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Exploring the Effects of Creativity and Student Success on Community College STEM Students Taking Fine Arts Courses

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EXPLORING THE EFFECTS OF CREATIVITY AND STUDENT SUCCESS ON COMMUNITY COLLEGE STEM STUDENTS TAKING FINE ARTS COURSES

JAMES LEDUC

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF EDUCATIONAL DOCTORATE IN EDUCATIONAL LEADERSHIP

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ABSTRACT

This study examined overall success and creativity in students taking STEM courses at a Midwestern community college. There were four hypotheses in this study. The first was that STEM majors who had taken one or more fine arts courses would report a higher GPA than STEM majors who have not taken fine arts courses. The second was that there would be a positive correlation among STEM majors between the number of fine arts courses taken and grade point average. The third is that STEM majors who had taken one or more fine arts courses would demonstrate greater creativity than STEM majors who had not taken fine arts courses. The fourth is that there would be a positive correlation among STEM majors between the number of fine arts courses taken and creativity. The study did not show a significant difference between STEM majors who had and who had not taken fine arts courses.

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CHAPTER I

Introduction

Background of the Problem

STEM education is an acronym used to discuss education focusing on Science, Technology, Engineering, and Mathematics. STEM education focuses on the importance of science, technology, engineering, and mathematics in creating future scholars and professionals. However, many colleges and universities require that STEM students take fine arts courses during their college tenure. These courses become a part of STEM students' overall experience during their college tenure. Educational institutions continue to reflect on the impact of fine arts courses for students completing a STEM degree.

Impact of Arts Education on STEM Students

Students who participate in fine arts curriculum while pursuing STEM majors employ their minds in exciting ways focusing on creative thinking when taking fine arts courses and apply these unique skill sets in their STEM studies and careers (Grimberg et al., 2018). According to a survey conducted by Michigan State University, STEM students who integrate fine arts coursework and extracurricular activities into their overall studies consistently show more significant achievement in all their courses. These STEM students had overall higher participation and lower dropout rates during their college tenure (Brady, 2014). The STEM students studied showed 22% higher English scores, 20% higher math scores, and demonstrated more creative problem-solving skills (Brady, 2014).

Integrating the fine arts into STEM

Educator Anne Jolly reiterates the importance of integrating the arts into STEM education in her research. She emphasizes that the arts enhance STEM students' experiences as they pursue their studies. The arts allow STEM students to employ creative skills in their courses and future careers (Jolly, 2014). South Korea’s Ministry of Education, Science, and Technology has been a pioneer in integrating the arts into all education areas. They were one of the early proponents of adopting the STEAM model across all education levels. South Korea has seen an increase in students' cognitive skills and overall learning experience in adopting fine arts courses and activities within STEM subjects. Students discussed the long-term effects of the arts in their primary and secondary education and in pursuing STEM degrees in higher education (Kang, 2019).

STEAM in Action

In the current economic and political climate, budgets have moved to focus primarily on STEM. Funding continues to be cut for the fine arts and humanities. For this reason, educational areas are often pitted against each other rather than finding ways to work together to promote an integrated method of learning (Grant, 2016). The elimination of fine arts’ learning opportunities directly correlated to politicians pressuring the colleges on presenting STEM education, which was deemed more beneficial for the students. This idea of STEM being more lucrative and productive can be seen across educational institutions at all levels. Fine arts courses and activities can benefit STEM education. Developing curricula focusing on science, technology, engineering, art, and mathematics, creating a STEAM model for educators could shape more well-rounded students prepared to creatively meet their STEM career challenges (Liao, 2016).

Students can apply creative skills from fine arts courses in STEM courses. However, students are not always taught or encouraged to bridge the creative aspects of STEM in their work. Studies have focused on the positive effects of the fine arts and STEM collaborating to develop robust scholarly experiences. In 2018, the Einstein Festival worked to bridge the gap between scientists and artists. During the festival, experts in STEM and fine arts collaborated to create performing arts installations that brought Albert Einstein's theories to life to a broad spectrum of people (Grimberg et al., 2018). In 2016, a design studio was developed that brought together students in both engineering and sculpture. Students created designs that combine STEM elements with the fine arts forming a STEAM curriculum through detailed exploration. Hesitancy from STEM students overwhelmingly changed to excitement. Students found exciting ways to work together to bring their strengths to the table and develop new ways to think critically and creatively that could be applied outside the classroom setting in their engineering careers (Sochaka et al., 2016). These are just two crucial examples of the benefits of fine arts courses for STEM students. Research shows that some of the most successful STEM practitioners connect to the fine arts (Root-Bernstein, 2015). Thus, fine arts education can be embraced to enhance current STEM education creating well-rounded STEM scholars who creatively use their minds even within their chosen field of study.

Creativity in STEM students

The literature shows that students who engage in fine arts courses while pursuing a STEM major demonstrate more creative approaches to thinking (Payton, 2017). Payton examined students who take STEM and fine arts courses concurrently. The study discusses students' unique experiences by taking classes in various subjects (Payton, 2017). Payton (2017) stated that students must be asked why they have chosen to study STEM and fine arts. The interviews were done with focus groups, explicitly addressing STEM majors taking dance courses (Payton, 2017). These students' detailed experiences display the benefits to their overall educational experiences (Payton, 2017).

Wilson (2018) conducted a study that focused on some STEAM education issues. The study reviews students with a wide-reaching STEM and fine arts curriculum, which affords them a unique approach to problem-solving (Wilson, 2018). The research reflects how this varied course of study and thinking leads to a more creative process for students in each aspect of their education (Wilson, 2018). Wilson discussed the work done in lesson plans across both fields of study and enhances students' overall outcomes in each aspect.

