote social-emotional learning through positive and negative emotional regulation (Brown & Sax, 2013).

History of STEM and STEAM in Education

Science Technology Engineering and Mathematics (STEM) is the integration of four subject areas to provide critical thinking skills marketable in the 21st-century workforce (White, 2014). The skills obtained in a specialized STEM curriculum propose to better student skills in innovation and engineering future technologies. Science Technology Engineering Mathematics education was an initiative created by the National Science Foundation. It later became a household term in the early 2010s after a mention in the State of the Union Presidential Address on January 25, 2011 (Halverson & Sheridan, 2014; White, 2014). The focus on STEM subjects developed as a result of the growing concern for American students' ability to be competitive in the growing global economy (Halverson & Sheridan, 2014; White, 2014). The emphasis of STEM education was linked to President Obama’s Race to the Top-District program (Sweeny, 2017). In 2015 more than 1.5 million dollars in funding for STEM education was allocated via the Elementary and Secondary Education Act (Brown, Brown, Reardon, & Merrill, 2011). The focus on science education with an emphasis on the integration of the other STEM subjects led to the development of the Next Generation Science Standards (NGSS). Sousa and Pilecki (2013) emphasized the validity of a new curriculum can only be tested if the instruction matches what real scientists and mathematicians do. To better utilize the STEM subjects, they proposed the integration of additional skills and activities into STEM, mainly through art (Sousa & Pilecki, 2013). Sousa and Pilecki (2013) suggested that the main objective of both art and science is discovery. Purposeful integration of art with STEM subject areas offers broad experiences for learners to extend and deepen their understanding through integrated subject discovery.

Art education can add to a complete picture of the skills needed by students to expand the reach of STEM education. Cook, Bush, and Cox (2017) embraced the advantages of the intentional integration of multiple subject areas and the addition of art to STEM. Art contributes to diversity in subject areas and expands future career opportunities (Cook et al., 2017). Art is a design component to more extensive projects which employ science, technology, engineering, and math. The addition of art to STEM, also known as STEAM, brings an element of design and imagination to existing fields. Cook et al. (2017) term this focus of art as “Imagineering”. The STEAM curriculum calls for creative and critical thinking for the next generation of careers (Quigley, Harrington, & Herro, 2017). According to Jamil, Linder, and Stegelin (2018), the prosperity of the future workforce is dependent on the innovative thinking across technology and the arts, including a sound understanding of science, engineering, and mathematics. Taljaard (2016) stated in his review of technology’s role in the evolution of STEAM that he found the use of multi-sensory technology can benefit education through links to real-life situations. A collaboration of sensory tools explicitly utilizes what psychologist Jean Piaget found to be true in his cognitive development theories, that concrete objects support higher-level thinking and promote cognitive development (Barrouillet, 2015). According to Montessori (1967), work done by the hands with concrete objects fosters a deeper understanding of content when transferring to the abstract.

The integration of STEAM to Common Core State Standards content is often associated with the Project Based Learning (PBL) pedagogy (Quigley et al., 2017). In PBL, students work collaboratively to create solutions for real-world problems. Projects are group-based, which promotes motivation to achieve (Forlund Frykedal & Chiriac, 2014) and social-emotional learning (Money, 2018). Project Based Learning consists of three constructivist principals:

learners are involved in active learning, learning is content-specific, and learners achieve their goals through social interactions (Kokotsaki, Menzies, & Wiggins, 2016). Project Based Learning links hands-on learning to real-life solutions. Key components of PBL include the use of hands-on learning, which builds from our interaction of the world around us. Project Based Learning and STEAM are two areas of education that continue to evolve with innovative materials and teachers.

The Makerspace and Maker Movement

Educators seek new ways to include STEAM and PBL in the classroom. One strategy is the creation of a makerspace area through a culture of hands-on creating, designing, making, and innovating (Peppler & Bender, 2013). Sheffield, Koul, Blackley, and Maynard (2017) defined a makerspace as STEM for the future whereby students develop and acquire critical twenty-first-century skills. Sheffield et al. (2017) define twenty-first-century skills as problem-solving, cortical and creative thinking, collaboration, and communication. The growing area of STEAM and the do-it-yourself (DIY) phenomena has created the maker movement, a growing body of hobbyist, tinkers, engineers, hackers, and artists who build for both playful and useful ends (Martin, 2015). Halverson and Sheridan (2014) saw the maker movement as beneficial to children, adults, and families to express creative drive. Peppler and Bender (2013) stated there is a growing national recognition of the maker movement and its potential to transform how we learn. According to Martin (2015), there is an opportunity to engage K-12 students in STEM through the maker movement. The makerspace is a blend of activities that foster PBL in the positive feedback practice approach (Bers, Strawhacker, & Vizner, 2017). Halverson and Sheridan (2014) defined the maker movement as the creative production of artifacts broadly seen in a growing number of educational areas. In 2014, the White House hosted the first Maker

Faire to declare a 'National Day of Making' (Neuhauser, 2014). During the event, President Obama announced plans to expand the federal support of makers with new initiatives, including outreach, competitions, and a U.S. Patent and Trademark Office hotline (Neuhauser, 2014).

The maker movers are tinkerers, inventors, and entrepreneurs. The CEO and co-founder of TechShop, Mark Hatch, defined the nine key ideas to the maker movement: make, share, give, learn, tool up, play, participate, support, and change (Hatch, 2014). The most important aspect of these makerspaces is the physical object component and play. The *Makerspace Playbook* linked he origins to the movement to the desire for experimental play (Maker Media, 2013). The process of exploration is what sets the stage for innovation. The *Makerspace Playbook* defined the three impact areas in the implementation of makerspaces: inspiration, innovation, and education (Maker Media, 2013). Core art education includes the act of making art (Sweeny, 2017).

Makerspace curriculum and tools are flexible to accommodate a range of ages and abilities in its participants. In Sheffield et al. (2017), the makerspace included technical devices such as robotics, 3-D printers, and web-based model applications to engage learning in creative, higher-order problem-solving. Makers, as defined by Sheffield et al. (2017), are students who enter the designated space to collaborate and tinker with an endpoint in mind. Sweeny's (2017) research centered the primary focus of the makerspace movement on creative problem solving when makers interact with a variety of materials for a task. Seymour Papert, of the Massachusetts Institute of Technology (MIT), is considered the originator of the modern makerspace through his pioneering work in constructivist theory in education (Sweeny, 2017). While attributed to several theories or paradigms, constructivism emphasizes that learning is an active process whereby learning is constructed (Fox, 2001). Constructivism is a central aspect of hands-on learning, and PBL has specifically designed the makerspace for STEAM exploration. According to Fox (2001), constructivism emphasizes that effective learning requires meaningful, open-ended, challenging problems for the learner to solve. The act of open discovery occurs within the makerspace setting.

Sheffield et al. (2017) studied the effects of a makerspace in the classroom on female student engagement at an all-girl Catholic school. The purpose of the study was to research ways to engage female students. According to Sheffield et al. (2017), women fill close to half of all jobs in the U.S. economy but hold less than 25% of STEM jobs. The students used the makerspace to demonstrate 21st-century skills when not given directions to follow. The makerspace encouraged the use of trial and error to check and improve strategies similar to tasks required for collaboration and communication in PBL. Researchers found the female students brought creativity to the makerspace sessions (Sheffield et al., 2017). The research broadens the scope of STEM education to entice and excite all types of learners, regardless of gender.

Robinson (2018) discussed the importance of student involvement in the makerspace design space, which ensures the materials create a student-centered learning environment. Ownership in the materials and design, build on social-emotional community development. Robinson (2018) used the term genius hour to apply the makerspace time for students to create. He supported the framework of the genius hour makerspace as a place of choices that leads to purposeful learning (Robinson, 2018). The challenges students encounter in a makerspace encourage problem-solving and critical thinking while in communication and collaboration with peers (Robinson, 2018).

Obstacles and Critiques of the Makerspace

The implementation of a makerspace comes with obstacles and critiques. A well-designed makerspace can have costly materials and require additional space that is not readily available. The makerspace area, which can contain tools that require adult supervision, is an area of safety concern for the school; critics of makerspaces fault the makerspace for narrow reach across gender and cultural backgrounds.

Robinson (2018) outlined obstacles in the creation of a makerspace, such as the cost of materials. Makerspaces have no preferred list of materials or tools, but rather evolving and revolving areas of exploration. The tools and materials required for implementation are ultimately a decision of the makerspace managers. Teachers can ask students, parents, and staff to help participate in gathering free donated materials. Managing a makerspace would require funding and maintaining a financial plan for future operations.

The physical space to accommodate the equipment and materials for a makerspace is an obstacle for educators. Makers are working to resolve these issues with such innovations as Wendell's Portable Maker Workshop initiative (Wendell, Wright, & Paugh, 2017). Wendell et al. (2017) created a portable maker station on a rolling cart that stores the necessary materials. Having maker materials in only one location limits the goals of STEAM and PBL learning. Hands-on projects require the materials to be accessible in a variety of content and curriculum areas throughout the school day. Locations for a makerspace can vary. Examples of rooms that can be reused, or transformed into a maker area include the computer lab, the library, photography darkroom, outdoors, stages, and science labs (Maker Media, 2013).

Safety is another consideration in the implementation of a makerspace area (Robinson, 2018). The *Makerspace Playbook* includes explicit directions for safely planning a space for exploration. Tools in the makerspace may require additional adult supervision or instructions to ensure student safety. Materials should pass a safety inspection prior to use by students. Another safety strategy is the allocation of jobs for the makers, such as a project manager, safety monitor, and research roles. When designing a makerspace, the idea is to allow the exploration of new materials or tools safely.