The effects of fine arts coursework afford a unique approach to problem-solving involving creative and critical thinking. Payton (2017) and Wilson (2018) are taken a step further in a previous study developed by Sochaka et al. (2016). Sochaka et al. (2016) explore a first-hand experience of creating an engineering studio that explores all aspects of STEM and the arts to cultivate a unified learning approach. The research explores how course development and course materials can make a well-rounded educational experience (Sochaka et al., 2016). Students applied creative and critical thinking skills in their STEM courses when fine arts activities were employed in the curriculum leading to positive effects on their overall success rates in their STEM studies. Students reflected on what they learned and applied them in other STEM courses (Sochaka et al., 2016).

Sochaka et al. (2016) focus on changing the STEM model to STEAM, concentrating on Science, Technology, Engineering, Arts, and Mathematics. Sochaka discusses how STEAM integration could work to encourage a more integrated experience for students. The ideas expressed about STEAM integration are also seen in Ge et al. (2015). Ge et al. propose the same concept of integration through research, as defined by Sochaka et al. (2016). This text covers changes in curricula not only in STEM but also in the arts. The investigation continues to show specifics on how creativity can be applied not only for students but also for educators when subjects are addressed and taught over a wide variety of disciplines (Ge et al., 2015). The research's primary focus is on how STEAM education can be applied in primary and secondary education to continue STEAM's tradition in higher educational settings (Ge et al., 2015).

Funding has been a consistent issue for fine arts degrees in primary, secondary, and higher education coursework. The funding problems have been addressed in studies focusing on STEM and fine arts education and their integration. Payton (2017) acknowledges through their research the aspects of funding that can be addressed when STEM and fine arts work together and promote a unified approach to education. Harris's (2017), out of Australia, research is focused on funding and policy. Harris reviews how STEM has become a key component in Australia’s education model. Australia continues to push career-focused STEM fields in its educational institutions. This idea can also be said of the United States and many other countries (Harris, 2017). Harris (2017) discusses STEAM and how it can be integrated into the existing STEM education to create a well-rounded student. The research reflects on how Australia is missing the opportunity to develop a wide-reaching curriculum that reviews the importance of STEM and reviews the importance of the arts (Harris, 2017). Harris (2017) focuses on a Creativity Index, reflecting on the STEAM approach and its use as a cross-disciplinary education method.

Root-Bernstein (2015) takes research focusing on fine arts courses' effects in a different direction. Root-Bernstein reviews previous research that discusses that greater creativity can be found in people with a wide variety of educational experiences. This education model can be found formally in primary, secondary, and higher education settings and in fine arts classes and activities taken outside of traditional schools (Root-Bernstein, 2015). Root-Bernstein (2015) explores that many STEM students display an interest and continue to study fine arts. This research continues to show that STEM majors carry over their fine arts work into their STEM professional life as well (Root-Bernstein, 2015). Many of the most extraordinary STEM professionals and the most decorated have studied and continue to focus on fine arts (Root-Bernstein, 2015). This research reflects the positive aspects of fine arts education on STEM careers (Root-Bernstein, 2015).

Grant (2016) reviews the fine arts' active experiences and their coursework. Grant discusses how these areas can develop students' creativity and foster critical thinkers who can uniquely explore various topics in their education and careers. Grant (2016) reflects on how a partnership formed between the Braithwaite Fine Arts Gallery and the Garth and Jerri Frehner Museum of Natural History at Southern Utah University. Grant (2016) explores how this collaboration integrated STEM and fine arts, creating a whole STEAM experience for students in primary and secondary schools, creating a positive and enriching experience (Grant, 2016). Segarra et al. (2018) add to this same idea by exploring how the arts can train STEM professionals. She states that skills can be used in scientific studies in secondary and post-secondary educational settings and discusses how STEAM can help STEM employees (Segarra et al., 2018).

Grimberg et al. (2018) afford another uniquely integrated STEAM experience. Grimberg et al. (2018) reflect on the Celebrating Einstein festival. The festival works to bridge the gaps in the arts and STEM (Grimberg et al., 2018). The festival uniquely combines science and the arts in each aspect of it. This particular study focused on science and skills and integrated them into the festival (Grimberg et al., 2018). The research discusses each festival's location across the United States, doing qualitative research on each participant and attendee's experience (Grimberg et al., 2018). The same concept was explored by Kissell (2019) in her article on the idea of the BLINK festival and using the arts to study various subject matters. Students explore each aspect of STEM education through the lens of the arts. This idea connects them to their communities as well (Kissell, 2019).

Kim et al.'s (2012) research also reflect the positive way fine arts courses and activities can work with STEM to create a STEAM-based curriculum. This study further shows the benefits and offers ideas that can be used in classroom settings to develop a curriculum applied in STEM and fine arts classes (Kim et al., 2012). The research focuses on the ideas of critical and creative thinking. Creating an education method that bridges both disciplines promote a well-rounded curriculum for each subject matter (Kim et al., 2012). Kilip and Park (2012) continue on this same line as well. Kilip and Park (2012) work towards finding a system of education that implements learning methods across STEM and fine arts. The research works to develop a more well-rounded educational experience (Kilip & Park, 2012). Liao (2016) drives this concept of STEAM education home in their study. Liao's research finds that STEM and fine arts working together can be a powerful combination creating students who find engaging ways of thinking and learning (Liao, 2016).

The existing literature displays the positive impact of fine arts courses on STEM students' success during their education. The research demonstrates a directive to incorporate the fine arts as part of a student's curriculum. In applying the skills discovered in the fine arts, STEM students can access even further creativity methods and use these skills in their course of study. Their honed creativity also serves them well in their future STEM careers. This literature leads to the idea that STEM and fine arts can foster a student and professional who applies creative thinking.

Problem Statement

The students' problem is that fine arts courses are not recognized as beneficial for scholars pursuing a STEM major at a two-year institution. Students in the above research clearly express the benefits of STEM and fine arts courses. They also discuss the life-changing effects of taking a well-rounded series of classes. This well-rounded curriculum also shows increases in their overall success rates affecting their grade point average. This research study works to reflect on the benefits of taking courses in STEM and fine arts, affording students the ability to develop their creativity. It also allows students to use creativity in thinking for all their classes. This thinking method also ensures students expand their expertise to think outside the box when needed and have an open mind to various ideas presented to them in their academic, professional, and personal lives.

Much of the current research focuses on the benefits of fine arts coursework in STEM courses in primary and secondary education. Although there have been studies on the effects on college and university students, there is limited data available to see the long-term benefits of integrating the fine arts for students pursuing a STEM major in higher education and even more so as related to the two-year institutions.

Hypotheses

This study will explore the potential for fine arts coursework to promote creative thinking and overall student success among STEM students pursuing an associate degree at an urban Midwestern community college in a Midwestern college and university system. As Sochaka et al. (2016) addressed in their study, students who take courses in fine arts to pursue their STEM majors see a deeper level of success in their major by graduation (Grimberg et al., 2018). STEM students who choose to take fine arts courses during their college tenure show a greater connection to employing creative thinking skills in their coursework and pursue career opportunities within the STEM field post-graduation (Grimberg, 2016).

Grant (2016) shows that students reported more overall success in their STEM coursework when it was enhanced by studying fine arts. Root-Bernstein (2015) found that students took the skills in their fine arts work and applied these to tremendous success in their grades in STEM assignments and courses.

Hypothesis 1: It is hypothesized that STEM majors who have taken one or more fine arts courses will report a higher GPA than STEM majors who have not taken fine arts courses.

Root-Bernstein's (2015) study explores the long-term effects of fine arts exposure on STEM majors. These effects can be seen while pursuing their studies and continuing their careers in the STEM field (Root-Bernstein, 2015).

Hypothesis 2: It is hypothesized that there will be a positive correlation among STEM majors between the number of fine arts courses taken and grade point average. Root-Bernstein's (2015) study explores the long-term effects of fine arts exposure on STEM majors. These effects can be seen while pursuing their studies and continuing their careers in the STEM field (Root-Bernstein, 2015).

Integrating the arts into STEM coursework shows that students can work with their brainpower more fully applying creative approaches to their STEM courses (Jolly, 2014). Brady (2014) discusses the improved success rates of STEM students who study fine arts and focuses on how fine arts coursework allows students to avoid burnout in pursuit of their STEM majors.

Hypothesis 3: It is hypothesized that STEM majors who have taken one or more fine arts courses will demonstrate greater creativity than STEM majors who have not taken fine arts courses.

Grimberg et al. (2018) use the example of the Celebrating Einstein Festival. The festival combined the arts with STEM fields focusing on more creative approaches to scientific problems. Kang (2019) uses the success of STEM students in South Korea to display the importance of STEM students applying innovative techniques to problem-solving learned while integrating the arts into their major coursework.

Hypothesis 4: It is hypothesized that there will be a positive correlation among STEM majors between fine arts courses and creativity.

Significance of the Research

Fine arts courses and activities can significantly affect the experiences of STEM students. They can work to nurture a more well-rounded and creative student who thinks with their entire brain, even within the scientific laboratory (Root-Berenstein, 2015). These findings are particularly crucial as funding continues to be decreased across the country regarding fine arts programs, courses, and extracurricular activities (Grant, 2016). By focusing on integrating the fine arts as part of the curriculum and experiences for STEM students in higher education, specifically a two-year community college in the Midwestern colleges and universities system, creativity and GPA success can be explored (Sochaka et al., 2016).

This well-rounded and creative approach to thinking and problem solving can produce a more unified educational system enabling students to explore STEM education and a STEAM education model affording a more creative student and a more creative working professional within the STEM arena (Liao, 2016).

As the above literature addresses, excellent instruction, and a well-rounded curriculum matter most for students, no matter what degree they pursue. Fine arts can be a robust method to provide essential tools for creating creative individuals who apply creative ideas across the map in their studies and professional development. In reviewing the positive effects of fine arts coursework and STEM activities, these experiences' benefits can not only be explored but fully realized by institutions across the country.

Limitations

The research is connected to the experiences of STEM students pursuing an associate degree at an urban Midwestern community college within a Midwestern college and university system. The unique elements within the system specific to the community college include the system's unique structure, system curriculum requirements, system courses required, and system credits necessary to receive a STEM degree at the community college. Consequently, although the system is the third largest such system in the nation, it is possible that the findings might not generalize to two-year students across the country.

Definition of Key Terms

STEM Major

Focuses on students who are in their second year of a two-year associate degree. This STEM emphasis is equivalent to four-year students declaring a STEM major.

Fine Arts Education

Includes the visual arts, focusing on both two and three-dimensional art, and the performing arts reflecting on music, dance, and theatre. In recent years, some in fine arts education have included film and television production and other audio pursuits for radio and voiceover.

STEAM Education

STEAM takes STEM one step further within academic settings. While STEM focuses solely on Science, Technology, Engineering, and Math, STEAM works to integrate the Arts umbrella into an educational model that employs a more unified curricular approach.

Curriculum

Focuses on the course of study within a particular major while pursuing a college degree.

Educational Assessment

Education assessment is also referred to on some occasions as educational evaluation. Assessment for educators is not just based on grades or how well students do in a graded assignment or graded course. Assessment works to explore data empirically by looking at student success and student engagement in particular classes, lessons, and programs academically. Educational assessment is not used as a means of grading but as a means for educators to review their courses and programs. Educational institutions also use assessment to refine courses, programs, and ideas to create a more positive experience that benefits students.