The development of the maker movement has its critics. Dr. Leah Buechley, a keynote speaker of the FabLearn conference at Stanford and former associate professor at MIT, criticized the narrow reach of formal maker spaces to primarily white boys and men (Quattrocchi, 2013). Buechley pleaded with the maker community to find ways to reach a more diverse group of makers and all types of children (Quattrocchi, 2013). Sweeny (2017) suggested that the maker movement raises a variety of issues for art educators. Makerspaces traditionally align with the curriculum goals of STEM (Sheffield et al., 2017), which Sweeny (2017) claimed is at odds with the traditional disciplines, such as art. The addition of art education to the makerspace changes the format of art instruction and learning. Makerspaces are generally associated with STEM/STEAM initiatives, which commonly tie to commercially driven and politically driven agendas (Sweeny, 2017). Marketing and monetary gains may play a role in the process of inquiry, materials, implementation, and use of the makerspace.

Current Makerspace Research

Sweeny (2017) used an undergraduate art course to propose the integration of art education in a makerspace environment. The study involved undergraduate art students who had mostly not heard of a makerspace before the course. Most of the art students approached the makerspace as a potential area of learning as their future careers as art educators (Sweeny, 2017). The participants were asked to research makerspace artists, create a makerspace area of a classroom, and complete a final art project. The researcher concluded that all students utilized traditional art techniques, but with innovative and some non-conventional methods, such as the use of a pendulum to distribute paint and a motorized robot who was able to hold a pen or brush (Sweeny, 2017). Sweeny (2017) suggested two areas of future study in the education of art students and makerspaces for classrooms: to identify artists who work in a way that is aligned with the parameters of a makerspace and to understand the process of trial and error facilitated by a makerspace.

Hynes and Hynes (2018) surveyed 276 design, engineering, and liberal arts major undergraduate students to understand better their preference for the design of a makerspace (Hynes & Hynes, 2018). The researchers sought to determine how to design the makerspace to engage like-minded students best. According to Hynes and Hynes (2018), makerspaces in both university and public settings are primarily occupied by male makers. Hynes and Hynes (2018) sought to develop a makerspace that would attract all students, not only engineering or male students. The researchers found students preferred an orderly, clean space that still encouraged free exploration. Messier and more chaotic looking spaces were rated lower. One key observation revealed that students were more drawn to a makerspace that had familiarity; that is, it looked similar to spaces they had already encountered in high school or other public places (Hynes & Hynes, 2018).

Clapp and Jimenez (2016) investigated three areas of the topic of STEAM and maker-centered learning. The researchers created three possible ways to approach the 'A' in STEAM: arts as a discipline, aesthetics in the design, and creativity. Clapp and Jimenez (2016) analyzed data to highlight the opportunities and challenges to STEAM in the maker classroom. Clapp and Jimenez (2016) examined the integration of art in STEM, and what they termed STEM-with stickers and 'arts-and-crafts effect' due to STEM concepts not being inherently artistic. The fear of adding art components to simply call it art education without deep artistic experiences was a central focus of the research (Clapp & Jimenez, 2016). Clapp and Jimenez (2016) emphasized that when educators create STEAM-focused learning experiences, they must be intentional about art incorporation, integrate art effectively, and purposefully encourage arts learning through arts-based concepts and practices. The literature suggests an inconsistent educational experience within the STEAM makerspace to provide deep engagement in artistic discipline and the challenging task for educators who implement art into a makerspace (Clapp & Jimenez, 2016).

Keune, Gomoll, and Peppler (2015), dedicated their recent research to the intersection of art and technology, specifically in the makerspace. In an analysis of three makerspace locations: a community library, children's museum, and business location, Keune et al. (2015) studied the importance of artifacts for the youth makerspace. Regarding the three types of makerspace locations, they examined schedule artifacts, youth projects, and tools for making (Keune et al., 2015). In their research, they sought to discover how a makerspace can support co-constructive learning through the arrangement of its artifacts (Keune et al., 2015).

The goal of the artifacts was to communicate flexibility to learn, which Keune et al. (2015) defined as having flexibility regarding time, project, and tools. The researchers found that maker educators in the three sites developed a schedule based on prior experience with youth builders (Keune et al., 2015). In a further study of the youth makerspace projects, Keune et al. (2015) discovered the co-construction possibilities through the project pliability, accessibility, and mobility. In three makerspaces, the researchers found that the capacity for maker creativity and maker culture was related to the high- and low-tech tools in each makerspace (Keune et al., 2015). Tool accessibility was particularly crucial for success, and offering the youth participants an opinion on the construction of the space was valuable (Keune et al., 2015).

In further research, Keune and Peppler studied the progress of makerspaces over 24 months (Keune & Peppler, 2019). The research team selected a makerspace as part of the Open Portfolios Project's Megalab, an out-of-school makerspace location. In the case study, the monitoring adults recognized that the students had become 3-D printer troubleshooting experts (Keune & Peppler, 2019). The research concluded that those using the makerspaces needed more extended time to become familiar with materials and that the problem-solving aspect of the technological roadblocks deepen the youth understanding and construct additional learning (Keune & Peppler, 2019).

In their most recent publication, Keune, Peppler, and Wohlwend (2019) studied the vital role makerspaces play in the development of STEM career skillsets for women (Keune et al., 2019). The researchers focused on outcomes for women to enter STEM career fields due to the predominantly male domain (Keune et al., 2019). The researchers introduced the notion of 'tinkering with development' whereby project design, spatial discrimination, and project sharing drive human trajectories (Keune et al., 2019). The results focused on work, which was meaningful to the individual and included sharing ideas. The collaboration of ideas pointed to the participant as a newly created expert in their 'field'. Recognition achieved through displaying, legitimizing, and circulating was a significant factor in impacting youth success (Keune et al., 2019). Sharing, displaying and presenting the makerspace projects impacted the youth through building their confidence.

From the study, Keune et al. (2019) made recommendations for makerspace implementation to benefit female youth. First, they recommended considering the project location (Keune et al., 2019) and secondly, the importance of the educator facilitating the makerspace. The researchers explained the significance of displaying the projects created in the makerspace as having considerable value to the youth. They called the displayed projects a spatial portfolio, where others can examine, experience, and enjoy the work of youth created in the makerspace, highlighting their newly constructed investigations and creations (Keune et al., 2019). Building a personal identity is critical to affecting female youth makerspace success and developing an interest in STEM (Keune et al., 2019).

Cross (2017) conducted a mixed-methods study implementing a makerspace as an application of constructivist learning. She noted the lack of research available on K-12 makerspaces. In her research, Cross (2017) found that 40% percent of respondents never received professional development on makerspaces and that there were significant benefits to staff and community collaboration for professional development. Teachers reported benefiting from professional development in the form of conferences and hands-on workshops.

The research included a survey of educators with responses, including potential problems with makerspace implementation (Cross, 2017). In the responses, educators running the makerspaces reported that funding is the number one obstacle to implementation, with space and time listed as significant obstacles (Cross, 2017). Another obstacle was the lack of understanding by teachers and students on the value of the makerspace (Cross, 2017). One respondent noted the productive struggle students experienced when they were first offered the freedom of the makerspace (Cross, 2017). Educator responses also reflected on the practical implementation of the makerspace into the daily schedule. One educator respondent used the end of the school day for students to explain and present their projects to the class, giving other students ideas and creating a culture where design think-time is encouraged (Cross, 2017). Other educators took their student projects into the local community with galleries and maker faires, and to a global audience via online videos and other digital media such as Instagram. While there was a significant focus on sharing the projects, the research found that only 15% of educators used formal grading in the makerspace (Cross, 2017).

In the implementation of school makerspaces, Cross (2017) found that education majors had the most challenging time with relinquishing control to students and that students also struggled with the newly given freedom that was significantly different from their classroom routine. While the research found educators experienced challenges with a makerspace, the survey results suggested a meaningful impact on students, such as the ability for students to persevere through a problem (Cross, 2017). Respondents reported that students used problem-solving skills with activities 79% of the time (Cross, 2017). Another positive component from the survey results was the number of teachers who reported student collaboration with peers and the student ability to learn from failure. The results showed that educators were given the opportunity to recognize student talents not typically highlighted in general education (Cross, 2017). From the survey, the consensus was that educators wished they had started the makerspace sooner for the many benefits it offered their students and classroom (Cross, 2017).

Makerspace in Early Childhood Education

Art education can help young students perform to their full potential across academic disciplines and throughout their academic careers (Kirby, 2018). The implementation of the art curriculum in early childhood education provides a creative outlet where they can acquire problem solving and interpersonal skills (Kirby, 2018). Focus on art education varies across the United States. In their study of kindergarteners, Montgomery, Miller, Foss, Tallakson, and Howard (2017) found the students experienced less than 24 hours of art instruction during the school year. The National Center for Education Statistics found that a typical third-grade public school student spent 0.8 hours per week on art instruction in 2011-12, which accumulated to 2.5% of their time spent in art instruction (Hoyer et al., 2017). The typical full week of school for a public school third grader was 33 hours (Hoyer et al., 2017); therefore, students received 29.7 hours of art instruction over the 180 days of school.

Early childhood is a time of explosive growth and development of neural connections within the brain (Sousa & Pilecki, 2013). Artistic activities such as singing, drawing, and dancing engage the senses and develop pathways within the brain that aid in successful learning (Sousa & Pilecki, 2013). Velazquez-Martin (2013) found evidence to link art in early childhood education to improved emotional and academic outcomes. In the comparative study, children who attended the arts-enriched preschool program showed a significant decrease in teacher-reported negative emotion, suggesting arts play a role in the improvement of negative emotional regulation and emotional growth (Velazquez-Martin, 2013). In the area of academics, children at the art-enrichment program surpassed national averages by the end of the school year in comparison to the children at the non-arts school who fell below the national averages for the year (Velazquez-Martin, 2013).