Critical Thinking

Critical thinking is the disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action." (Ennis, 1992)

Creative Thinking

Creative thinking employs finding the definition of the problem, gathering necessary information, and exploring the concept of the problem. Creative thinking also uses idea generation and evaluation while implementing planning and creativity (Mumford, 2009). Creative thinking is sometimes unsettling within specific fields at first. Still, it can often lead to thinking outside of a traditional thinking mode, affording more unique solutions to problems that arise. It can be used not only in creative fields such as liberal and fine arts, but it is also often applied to STEM fields today. This research study addresses how this can be used by STEM students who pursue involvement in fine arts courses and activities (Mumford, 2009).

CHAPTER II

Review of the Literature

In discussing the effect of fine arts courses on STEM (Science, Technology, Engineering, Math) majors, it is essential to review the current shift from the educational model in higher education that focuses on a core curriculum featuring the fine arts to a STEM-focused curriculum model. Curriculum in higher learning institutions focused on employing a well-rounded curriculum throughout the 1970s to 2010. However, this has significantly changed over time to focus even more on STEM courses over the fine arts (Colwell, 2018). There has been a significant push to fund STEM more robustly than the fine arts and liberal arts. After the financial crisis of 2008, many colleges and universities eliminated courses in the fine arts, foreign languages, and history because many students and parents felt that these courses were not necessary for today's job market. However, most scholars agree that STEM majors greatly benefit from exposure to the arts and humanities (Mullen, 2019). The number of students majoring in the fine arts and humanities has decreased by over 10% since 2010. This decrease is contrasted with a continued uptick in STEM majors (Mullen, 2019). Mullen (2019) points out that many schools are eliminating the fine arts more and more while increasing STEM courses and majors. Many scholars note that this is creating STEM majors with excellent knowledge of their field of study. Still, these students lack creative ways to employ their STEM skills across global, political, and economic situations as they move into their STEM careers (Mullen, 2019). Mullen (2019) also notes that career advancement and changes in career trajectories for STEM majors could be significantly enhanced by the fine arts and humanities courses they take over their college tenure. The skill sets unique to the fine arts could greatly benefit STEM students to think outside the proverbial box and work to find creative solutions to the problems they encounter in their fields (Mullen, 2019).

Exclusively STEM-focused careers have been the push for some time. President Obama even focused on the Staple Act, granting immigrants a green card upon completing a STEM-related Ph.D. (Adamson, 2014). Although the initial idea was to help with the STEM shortage, some signs point to adverse effects resulting from the STEM-only emphasis on education. The fine arts account for no less than four million jobs. The fine arts also stimulate 135 million dollars in economic activity and 22 billion in revenue for cities, states, and the entire United States (Adamson, 2014). Despite these numbers, the fine arts continue to be ignored in favor of STEM-only education. Studies show that students involved in the arts are four times more likely to participate in math and science fairs and three times more likely to serve in campus leadership positions (Adamson, 2014). Adamson (2014) points out that there is undeniably great value in STEM education but that the fine arts must be a vital part of a student's education and produce global citizens who can work in any field employing a more creative skill set no matter what their career path.

Over the last several years, funding for the fine arts has been dramatically cut across the United States. At this point, almost 1.5 million primary and secondary students have no access to music education. Four million of these students have no access to the visual arts, and 23 million have no exposure to theatre or dance education (Adamson, 2014). K-12 education has made a big push for STEM education funding, which was reiterated under the Obama administration. However, studies show that colleges and universities are graduating as many STEM students as before this push began.

Similarly, the retention rates amongst STEM students are more vital than it ever has been before (Adamson, 2014). Despite these statistics, many politicians are overwhelmingly pushing to decrease access to the fine arts at all educational levels. This push has weakened the fine arts curriculum and pitted the fine arts against STEM.

The fine arts continue to see budget cuts. The elimination of the fine arts' learning directly correlates with pressure from politicians for colleges and universities to promote STEM education over the fine arts and humanities (Adamson, 2014). It displays the belief that STEM is more lucrative and productive. This idea can be seen across educational institutions at all levels. However, fine arts courses and activities can benefit STEM education (Colwell, 2018).

Across the globe, ideas have begun to develop, emphasizing a need for detailed arts policy connected to a thorough arts curriculum assessment. Educators, politicians, and community members realize that these policies focusing on arts education would enhance the value of arts education in the classroom and every area of society (Colwell, 2018). Lyndon Johnson established the National Endowment for the Arts in 1965 amidst opposition that the government should have no role in promoting the arts on a federal level (Winter, 2001). Despite the objections of more conservative political factions, studies confirm overwhelming support for the arts and artists and arts education amongst the general public. Winter (2001) states that 60% of people support government funding for the arts, and 70% support individual artists. This support is shown in large numbers amongst many people. Many politicians still push back on the idea that the arts play any role in our society, national, or international affairs (Winter, 2001). These same thoughts are reiterated as many feel that if an artist's work is subsidized, the public should hold these fine artists up to censorship to receive government funding (Winter, 2001). Situations such as these have further eroded the fine arts importance, significantly impacting fine arts education across the United States.

Impact of Arts Education on STEM Students

Studies have shown the positive effects on student success and creativity in STEM students who take fine arts courses during their K-12 and college tenure. Jolly (2014), an arts educator, discusses that eliminating the fine arts in favor of strictly STEM-based education programs weakens students' success rates. Jolly also reiterates that eliminating the fine arts harms STEM majors as well. Her studies reveal that the fine arts magnify the experiences of STEM students during their college tenure. Through fine arts courses and activities, STEM students learn vital creative skills directly applicable in their STEM courses and STEM-related jobs (Jolly, 2014).

The need for well-rounded employees reiterates the need for the arts to be a part of a student's educational process. In 2008, Conference Board and Americans for the Arts, in association with the American Association of School Administrators (AASA), surveyed K-12 administrators and corporate executives. The study revealed that more and more companies want future employees to be STEM knowledgeable and have creative and fine arts knowledge (Tarnoff, 2010). Executives felt that workers who had studied fine arts during their college career displayed a better capability to brainstorm innovative approaches and contribute new ideas outside the box (Tarnoff, 2010). Tarnoff (2010) argues that his best STEM workers have taken fine arts courses. These employees display the strong ability to blend the technical with the creative fostering a more desirable and productive work environment.

Similarly, Eisner (2010) argues that every field of study is a form of art and that each practitioner is an artist. He reiterates that the primary mission of education is to nurture artists in every field, including STEM. Eisner's (2010) view of artists extends far beyond our idea of fine artists pursuing an art medium. He points out that art can and should be found in every job and every object made worldwide. For this reason, he firmly believes that students can use the skills discovered in the fine arts in every field. He supports integrating the fine arts into education so that students can apply these skills in the workforce (Eisner, 2010).

One can see the power of integrating the arts clearly in South Korea. They have pioneered the integration of the fine arts across their educational programs. Their Ministry of Education, Science, and Technology was one of the first in the world to adopt a STEAM-based education model. In adopting fine arts courses and activities in collaboration with STEM studies, South Korea has seen an increase in students' creativity and overall success rate. Students frequently discuss that these creative skills learned in their fine arts courses had had long-term effects throughout each level of their education and in pursuing STEM careers post-graduation (Kang, 2019).

A 1996 study detailed the effects of the fine arts on elementary school students in the United States. The study concluded that these students made significant leaps in their reading. These same elementary school students took giant steps forward over two years in mathematics (Gardiner & Knowles, 1996). The same students found a more remarkable ability to focus on their fine arts courses and across all disciplines. Students discovered that participation in the arts became an enjoyable experience. They also found that fine arts skills significantly impact and could be used in math and science (Gardiner & Knowles, 1996).

Grimberg (2018) observed that students who engaged in fine arts curriculum while pursuing STEM majors at the college level applied greater creative thinking skills in their STEM studies and careers (Grimberg, 2018). Similarly, a study conducted by Michigan State University showed that STEM students taking fine arts courses in conjunction with their STEM courses showed higher achievement in their classes. These same STEM students displayed higher participation and lower dropout rates during their college tenure (Brady, 2014). Brady's (2014) study showed that these STEM students taking fine arts courses had 22% higher English scores, 20% higher math scores, and demonstrated more creative problem-solving skills in each of their studies across all subjects (Brady, 2014)

Feldman (2015) further drives home the importance of the fine arts in helping students apply unique approaches to technical skills. She also reflects that fine arts courses can open doors to exploring STEM fields in unique ways that would not be unlocked without exposure to the fine arts. Feldman (2015) applied the skills she learned in fine arts to form a unique approach to teaching math that worked with various students on their particular learning style. The fine arts' value shows students that they can focus on STEM as well in different ways. Students can apply their STEM and fine arts skills to work in design, coding, or a myriad of other STEM fields. By empowering STEM students to explore the fine arts, better scientists and engineers can think scientifically and artistically. Artists can reconnect with the sciences to see the importance of STEM in their artistic endeavors (Feldman, 2015).

Integrating the Fine Arts into STEM

The fine arts certainly have merit in their own right. They are an exciting endeavor that allows amateur and professional artists to delve into art for art's sake and the excitement of enjoying the fine arts and creating it. However, many educators have begun examining the importance of the skills integrated into other disciplines and, in particular, STEM disciplines. Robelen (2011) compiled expert opinions and research focusing on merging the fine arts into STEM courses and curriculum, noting that the fine arts enhance STEM concepts and help students take the concepts they learn from STEM in more concrete ways rather than the abstract.

Mark Baurelein (2010) further details the importance of integrating the arts into STEM courses. Baurelein (2010) discusses how the National Endowment for the Arts must push for the arts to be a valuable part of education at all levels. The NEA must act as a voice to politicians from each state to discuss the importance of the fine arts in shaping students' educational tenure and future careers in any field, including STEM. Since the No Child Left Behind’s (NCLB) creation, STEM has been emphasized as industry leaders initially called for a more STEM-focused workforce. However, many of these same leaders realize that the arts must and should be included in education at all levels to develop more well-rounded employees—integrating the fine arts and STEM. As the fine arts continue to struggle for funding and face continued budget cuts, many educational institutions find gains in STEM disciplines by integrating the fine arts into their curriculum (Robelen, 2011). Robelen discusses that integrating the fine arts into the STEM curriculum pushes students to use their artistic skills in their STEM studies and become creative thinkers employing problem-solving skills outside the box.

Rinne, Gregory, Yarmolinskaya, and Hardiman (2011) discuss the benefits of arts integration in content retention in primary and secondary education. Arts integration also benefits students with long-term memory in their various subjects. Their study found that students had tremendous success in their courses when teachers incorporated the fine arts into their lesson plans across disciplines. The study found that mastery of the subject matter was more easily found amongst students when exposed to the fine arts across all of their courses, including STEM. Similarly, Wu and Rau (2019) discuss further practical examples of arts integration. They examined the integration of the fine arts into STEM disciplines. Their research focused on the effect of the visual art of drawing on STEM courses. The study focused on how drawing activities enhanced the STEM learning environment. Wu and Rau (2019) identified six ways to nurture drawing activities to enhance STEM learning. Their study concludes that the fine arts, and in this case, drawing, can positively impact students examining various STEM disciplines.