When examining early childhood education, there are standard tools educators use to bring innovative and hands-on learning to students. One such strategy is the use of learning centers, which offers a useful classroom tool for exploration and investigation. The cornerstone of learning centers is accessibility for all that arouses curiosity and inspires exploration (Ashbrook, 2018). Ashbrook (2018) emphasized a focus on materials when educators are creating learning centers for children. The creation of a makerspace is an appropriate application of the learning center pedagogy for early learners.

Bers, Strawhacker, and Vizner (2017) stated that the intentional design of a makerspace environment with appropriate technologies, tools, resources, and community values can promote creative learning in early childhood education. The collaborative component in the PBL environment of the makerspace correlates with the Reggio Emilia's philosophy of education (Bers et al., 2017). Bers et al. (2017) emphasized that Reggio Emilia and the maker movement share a similar philosophy and "provide a foundation for understanding how a learning environment can be set up to improve and support an authentic teaching and learning process" (p. 76). In their research on Early Childhood Makerspaces (ECMS), Bers et al. (2017), used six developmental assets to measure the learning experiences in the ECMS: content creation, creativity, choice of conduct, communication, collaboration, and community building. They proposed that the design of the ECMS is essential to the learning environment message. Bers et al. (2017) emphasized that careful consideration should be made for developing the framework of a makerspace for early childhood spaces where students are too young to physically or developmentally work and collaborate without some adult assistance. Two case studies found that artifacts in the space stimulate community building, and children explore new ideas and express themselves using novel tools and media (Bers et al., 2017).

Early Childhood Makerspaces require tools specific to young students for safety and their level of dexterity. Elements of a maker space in early childhood settings should accommodate young participants. Bers et al. (2017) suggested the use of Reggio Emilia's Third Teacher approach with ECMS, which involves picture diagrams, audio-recordings, videos, and written guides. This intentional use of space offers inspiration and instruction. Purposeful design to the ECMS engages children and adults under the cornerstone of the makerspace framework: communication and community building (Bers et al., 2017). The space included several center areas to engage in different materials, such as a carpet area for Lego construction and tables with stools.

Jamil, Linder, and Stegelin (2018) studied the use of STEAM approaches to pedagogy in preschool and early childhood education settings. Their research sought to gain insight into the practical implementation of STEAM in early education. Early childhood education environments innately lend themselves to hands-on learning in multiple disciplines; therefore, the progression to STEAM education appears to be a natural next step in curriculum development (Jamil et al., 2018). Jamil et al. (2018) found multiple barriers to teaching STEAM in early childhood education, including the interwoven nature of knowledge, beliefs, and practice in teaching. Teacher beliefs on STEAM education and their ability to adequately teach STEAM education were considered a barrier to implementation (Jamil, Linder, & Stegelin, 2018). Jamil et al. (2018) offered professional development in STEAM education with an after-training survey and then additional interviews to conduct their research. Results showed a focus on products, instruction, view of children, and management (Jamil et al., 2018). They concluded that considerations should be made in teacher training to allow educators to implement interdisciplinary learning using STEAM. Teacher beliefs about new approaches to STEAM teaching are invaluable for the implementation of new curriculum design for the benefit of the youngest learners (Jamil et al., 2018).

Play is an integral part of early childhood development and education (Wohlwend & Peppler, 2015). The use of play by young children allows experimentation with new ideas, materials, and objects. Wohlwend and Peppler (2015) proposed an update to early childhood education with the inclusion of a play-based curriculum that is rigorous, technologically relevant, and collaborative. Wohlwend and Peppler (2015) defined playshops as a curriculum model that encourages playful and collaborative learning with a combination of literacy, arts, science, and technology. When studying their playshops, Wohlwend and Peppler (2015) found that the curriculum supports deeper learning for more children. They advocate for play-based yet rigorous curriculum in early childhood education that applies Common Core standards (Wohlwend & Peppler, 2015). In their play-based learning studies in early childhood education, Wohlwend and Peppler (2015) propose that hands-on activates minds-on learning. Play-based learning deepens core content areas through innovative learning, design and creativity, collaborative learning, and diverse population participation (Wohlwend & Peppler, 2015). Playful learning goes far beyond an enrichment activity and should be considered a basic core standard for engaged and rigorous learning (Wohlwend & Peppler, 2015).

According to Savva and Erakleous (2017), children resemble artists in that they are not copying the world around them; instead, they are engaging in the continual creation and re-creation of their environment. Savva and Erakleous (2017) conducted an early childhood education study using a tool called ‘skeptikó’, which means the practice of knowing. Using their tool, Savva and Erakleous engaged pre-service teachers in planning for play-based art activities. Play is an essential component of this process. Savva and Erakleous (2017) stated that teachers should consider the quality of art play and the transfer of knowledge formed while in play-based art activities. A central component of art-based play education in the early childhood setting is the environment or play space (Savva & Erakleous, 2017). Allowing the process of thought-provoking play requires purposeful planning by teachers, including the construction of the play environment (Savva & Erakleous, 2017). In their research with pre-service teachers, Savva and Erakleous (2017) used a survey tool to guide activities for play and art within the early childhood education classroom.

Inferences from Research

Current research supports the cognitive benefits of art education in young children (Kirby, 2018; Sousa & Pilecki, 2013). A review of the literature links art education with academic and social-emotional advantages through preschool to high school graduation (Hoyer et al., 2017; Velazquez-Martin, 2013). While art education is considered a fundamental human right (McClure et al., 2017), curriculum time for the arts continues to be limited in comparison to other subject areas (Hoyer et al., 2017). Researchers continue to establish the importance of art education to student success, while schools are not changing to meet the need. Test scores are not the only means to measure achievement. The literature suggests the importance of art education to the whole-child and that play-based inquiry is the optimal form of education for young minds.

Education is continuously changing, intending to improve. The foundational design of public-school education continues to shift with the changing needs of 21st century workers. Businesses are looking for creative talent in their workers who can innovate (Lichtenberg, Woock, & Wright, n.d.). Offering opportunities for creative exploration is key to the future of education. Innovation and creativity are the cornerstones of what drives educators and students to the Maker Movement, the driving force to the creation of makerspaces across the country (Halverson & Sheridan, 2014; Hatch, 2014; Sweeny, 2017; White, 2014). In makerspaces, students develop hands-on skills to fuel the next generation of thinkers in careers that have not yet been invented.

Methodology

This author utilized issue-focused research to explore the acquisition of art education by kindergarteners in the general education classroom. The author sought to observe the effects of a classroom makerspace on art achievement set by the Washington State K-12 Art Learning Standards for Visual Arts (Office of Superintendent of Public Instruction, 2017). The author proposed a classroom makerspace would have a positive effect on art achievement standards set by the Washington State K-12 Art Learning Standards for Visual Arts (Office of Superintendent of Public Instruction, 2017). Observational data collection occurred during the kindergarten free choice time at the end of the school day. Data collection tools included student artifacts and observational checklists recording student participation. The researchers sought to explore new ways to integrate art education into the classroom after a reduction in art funding over other core subject areas such as math (Knight, 2013; Mazzocchi & Mazzocchi, 2015). While studies continue to show the importance of art education for children, legislation continues to reduce art educational funding access to art in schools (Cavanagh, 2017; Sousa & Pilecki, 2013; Zubrzycki, 2015). This author outlined the funding and time demands required for the implementation of a makerspace in the general education classroom.

Context

The author conducted the study in a suburban elementary school located in the Pacific Northwest. The school had Physical Education, Music, Library, and Technology specialists, but is without an art teacher. The school served a population of over 600 students grades kindergarten through third grade, 73% of whom are from military families (Office of Superintendent of Public Instruction, 2017). Washington State law defined the arts as a core subject and part of basic education. The Washington State Arts Commission (WSAC), in conjunction with the Arts Education Research Initiative (AERI) in 2009, collected data on the status of art education in Washington State K-12 public schools. The report outlined the status of art education in the state, recognizing the vital role art education plays in a well-rounded education. A total of 478 school principals participated in the study. The participating schools mirror the student and school demographics across the state. The respondents reported that 33% of elementary students are getting an average of one hour of arts instruction per week (Washington State Arts Commission, 2009). Only 8% of elementary schools provide formal art instruction in all four arts disciplines. 63% of school principals reported that they were dissatisfied with the quality of arts education in their schools, and 42% of principals say that statewide testing gets in the way of meeting arts learning goals (Washington State Arts Commission, 2009).

Art instructional time has significantly decreased in Washington State from the 2005 AERI survey results. In 2005, according to the Washington State Arts Commission (2009), the average annual time an elementary student engaged in visual art instruction was 46.4 hours. While in 2009, principals reported only 26.6 hours of visual art instruction, a 74% reduction in visual art curriculum time for elementary students (Washington State Arts Commission, 2009). The AERI results also showed a significant lack in a formal curriculum in the arts. Only 46 % of schools reported using a curriculum aligned with state standards in visual arts. Washington State reported being below the national average for art education in middle school. Nationally 69% of schools employ a full-time specialist in music and visual arts, compared to 58% in Washington State (Washington State Arts Commission, 2009).

The research included results showing a decrease in support from community members and organizations. While the 2005 AERI study found that 54% of schools received support from outside organizations, only 25% of schools reported they received help in the 2009 survey (Washington State Arts Commission, 2009). The report cites an increased emphasis on mathematics, reading, and other core subjects as a possible barrier to building nonprofit partnerships with schools for the benefit of art education. The Arts Education Research Initiative research suggests that community and school partnerships have a substantial impact on the level and success of art education (Washington State Arts Commission, 2009). Community partnership also play a significant role in the funding for art education in Washington State; 33% of schools reported the funding support of a Parent Teacher Student Association (PTSA), 22% reported parent donations supported art education, and 9% reported the help from foundations (Washington State Arts Commission, 2009).