Ruiz, Gallois, and Herras (2018) examined the role of the fine arts in students studying science, focusing on using theatre techniques. The study focused on five secondary schools in a mixed-methods study. The study revealed that drama-based activities in the classroom reduced the stereotypes around STEM and STEM careers. The study demonstrated that both secondary schools and colleges, and universities should seek out unique ways incorporating the fine arts to recruit and engage potential STEM students (Ruiz, Gallois, & Herras, 2018). They concluded that STEM instructors could work directly with fine arts instructors such as theatre teachers to find unique and creative ways to approach STEM learning. This idea produces interest in STEM fields and cultivates an innovative approach to STEM careers as well. The study results suggest that integrating artistic techniques into STEM courses can stimulate many students into pursuing STEM careers and sheds the stereotypes associated with STEM jobs (Ruiz, Gallois, & Herras, 2018).

Colleges and universities are also seeing the benefits of integrating the fine arts into STEM coursework. The creative skills taught in fine arts courses can be applicable in STEM courses. An issue arises because STEM students are not always taught or encouraged to bridge the creative aspects discovered in their fine arts courses into their STEM disciplines. Morris (2012) discusses that consumerism has affected the idea of arts education, particularly at the college level. She discusses that the college curriculum has shifted from creating well-rounded students who study STEM and focus on the fine arts and humanities and their curriculum. Morris (2012) cites that the fine arts and humanities are a vital part of education. She notes the importance of integrating the arts into the college curriculum. Morris (2012) reflects on studies and reports emphasizing the fine arts' role in teaching creativity, cultural competency, and diversity. She discusses the role of the fine arts in creating global citizens in every walk of life. These ideas can also be seen in Thomas (2015), who believes that fine arts integration across academic disciplines creates "transdisciplinary nomads." This integration allows students to move freely across each field of study during their college tenure. Thomas states that these nomads can transcend the subject matter. They are not focused solely on one subject matter but can move from each subject creatively and freely (Thomas, 2015).

Studies have discovered positive effects when the fine arts and STEM collaborate to shape unique learning environments. The Einstein Festival in 2018 was an example of bridging the gap between STEM and the fine arts allowing artists and scientists to work together. Throughout the Einstein festival, STEM experts collaborated with fine artists on creative and performing arts installations focusing on Albert Einstein's theories. These performances brought Einstein's ideas to people across all walks of life and all fields of study (Grimberg, 2018).

Brooks and Nemirovsky (2016) studied the integration of the fine arts into mathematics courses. The study discussed ideas regarding blending mathematics with the fine arts. It has often been argued that creativity, student success, and subject matter transfer are greatly enhanced in STEM courses by integrating the fine arts curriculum. The study presents analyses of reflections, surveys, and personal interviews from students studying Geometry with a fine arts-integrated focus (Brooks & Nemirovsky, 2016). Students in the geometry courses used the arts directly in their coursework. They applied a variety of visual arts ideas to their studies. First, the students reflected on how geometry was used in Renaissance art. The students also visited a contemporary art museum and worked to create new art utilizing geometry concepts. The study focused on the students' exposure and participation in the fine arts and how this affected their overall success in the geometry course (Brooks & Nemirovsky, 2016). The students in the class did not necessarily identify themselves as artists. However, they found that art helped them connect more closely to the ideas being addressed in the geometry course. The artistic pieces using geometric concepts did not look like the assignments found in a traditional geometry course. However, the study found that students engaged in the ideas on a more holistic level focused on these concepts and discussed them more easily. The students found the creative assignments helped them foster a deeper understanding of geometry and felt it enhanced their overall success in the course (Brooks & Nemirovsky, 2016). Brooks and Nemirovsky found that integrating fine arts curriculum into mathematics allowed students to see that creativity and art can be found in any subject, including STEM fields. They concluded through their study that the fine arts may open far more creative ways to apply mathematics and develop other math methods to be used every day.

Payton (2017) focuses on arts integration into STEM even further in higher education. He demonstrates that STEM students who study fine arts courses display more varied and creative approaches to thinking during their college tenure. Payton's study focused on STEM students' unique experiences taking fine arts courses (Payton, 2017). Payton asked questions of these students examining why they have chosen to study both STEM and fine arts. The interviews were done with focus groups, explicitly addressing STEM majors taking dance courses (Payton, 2017). These students' interviews showed that their dance courses' experiences positively benefited their overall educational experiences in pursuing their STEM majors (Payton, 2017).

Adkins, Rock, and Morris (2017) analyzed the positive effects of blending the arts into the science curriculum even further. They began with the established premise that science and art are presented separately in classes and rarely work together to promote learning. Their study worked to discuss these students employing the visual arts in a life science laboratory class. Adkins, Rock, and Morris (2017) examined the benefits of blending science and art and its influence on undergraduate students in finding creative ways to learn biology. The study found that biology students who applied the visual arts to their STEM studies displayed a more remarkable aptitude overall in their scientific studies and showed an overall more tremendous success than the control group. Their research concluded that art could be a valuable tool in teaching the sciences to undergraduate college students and encourage a greater sense of creativity in STEM students overall in their college careers (Adkins, Rock, & Morris, 2017).

Another practical example of blending STEM and the fine arts can be seen in the research of Scholl, Iafrati, Long, and Pow (2014). They focused on a school of film and animation program at Rochester Institute of technology; the study examines an undergraduate program that fills a necessary void creating film, and animation graduates with extensive STEM knowledge. This integrated training combines STEM skills and fine arts skills. The program has met with great success and has been lauded by the motion picture industry. It allows students to mix fine arts and science. This multidisciplinary approach has allowed them to apply STEM and the fine arts into careers in the film industry (Scholl, Iafrati, Long, & Pow, 2014).