The AERI report outlines actions districts can take in Washington State to increase the quality and level of art education in public schools. According to the Washington State Arts Commission (2009), principal and teaching faculty should adopt flexible schedules to provide time for art education during the school day. Schools could also provide standard planning time for art educators and general education classroom teachers to collaborate on areas of classroom curriculum. Within the community, the Washington State Arts Commission (2009) recommended that cultural organizations work with schools and districts to develop sustainable partnerships and advocate for K-12 art education as part of the regular school day. Finally, the report asks that all parties work together for the common goal of art education for every student, every school, every year (Washington State Arts Commission, 2009). Focusing on the issue of limited access to art education in public schools, the researcher proposed the use of a classroom makerspace to increase the exposure to art education for elementary students.

Participants

The research study took place in a classroom containing twenty-two kindergarten students at a suburban school in the Pacific Northwest. According to the Office of Superintendent of Public Instruction (2019), the school population was 73% military, 15% low income, and 7% English Language Learners. Participants were in the class where the author was a student teacher from January through March of 2020. The author gained access to participants through daily student teaching. All ethical procedures were followed to maintain the highest standards of protocol when working with young children. The student population consisted of 13 girls and ten boys, ranging in age from five to six years old. Students in the classroom came from diverse cultural backgrounds. Two students received weekly ELL intervention. Three students received a daily reading intervention. One student was on an IEP for Autism Spectrum Disorder.

Intervention

The classroom makerspace was intended to benefit every student. The implementation of an elementary classroom makerspace was created with a triad focus: materials, time, and space, leading to an interconnected and effective makerspace (Appendix A). Consideration of all parts of the triad enables the makerspace to serve students adequately. Materials are the heart of the makerspace; thoughtful consideration is necessary for choosing materials for student use. Time allocation for the use of the makerspace is essential; providing students adequate time to use the makerspace allows them to benefit from its presence in the classroom. The final part of the triad is space; students should feel a sense of ownership over their learning space and be allowed adequate physical space to accomplish their explorative tasks in the makerspace. These three components, combined with equal consideration, will provide an effective makerspace STEAM intervention in the elementary school classroom.

Materials and Area

The elementary classroom had an area designated as the makerspace. To lower barriers to accessibility, materials, and supplies were considered (Cross, 2017). The makerspace consisted of materials bins, charts, and lists of project ideas with limited instruction. A list of supplies divided by materials intended for each of the STEAM subject areas is listed in Appendix B. Bins with art materials included markers, colored pencils, crayons, oil pastels, glue sticks, and liquid glue (Appendix E). Additional bins contained tools, such as scissors, rulers, different types of tape, and hole punchers (Appendix E). The makerspace consisted of containers with miscellaneous objects such as cardboard, pipe cleaners, cardboard tubes, plastic bottle caps, plastic containers, plastic lids, Styrofoam, egg cartons, paper, string, and other various reusable items. A complete list of recyclable and reusable items suggested for elementary schools is provided in Appendix C. Materials also included two trays of watercolor paint and a box of paintbrushes, a ruler, a tape measurer, and stencils. Each bin and box were labeled with the names of the items that belong in the container. The makerspace was intentionally designed to encourage the cross-use of materials (McClure et al., 2017). According to McClure et al. (2017), it is essential to ensure the aesthetic of the makerspace area is appealing to students, including the quality of materials. Materials were working order and organized to maximize the area for student use and exploration.

Throughout the study, all materials needed to remain in good working order and are clearly labeled and organized. Accurate signage communicated clear expectations about safe tool use (Keune et al., 2015). An example Keune et al. (2015) discusses from their study of makerspaces is a color-coding system to indicate tool access. For example, a red color-coded tool, such as small beads or air-dry clay (Appendix F), required teacher assistance (Keune et al., 2015). The makerspace was intentionally designed for students to provide enough space and materials so that a student can do one of the following: follow step-by-step instructions on a project, adjust a step-by-step project, or create a project independently with the provided materials. The makerspace needed a variety of materials to facilitate STEAM and art exploration fully. In the Montessori method of teaching, the materials are foundational to student learning. Similarly, a classroom makerspace had such standards. These materials lead to student-led exploration and discovery (Keune et al., 2015).

Attention was placed on the location and size of the classroom makerspace. In Cross's (2017) survey of educators, the biggest wish of those running a makerspace was for more space for exploration and storage for materials. If the makerspace area is too small, the students will feel limited in their ability to explore and create. The makerspace had adequate space for students, including a worktable. The classroom makerspace included small carrying trays and containers, which allowed students the option of taking their makerspace materials to their desks to explore and create when space was limited. By allowing students to take the makerspace materials to their desks, maximum numbers of students were able to use the materials and benefit from the makerspace. Students were asked to leave any wet items that need to dry overnight on their desks. The rules and procedures for the classroom makerspace were on display in clear view (Appendix F). Student work was shared with families via electronic applications, email, or other digital media. The artwork was displayed in the classroom, hallway, and class newsletter.

Procedures and Set-Up

Before opening the classroom makerspace, students received instructions on safety rules and clean-up procedures. Safety rules included proper use of scissors, proper use of a tape dispenser, and safely handling a hole punch. Procedures of the makerspace included the proper way to use liquid glue to avoid waste. Students were given specific instructions on the use of tools such as paper punchers, glue, and a stamp pad with an emphasis on maintaining the quality of the tools. Procedural instructions included specific instructions for clean-up of messy materials such as paint, chalk, and charcoal. The teachers discussed the importance of being mindful of resources such as paper and proper disposal of trash versus recycled items. Clean-up procedures focused on putting items back in labeled bins and boxes, disposing of waste in proper containers, and setting projects in a proper area to dry or rest. Special consideration was made to the quality and organization of the materials to provide a clean, structured environment, which encourages order. Children have a natural desire for order within their environment (Montessori, 1967).

The makerspace was available based on the classroom teacher's expectations and rules. In the kindergarten classroom, the makerspace was open during the free choice time, the optimal time of the school day for creative thinking and exploration. Free choice occurred at the end of the school day for approximately thirty to forty minutes. Kindergarten free choice is a time when students can pick and choose games and toys in the classroom. Free choice classroom items available to students include Legos, magnetic tiles, play kitchen, sensory table, and board games. The makerspace remained closed during the instructional time with a sign to indicate that it is not available for use (Appendix E). Students abided by this classroom rule as part of the classroom expectations. The makerspace opened in the classroom after rules and procedures were established.

During the first week of the makerspace intervention, students participated in small groups of four to five students. Each small group received instructions on how to check into the makerspace with the clip chart, the proper procedures to using the makerspace materials, and for clean-up. Students had one-on-one and small group attention from the teacher to ensure that the students had a strong understanding of the procedures and rules of the makerspace.

Data Gathering Instruments/Assessments

A variety of data collection tools were used to strengthen the validity of the issue focused research study on the use of a makerspace in the kindergarten general education classroom. Each data collection tool was standardized to decrease room for error and study the topic thoroughly. The use of multiple data collection tools validates the issue-focused research study through the triangulation of statistical information. In week two of the intervention, the author began collecting check-list observations of each student's participation in the makerspace. The data was collected from the student clip-chart using student numbers. The author recorded anecdotal observations and took photographs of student work. The makerspace was open during each Monday, Tuesday, Thursday, and Friday of full-length school days when free choice is allowed.

Assessment #1: Observational checklist. Teacher observations occurred daily to record student participation in the makerspace. A checklist recorded which students participated in the makerspace.

Assessment #2: Student artifacts. Photographs of student artwork during the study created a portfolio of student artifacts.

Results

Data collection occurred over 26 days of school when the makerspace was open for use. Results of the intervention showed that an average of 50% of the kindergarten class participated in the makerspace area each day (Figure 1). In the whole group analysis, students participated an average of 13 days during the intervention (Figure 2). Assessing the data grouped by gender, student participation was on average 60% girls and 40% boys (Figure 3).

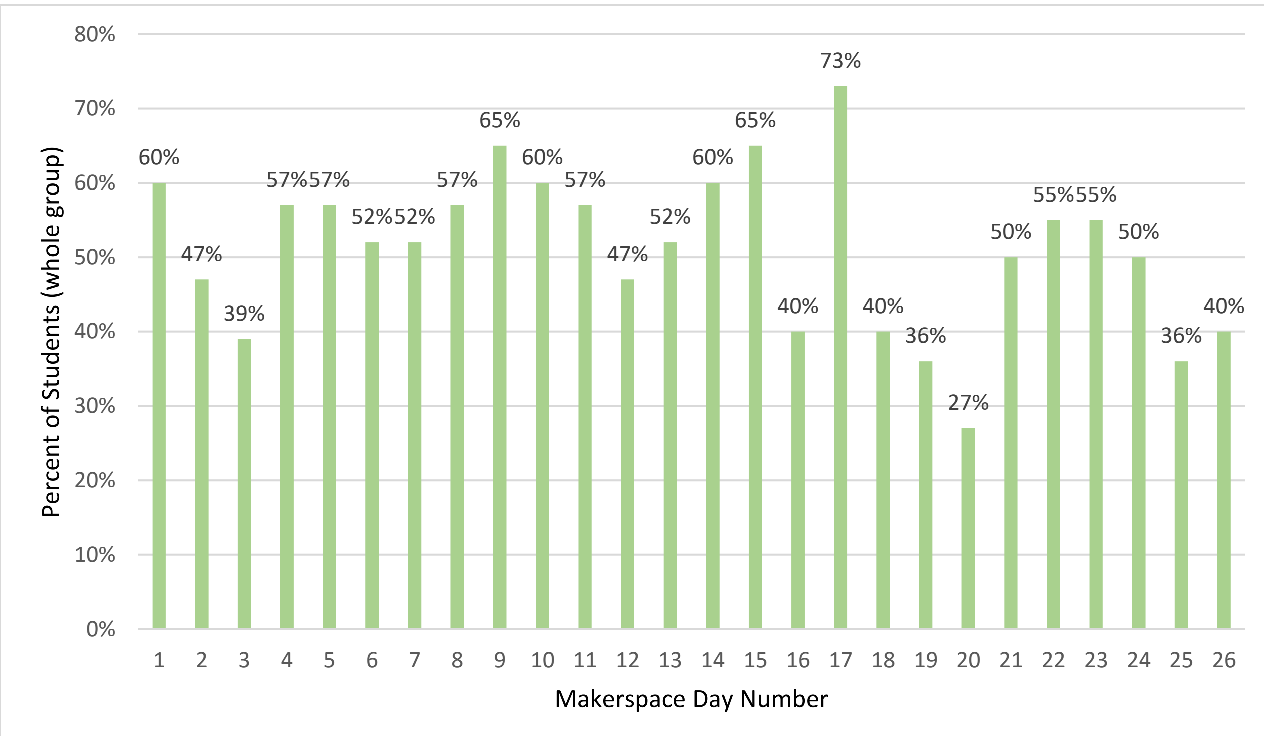

Figure 1. Percentage of whole group student participation by day.

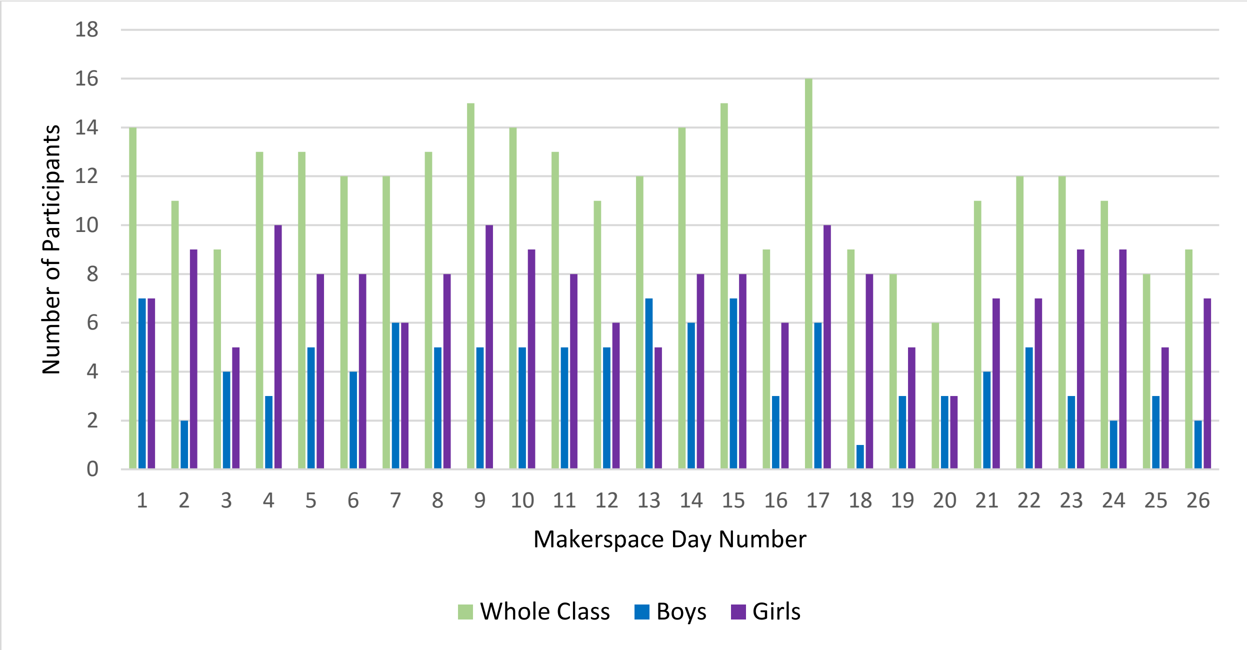

Figure 2. Student participation per day based on whole group, boy, and girl analysis.

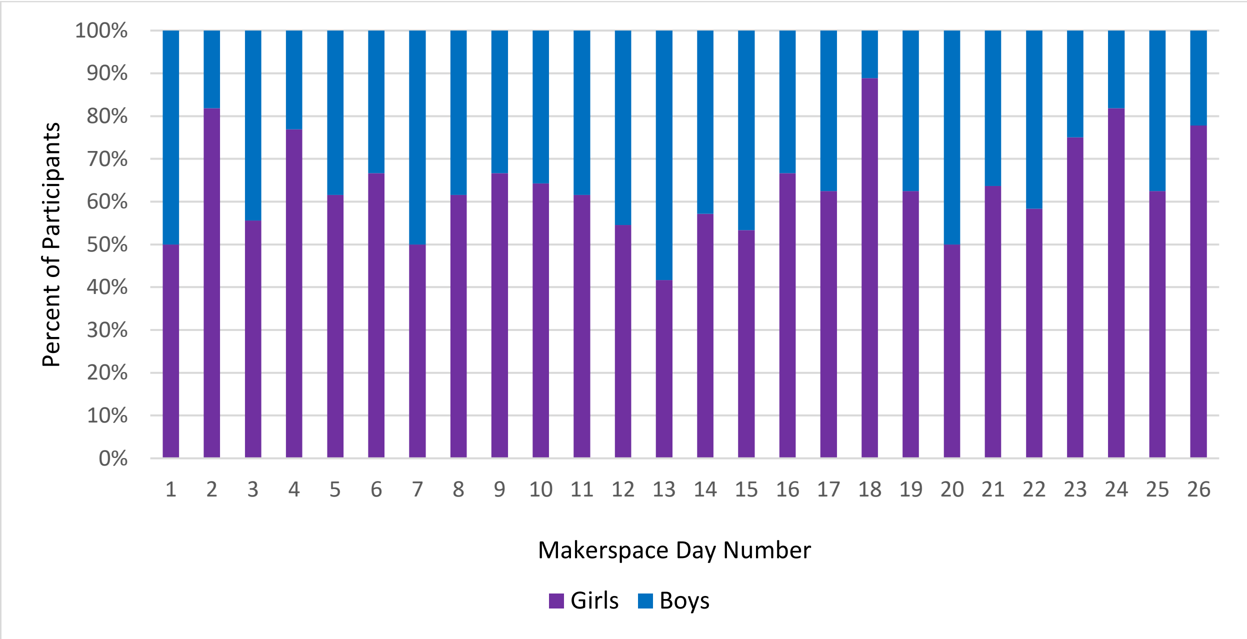

Figure 3. Student participation by gender per day.

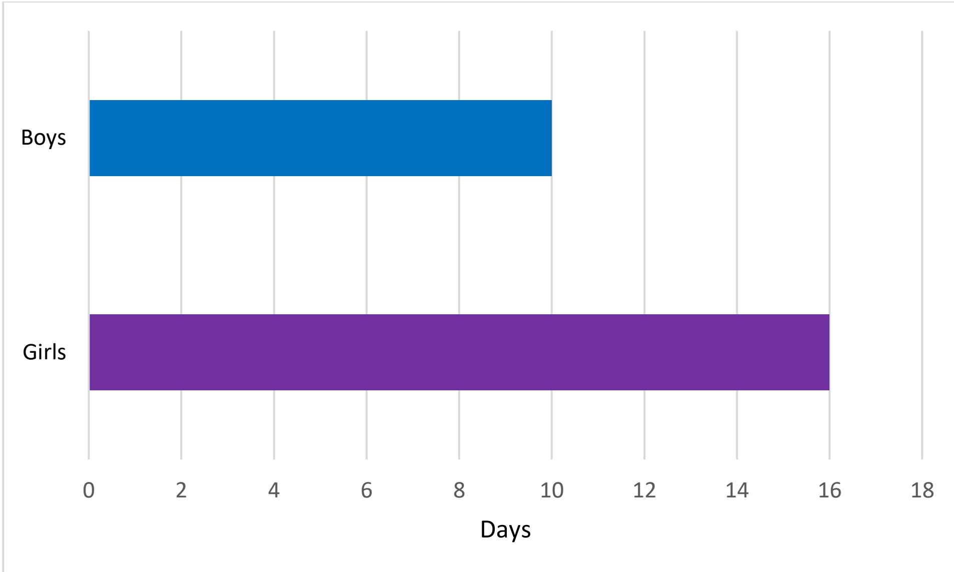

Figure 4. The average number of days participated by each student.