Simmons' (2001) study takes the importance of arts integration even further. Simmons (2001) focuses on the importance of integrating the fine arts to enhance a student's overall education experience. Simmons (2001) believes that the fine arts can enhance students of differing subject strengths, different backgrounds in their lives and engage students with a wide variety of creative interests. He concludes that fine arts integration into curriculum focuses more directly on multiple-intelligence-based instruction. Simmons (2001) points out the role of the fine arts in teaching creative thinking skills and cognitive thinking skills. He shows that the fine arts can convince students in any field, including STEM, to master many subject areas in their studies. Simmons (2001) agrees that this may not produce fine artists or a lifelong love of the fine arts, but it can make the foundation for well-rounded scholars at all education levels.

Developing a STEM-based curriculum that integrates the arts could create a different educational model focusing on creating more well-rounded students prepared to meet their STEM career challenges with a more creative approach (Liao, 2016). In 2016, a design studio brought together STEM students and fine arts students. The students' disciplines were focused explicitly on engineering and sculpture. Throughout the term, sculpture students and engineering students collaborated their disciplines on a variety of course assignments. Initially, there was hesitancy amongst the STEM students especially. However, this led to excitement as the students from both fine arts and STEM discovered creative approaches to the assignments. Students found that these creative skills were easily applicable in their respective fields of study and their future careers outside the classroom setting in their engineering careers (Sochaka, 2016). These are just two crucial examples of the benefits of integrating fine arts courses and STEM.

The effects of fine arts coursework afford a unique approach to problem-solving involving creative thinking according to Sochaka (2016). Sochaka researches a first-hand experience of creating an engineering studio that uses STEM and the fine arts to construct an integrated learning model. The research shows that students thought outside the box with integrated assignments applying critical and creative thinking to each project. The students found artistic merits and ideas within their engineering courses and studies. The integration of the fine arts with engineering increased the success rates in their engineering studies. The engineering students could also take what they learned and use them in their other STEM studies (Sochaka, 2016).

Wilson (2018) conducted a study that focused on integrating the arts and STEM and the issues in education regarding this integration. The study reviews students taking a variety of STEM and fine arts courses. Students discovered a creative way to problem solve in their STEM coursework (Wilson, 2018). The research reflects how this varied course of study and thinking leads to a far more creative process for students across their STEM discipline and helps them achieve tremendous success (Wilson, 2018).

Fantauzzacoffin (2012) reflected on the positive effects of engineering and art students at Georgia Tech collaborating on a project-based art and engineering class in a higher education setting. This course had students work together to problem-solve. Students applied STEM-based methods from the engineering curriculum while applying creative approaches from the fine arts curriculum. The idea pushed students to develop innovative and unique ways to problem-solve during each assignment in the class. The study displayed the benefits of applying this integrated model in creating students who were able to join the workforce using innovative approaches to problem-solving (Fantauzzacoffin, 2012)

STEAM in Action

Beyond integrating the fine arts into STEM, many scholars propose creating an entirely new model that would blend the arts directly into STEM education. The literature shows how the STEAM model can positively benefit students in creating well-rounded scholars applying creative approaches to their coursework in each subject and achieving tremendous overall student success. Sochaka's research (2016) reflects changing today's STEM model and transitioning to STEAM, focusing on science, technology, engineering, arts, and mathematics. Sochaka focuses on the STEAM model's ability to form a creative and unified approach to education. Ge (2015) utilizes a similar idea through research. This text reviews the change in course curricula not only in STEM but also in the fine arts. The investigation details how STEAM benefits students and faculty's creative thinking when a STEAM-based model is applied (Ge, 2015). The research's primary focus is on how educators can use STEAM education in primary and secondary education and continue STEAM's tradition in higher educational settings (Ge, 2015).

The STEAM curriculum allows students to apply the fine arts and its skillset into their STEM courses (Johnson, 2013). Students collaborate in their courses, using STEM and the fine arts for each assignment. STEM and the fine arts are treated equally in the classroom without any form of hierarchy. This model affords students the ability to demonstrate what they have learned in STEM through their artistic endeavors (Johnson, 2013). Students begin to think outside the box and apply skills in both STEM and the fine arts. They show tremendous overall success and can remember the concepts studied in their courses in each subject area (Johnson, 2013).

Funding also has been a consistent issue for fine arts degrees and coursework in primary, secondary, and higher education. The funding problems have been addressed in studies focusing on STEM and fine arts education as separate education areas. Payton (2017) focuses on the benefits financially with funding and budgets when STEM and fine arts work together on a STEAM-based educational model. Harris (2017), out of Australia, continues this line of thought. Australia continues to focus on STEM fields in its educational institutions, citing career needs in the country. This idea can also be said of the United States and many other countries worldwide (Harris, 2017). Harris (2017) discusses STEAM and how it can be integrated into the existing STEM education to promote a more multifaceted scholar. The research reflects on how Australia is missing the opportunity to develop a robust curriculum that stresses the significance of STEM while acknowledging the critical skills provided by studying the arts (Harris, 2017). Harris (2017) discusses the Creativity Index, reflecting on the STEAM approach and its use as a cross-disciplinary education method providing a more comprehensive education for its students.

McDonald (2019) examines STEAM education in Australia even further. She addresses the hierarchy between STEM and the fine arts. She discusses that the push for

STEM education in Australia's primary and secondary schools allows educators to develop creative approaches to each STEM discipline by adopting the teaching methods employed by fine arts teachers. McDonald (2019) explicitly discusses Tasmania. Tasmania is one of the most creative areas of Australia. However, the area also has a lower number of students completing their education successfully. These issues have hindered the development of a full STEAM model. McDonald points out that despite these challenges, Tasmania's teachers employ some of the most innovative STEAM-based educational opportunities creating more creative, well-rounded, and successful students across all subjects during the education (McDonald, 2019).