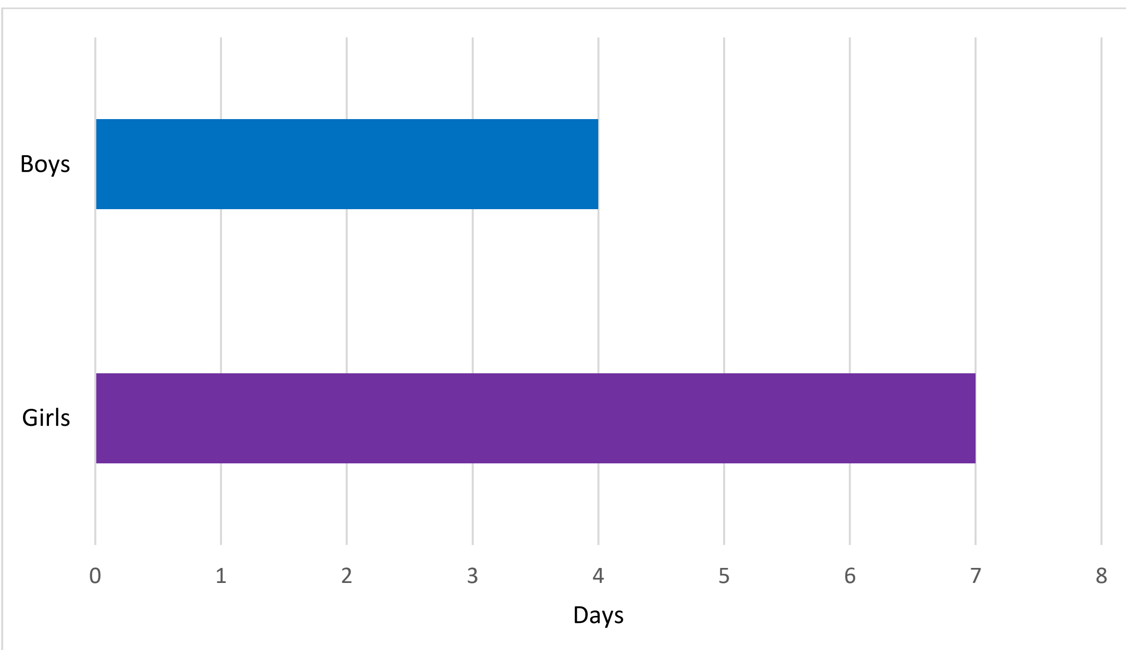

Figure 5. The average number of participants per day by gender.

In review of the average number of days participated by each student by gender (Figures 4 & 5), male students averaged 38% of days participating in the intervention. Female students averaged 62% of days participating in the intervention. A female student participated the most in the makerspace, 25 days, amounting to 96% participation. The student with the least amount of participation, 4 days or 15 % was a male student.

Discussion

Observational Anecdotal Data Analysis

The anecdotal data analysis of the makerspace intervention began with an inspection of whole-class data. For the entire 26 day intervention, an average of 50% of students participated in the makerspace each day. The highest rate of student participation was 16 out of 23 students in a single day, and the least number of participants in a single day was six students. From anecdotal data analysis of the intervention, female students were more active in the makerspace than male students. Overall, the data shows an impressive use of the makerspace by students on a daily basis. Students voluntarily and actively participated in the makerspace. The most significant result of this data is that the makerspace was valued by students and attracted students to explore STEAM education. The students showed a desire to use the makerspace and that it was a valuable tool in the classroom.

Implications

The results of the study demonstrate that the use of a classroom makerspace in the general education classroom, with an emphasis in art, is a viable method for STEAM exploration. Every student in the class participated a minimum of four times during the 26-day intervention, with an average number of 13 days of participation per student. Female students averaged 16 days of participation or 62% of the intervention period. The high rate of participation by students implies the successful use of the makerspace as a STEAM and art intervention in the general education classroom.

The use of a classroom makerspace can be viewed as a creative system, ordered and organized to effectively offer art education in the general education classroom. Student data revealed an interest in the makerspace and the variety of materials offered for use, such as chalk, paint, tape, glue, sticks, clay, cardboard, sequins, markers, straws, string, yarn, and rulers (Appendix G, H, I, and J). Anecdotal notes reveal students participated correctly in the procedural use of the makerspace, such as the use of trays for carrying materials to their personal desks. Students also abided by the rules of requiring teacher assistance to use 'red coded' items, such as the beads and the air-dry clay. Observations and anecdotal notes show students were able to use multiple materials within one class day to create dimensional art of various artistic mediums. The anecdotal notes also showed that students would regularly work together to create art pieces or to do a similar project. During the makerspace intervention, students were inspired by the general education classroom focus. Students would transfer this content into the makerspace, such as creating kites during the week of focus on the letter 'K'.

The makerspace intervention achieved the goal of engaging students in art education in a general education setting without taking away from core curriculum time. Students received the same amount of core curriculum during the school day. The makerspace area was an additional asset and resource in the classroom for students to explore and develop critical artistic skills. The makerspace intervention accomplished the objective of bringing art education into the classroom with appropriate tools, materials, and purpose for young students.

The makerspace intervention is a practical addition to the general education elementary school classroom that brings art to students who do not have an art teacher. The makerspace is designed to incorporate all five STEAM subjects into an organized hands-on area. For schools that cannot afford to hire a full-time art teacher, a classroom makerspace is a functional solution for a general education teacher. The general education teacher can incorporate the makerspace into different subject areas or allow students to explore independently and make their own discoveries. Nationwide, education continues to focus on STEM integration and inclusion in general education. The makerspace allows for an extension of this national focus to include the arts, a known and vital tool for student development. Bringing a makerspace into each classroom combines multiple subject areas and art without burdening the general education teacher with additional work. The makerspace also allows a school district without an art teacher, such as the author's school, to facilitate a STEAM and art curriculum.

Limitations

In reviewing the data analysis, there are four main limitations to the research and data collection for the makerspace intervention. Regarding absences, the classroom had an average of one to two students absent per school day during the intervention. Students would also miss the makerspace intervention at the end of the school day due to early dismissal with a guardian due to appointments. Student absences were not recorded or entered as a data point in the research analysis. The limitation of not including student absences in data analysis is that the resulting change in the percentage of participants per day and overtime is not shown.

The second limitation was student accountability. Students were asked to check into the makerspace using a clip chart. Data collection was dependent on students' ability to independently remember to check into the makerspace. The data was recorded based on those independent check-ins. Students may not have remembered to check-in for each time they worked in the makerspace, which could alter the number of student participants per day.

The third limitation was the time given to students each day. Students could enter the makerspace during the free choice time at the end of the school day. In order to go to free choice, students first had to complete their work from the day and then pack their bags to go home. Students were not allowed to go to free choice until either their work was complete, or with approval from the teacher. At the end of the school day, some students spend the entire free choice time completing unfinished work. The students who are not able to finish their work could not participate in the makerspace intervention.

The final limitation was the abrupt ending of the data collection due to the school closures in response to the COVID-19 pandemic. On March 12th, 2020, the Governor of the state announced the closure of all public and private schools for six weeks, following a subsequent announcement on April 6th to extend the school closure for the remainder of the academic year. Additional data collection in the classroom makerspace could have occurred for these six weeks of school, resulting in the complete cessation of data collection.

Limitations to the Makerspace

The makerspace has limitations primarily related to time and funding. Teachers will have control over students' access and time allotted to the makerspace in their classrooms. Teachers who embrace the makerspace may allow more student time and use, while teachers who lack enthusiasm or familiarity with the makerspace may limit the time allowed. The financial cost of the makerspace was previously discussed and is an issue the community can rally around to support financially with gifts or donations. The proposed makerspace would not receive district funding; therefore, it is limited by the generosity of the community or the ability to apply for funding grants. If there are not enough donated items, or the items are unusable, there will be direct consequences for the classroom makerspaces.

In the school where the study was conducted, there are 25 classrooms, which means the creation of 25 different makerspaces. Proper maintenance of 25 individual makerspaces would be a significant amount of work for staff and volunteers. A leadership team of administrators, teachers, parents, and volunteers will need to be formed to organize school makerspaces properly.

Recommendations Based on Makerspace Limitations

The author recommends two solutions to the makerspace limitations. First, a staff person or persons be given a stipend to work as the school-wide makerspace leader. The makerspace staff person would serve as liaison and coordinate communication and planning with the makerspace team and teaching staff. The roles of the staff person are to ensure that each makerspace is properly supplied and to coordinate any special requests for materials that may correspond with the curriculum. Providing a stipend for this work benefits the program by encouraging a designated staff member to take ownership of the makerspaces. The stipend also provides financial compensation for their time and work on the project.

The second recommendation is to pilot a library or hallway makerspace prior to classroom makerspaces. Currently, at the author’s school, there is a large area in the library that would be an excellent location to install a makerspace. Students could have access to the makerspace during their designated library time. Teachers could sign up to use the library makerspace for projects. If the school administration or PTA were able to find volunteers, the library makerspace could also be open during lunch recess for students who choose to stay indoors. A library makerspace could be an option for children who are required to stay indoors for reasons such as medical or otherwise.

A hallway makerspace is a unique solution to limited classroom space. The author’s school has three distinct hallway wings. Each wing could have a small makerspace area for teachers to use with small groups of students. Classroom teachers would be able to sign up in advance for the makerspace. The hallway makerspace would have specific rules, such as limiting noise and ensuring a clean work area. The advantage of a hallway makerspace is that it does not occupy space in the classroom. Its location in the hallway also grants access to many students. The hallways are divided by grade level; therefore, the hallway makerspaces could be designed for each grade level's interests and coordinated with the grade level curriculum content.

Recommendations

Recommendations for future implementation of a classroom makerspace in a general education school setting include the initial obstacles of opening a makerspace and the tools needed for maintaining the makerspace in a classroom or school. The first recommendation is based on the cost of starting and maintaining a classroom makerspace. The second recommendation is for future implementation to continue a classroom makerspace in the school, including the creation of a makerspace leadership team and providing an art educational link to the materials and content.

Offsetting the Cost of Implementation

Implementation of a classroom makerspace comes with a cost and a potential financial burden to the school. According to Keune and Peppler (2019), makerspaces are challenging to design due to the substantial investment required for materials such as 3D printers and computers. Costs include the purchase of bins or containers to hold the supplies, tape, and paper. With the leadership team procuring donations and materials from the community, implementing the makerspace should be financially viable. Extra school supplies donated by families at the beginning of the school year, such as markers and glue, can also be used in the makerspace.

Larger, more specific projects will require extra funding and materials. Higher cost items include acrylic paint, canvases, chalk, pastels, and ink. The list of possible supplies is extensive (see Appendices B, C, D). Funding a classroom makerspace can be supported by non-profit organizations such as Parent Teacher Association (PTA) through grants to purchase additional supplies, in addition to the donated materials gathered by the makerspace leadership team. The PTA grant and donated supplies to the makerspace is in response to the need for additional funding and as support for teachers to teach art in the classroom. In coordination with community support, the funding for the classroom makerspaces can be significantly reduced.

Recommendations for Future Implementation: Makerspace Leadership

A classroom makerspace requires oversight to organize supplies and implementation. The makerspace project would need a team of volunteers and a staff leader to ensure the makerspace was functional throughout the school year. The makerspace team would set an educational goal for the implementation of the makerspace and see that it is created successfully. At the author's school, the makerspace team would consist of a minimum of one staff member, a PTA board member, and other community volunteers.

The makerspace team would be tasked with the maintenance of materials for the classroom makerspaces. They would seek out donations for items from the community, including businesses, charities, and organizations, for reusable materials to include. There is an unlimited variety of items that can be used in the classroom makerspace. It would be the leadership's responsibility to distribute donated items to classroom makerspaces. Contrary to state and federal policies that require districts to funding for art education, research shows that resources are typically directed elsewhere (Knight, 2013; Taylor, 2012). The makerspace leadership would also play a role in any additional funding for the classroom supplies, and any school purchased supplies, such as a 3-D printer. In coordination with the PTA, the team would fund teacher requests for makerspace supplies and classroom organizational items. The PTA would fund the 3-D printer and printer cartridges in partnership with the school technology teacher. Involving the community in the development and maintenance of the classroom makerspaces would significantly increase the potential of the makerspace and its benefits to students. In their research on developing makerspaces, researchers found engaging community resources and concepts, such as mobile labs, increase accessibility, and effectiveness of the programs (Urzo, Foster, Keune, Peppler, & Stutzman, 2016).

Students would be invited to participate in the makerspace leadership team to allow for student voice. According to Keune et al. (2015), there is no clearly defined meaning of an expert maker, so that the entire student body may participate regardless of skill or interest. Student makers can offer valuable input to the development and implementation of the makerspace design when offered to participate on the makerspace leadership team.

Recommendations for Future Implementation: Art in the Makerspace

According to the Open Education Database, there are multiple types of makerspaces, including fablabs, hackerspaces, and makerspaces (Open Education Database, 2006). For the purpose of this research study, the classroom makerspace researcher emphasized the exploration of art education in the classroom. To be intentional about art education using the makerspace, the leadership team would provide outlined monthly art lessons for students based on grade level standards. An example list of monthly lessons is provided in Appendix D. The makerspace leadership team should oversee developing and implementing art lessons with the help of art educators. The materials for the monthly art lesson would be distributed to each classroom and would include an anchor chart with brief, age-appropriate instructions and pictures. The lessons would be created and specifically designed for independent use by students with minimal help from the general education teacher. Students are encouraged to complete one of the monthly art lessons prior to independent art exploration. The monthly lesson intends to gradually scaffold art skills while simultaneously incorporating the NCSS art standards. When students participate in the monthly focused art lesson in the makerspace, they receive independent art exploration and instruction, and they would otherwise not receive without a dedicated art teacher.

The art projects should be coordinated to build skills over the course of the student's career in elementary school. Each consecutive year students should receive more specially designed and scaffolded projects at the makerspace to develop further their artistic skills and understanding of the core art elements. Each student is encouraged to participate in the monthly focus art lesson at least one time. Students are also encouraged to repeat the art lesson multiple times to advance their learning and artistic skills.

Conclusions

The author's purpose in conducting this issue focused study was to research the current status of art education in public elementary schools in the United States. The research showed comprehensive support for the inclusion of art education based on the benefits to students academically and for their social-emotional health. Whether art education comes in the form of visual arts, music, dance, or performing, the influence of art education on the young mind cannot be understated. Visual arts offer avenues and outlets for students to express themselves and become creative thinkers. Incorporation of visual arts into the general education classroom is a challenge due to a complex series of hurdles such as time, funding, and teacher support. With the increased pressure to incorporate STEM into public schools, teachers have the unique opportunity to enhance the educational experience through the addition of art with STEAM.

The intervention for STEAM education, with a focus on the arts in the general education classroom, is the makerspace. A classroom makerspace requires planning, funding, and proper maintenance. Results of the makerspace intervention in a general education classroom showed significant use of the makerspace by all students. The author recommends the use of a classroom makerspace as an artistic, educational outlet for general education classrooms. When creating a classroom, makerspace attention should be given to the three foundational aspects of successful implementation: materials, time, space. When properly implemented, the classroom makerspace invites innovation and creativity beyond traditional classroom work. Students are intrinsically motivated to tinker with the materials and tools while gaining vital skills. The implementation of a classroom makerspace is an effective option for schools and districts to incorporate art and STEAM into the classroom when hiring an art teacher is not an option. Elementary schools should consider the benefits of art education, and the innovational journey students could experience while using a makerspace.

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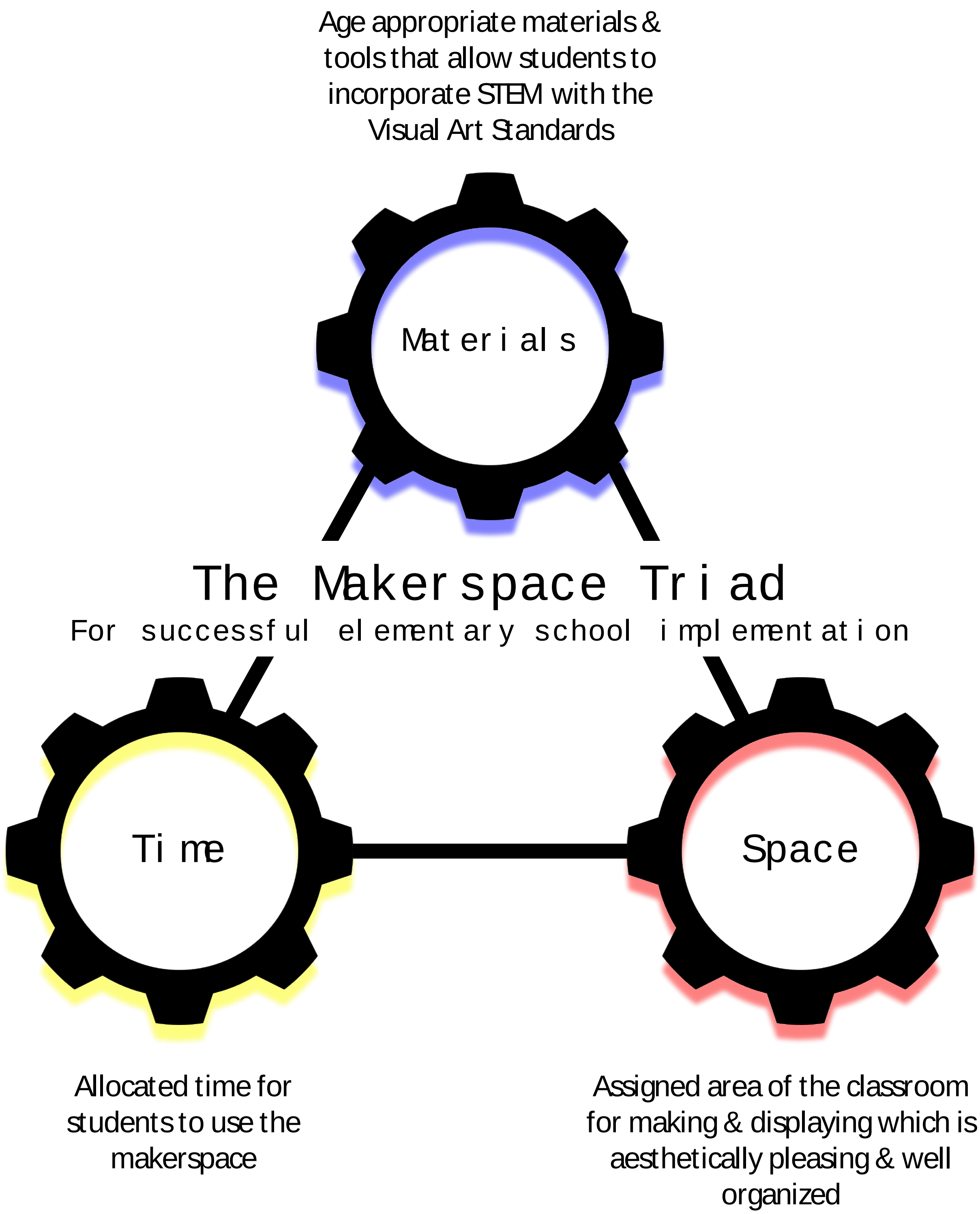
Appendix A


Age appropriate materials & tools that allow students to incorporate STEM with the Visual Art Standards
Materials
The Makerspace Triad
For successful elementary school implementation
Time
Space
Allocated time for students to use the makerspace
Assigned area of the classroom for making & displaying which is aesthetically pleasing & well organized

Appendix B

Suggested Materials for an Elementary Makerspace Divided by Content Area in STEAM

Science	Technology	Engineering	Art	Math
Magnets	Little bits	Circuit	Pompoms	Ruler
Cotton balls	3D doodler	Legos	Glue	Measuring tape
Sponges	3D printer	Blocks	Paint	Grid paper
Q Tips	Playdough	Cardboard	Brushes	Calculator
Straws	Zoob	Scotch tape	Chalk	Compass
Baking soda	Knex	Duct tape	Oil pastels	Protractor
Vinegar	Snap circuits	Cardboard rolls	Beads	Unifex cubes
Salt	Old electronics	Corks	String/yarn	
Sugar	Old keys	Hot glue gun	Pipe cleaner	
Spoons	Old electronics	Craft sticks	Crayons	
Measuring cups	Bubble wrap	Keva planks	Markers	
PVC pipes	Plastic baggies	Rubber bands	Scissors	
Tinfoil	Marbles	Velcro	Felt	
Plastic wrap		Nails	Fabric/lace	
Corn starch		Screws	Buttons	
Dish soap		Screw driver	Sewing supplies	
Oil		Binder clips	Clay	
Ivory soap		Dixie cups	Paper	
		Tooth picks	Mod Podge	

Appendix C

List of recycled Makerspace Supplies

Recycled-reusable cardboard products	Recycled-reusable paper products	Recycled-reusable plastic products	Recycled-reusable other products
Paper bags	Paper bags	Chip tubes	Styrofoam
Small boxes	Newspaper	Water bottles	Bubble wrap
Shoe boxes	Magazines	Plastic bottle lids	Wine corks
Toilette paper rolls			Packing peanuts
Paper towel rolls			Soup cans
Tissue boxes			Coffee cans
Egg cartons			Nuts, bolts, screws
Cereal boxes			Spools
			Wire

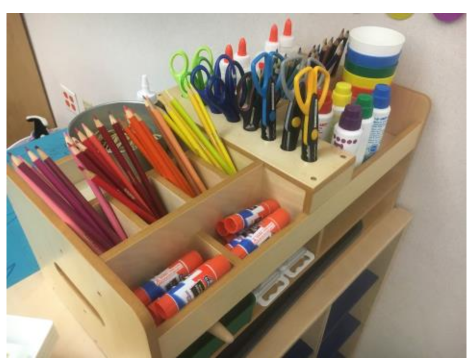
Appendix D

Suggested Monthly Art Themes in the Makerspace by Grade Level (10 months of the school year)

Kindergarten:	1st Grade:	2nd Grade:	3rd Grade:
Focus on Basic Materials, Color Theory & Shapes	Extended Focus on Color Theory, Shapes, & Materials	Focus on the Core Elements of Art in Nature	Introduction to Artists from History with a Focus on Still Life, Portraits, and Landscapes
Basic Portrait	Primary Colors	Warm & Cool Colors	Cezanne Still Life Apples
Scissor Work	Secondary Colors	Complementary Colors	Frida Kahlo & Dia De Los Muertos Sugar Skulls
Different Types of Glue	2D Shapes	Line	Degas Dancers
Using a Brush	3D Shapes	Texture	Van Gogh Starry Night
Primary Colors	Line	Form	Monet Water Lilies
Secondary Colors	Texture	Hue	Georgia O'Keefe Flowers
2D Shapes	Focus on Paint	Value	Mary Cassatt
3D Shapes	Focus on Watercolor	Space/Symmetry	Pablo Picasso Cubism
Line	Focus on Oil Pastels	Still Life	Andy Warhol Pop Art
Texture	Focus on Chalk/Charcoal	Portraits	Seurat Pointillism

Appendix E

Photographs of the general education classroom makerspace:

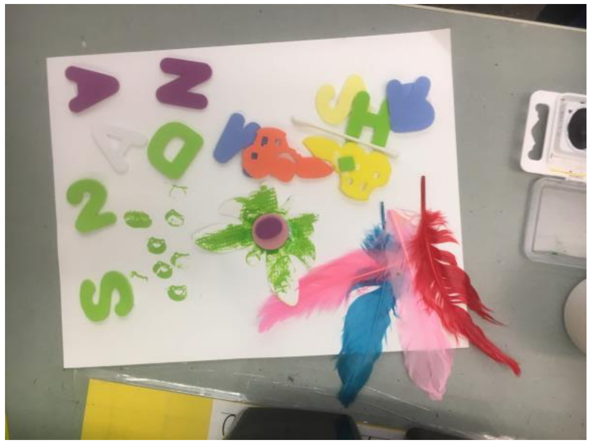


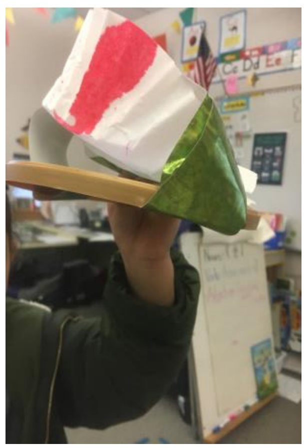
Appendix F

Photographs of the makerspace, a red tape to mark items needing teacher assistance such as a small beads or air-dry clay. Photos of the makerspace rules and procedures.

Appendix G

Photographs of student work with materials in the makerspace:

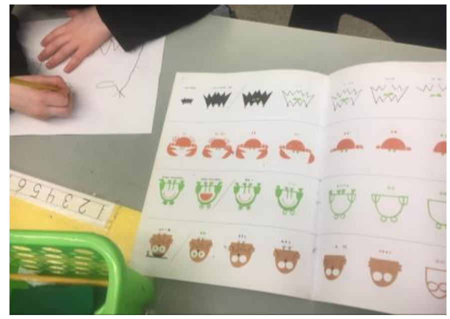
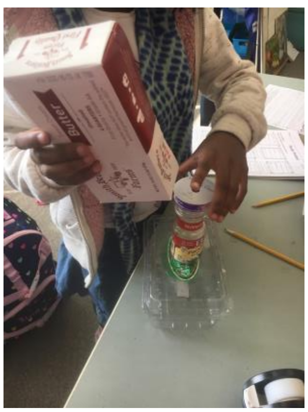




Appendix H

Photographs of student work with materials in the makerspace:

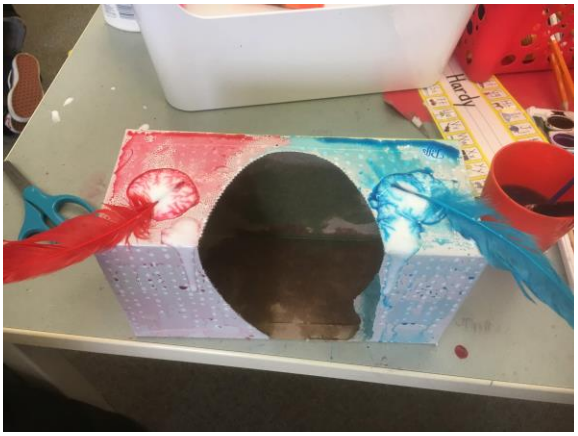


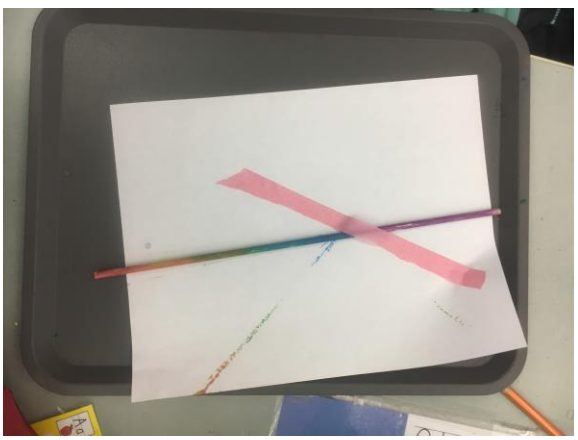



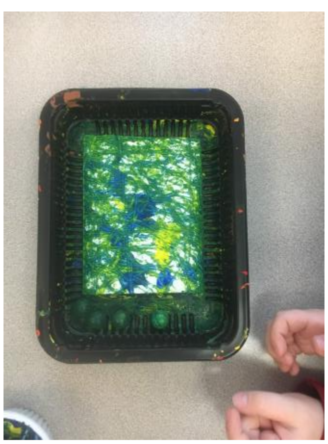


Appendix I

Photographs of student work with materials in the makerspace:







Appendix J

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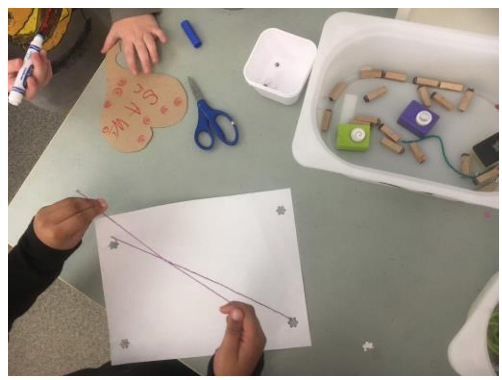

Author's Note

The author is a working student teacher, substitute teacher, parent, and active volunteer. The author develops and distributes Art Docent lessons to an elementary school of over 625 kindergarten through third grade students. There is no employed art teacher or specialist at the school. Researcher bias in the area of art education should be acknowledged. The author is also a certificated Montessori educator in primary grades. Montessori education emphasizes constructivist and scaffolded hands-on learning through specifically designed materials and lessons. The researcher is a co-author of a book on Montessori art education with Dr. Punum Bhatia of Montessori Casa International in Denver, Colorado; The Inspired Child: Art in the Montessori Classroom.

About the Author

Janelle Mock is a Masters in Teaching student from City University of Seattle. She is concurrently enrolled in the University of Nebraska's Master in Art Education program. Ms. Mock holds a Montessori Accreditation Council for Teacher Education (MACTE) Certification in primary grades from the Montessori Casa International in Denver, Colorado. She holds a Bachelor of Arts from Pepperdine University in Advertising and Graphic Design. Ms. Mock has authored three books, including a children's picture book about military deployment and a compilation of military spouse memoirs from the War on Terror. She has also authored, photographed, and designed a book for Montessori educators with art lesson plans for the primary grades. Ms. Mock lives in the Pacific Northwest with her husband and three children. After completion of her Masters in Teaching degree she hopes to begin her career in elementary education. Ms. Mock plans to continue to research and advocate for art education.