Kissell (2019) addressed the STEAM education model in her article on the idea of the BLINK festival focusing on the effect of the fine arts in studying a variety of subject areas. Students explore each lesson in their STEM courses through the lens of the fine arts. This idea connects them to STEM and fine arts communities, providing a creative way to solve each problem (Kissell, 2019).

Grant (2016) reviews the fine arts' active approach to student learning in the classroom. Grant's research displays how the fine arts can develop students into creative and critical thinkers who can utilize various unique methods during their education and careers. Grant (2016) details an example of a formed partnership between the Braithwaite fine arts Gallery and the Garth and Jerri Frehner Museum of Natural History at Southern Utah University. Grant (2016) discusses the positive effects of this collaboration of STEM and fine arts, creating a positive and successful STEAM-based learning opportunity for primary and secondary schools (Grant, 2016). Segarra (2018) adds to

Grant's thoughts exploring how the fine arts can train STEM professionals. She states that fine arts' creative skills can be used directly in scientific research in higher educational settings. She reiterates that the STEAM model affords STEM students a creative way to solve their future careers in STEM (Segarra, 2018).

Kim's (2012) research also reflects the positive effects of a collaboration between the fine arts courses and STEM working together to construct a STEAM-based curriculum. This study goes even further, providing practical tools that can be used in classroom settings to develop a STEAM curriculum (Kim, 2012). The research focuses on the concepts of critical and creative thinking enhancing STEM by using the fine arts. Creating an education method that bridges both disciplines fosters a well-rounded curriculum for students during their studies (Kim, 2012). Kilip (2012) continues these ideas. Kilip (2012) discusses the importance of finding an education system that implements learning methods across STEM and fine arts. The research develops a more well-rounded educational experience for students to apply critical and creative thinking skills across all disciplines (Kilip, 2012). Liao (2016) drives this concept of STEAM education home in their study. Liao's research finds that STEM and fine arts working together can be a powerful combination creating students who find engaging ways of thinking and learning (Liao, 2016).

Madden (2013) discusses another practical example of the STEAM model in action in a higher education setting. At Potsdam, the State University of New York worked directly with the Lockheed Martin company to develop a fine arts and STEM program. The STEAM model was used to establish a knowledgeable workforce and possessed a strong knowledge of fine arts and humanities and the ability to apply creative thinking in each aspect of their careers. STEM, fine arts, and humanities faculty examined literature and research in their fields with an eye on industry, business, and general education. In recreating the curriculum, the STEAM-based model was built to develop scientists who could apply unique creative solutions to address many scientific problems in their future careers (Madden, 2013).

South Korea's education system clearly shows the benefits of the STEAM model. These benefits are seen in each stage of education and the positive effects on STEM employees during their professional lives. Kang (2019) discusses the success of the STEAM model in South Korea amongst its STEM workforces. STEAM-based education has been developed and applied throughout South Korea. Many STEM teachers worked diligently to adopt the fine arts into their STEM classrooms, using the STEAM model each day in their lesson plans and assignments. Students showed more success in their STEM courses and often applied their fine arts experiences to their STEM assignments. Students utilizing the STEAM model were ahead in creative thinking and cognitive learning (Kang, 2019). The study interviewed college students and found that the STEAM model had long-lasting positive effects on these students in their college careers and when they entered the workforce in a STEM field (Kang, 2019).

The benefits of STEAM are numerous. With the STEAM model, STEM courses and studies are taken to another plane (Ward et al., 2020). Students look at their courses in both STEM and fine arts. They work to apply each of these in every way. Students can use their skill sets from the fine arts in each STEM field. Creating a STEAM model makes more innovative approaches to STEM studies and STEM careers (Ward et al., 2020).

Root-Bernstein (2015) drives home the positive impact of the fine arts courses on STEM students and the positive effects of the STEAM education model. Root-Bernstein reviews previous research, reiterating that greater creativity can be found in people with a wide variety of educational experiences. This education model can be found formally in primary, secondary, and higher education settings and in fine arts classes and activities taken outside of traditional schools (Root-Bernstein, 2015). Root-Bernstein (2015) discusses that many STEM professionals display an interest and continue to study the fine arts even after they are no longer are taking fine arts courses. The research clearly shows that STEM majors apply their fine arts coursework to their work-life (Root-Bernstein, 2015). Many of the most extraordinary STEM professionals and the most decorated have studied and continue to focus on fine arts (Root-Bernstein, 2015). This research reflects the positive aspects of fine arts education and STEM careers (Root-Bernstein, 2015).

Creativity in STEM Students

Robert Sternberg (2010) believed that creativity is a necessity for the workforce, and for that reason, it must be used by educational institutions at all levels. Using creative methods in the classroom, Sternberg (2010) believed that this would unlock the students' creative skills and they would use them during their educational career. Sternberg emphasizes that teachers must be given the skills to teach from a creative standpoint. In this way, students will grow to enjoy the learning process more thoroughly and realize that they can use creative ways to approach any subject. Similarly, these creative skills could also be employed in their future careers (Sternberg, 2010). The fine arts engage creativity in their teaching methods and can be a gateway to exploring creativity in students' practice.

Kagan (1967) believed that creativity was and should be found in each aspect of education, creating robust classroom experiences. Kagan (1967) focused on the importance of creativity in the learning environment. Kagan's research outlined that creativity promoted the idea of total engagement in the classroom. This engagement and creativity focused on creating a classroom where students have full involvement. This type of creative engagement is seen in fine arts classrooms, but it is clearly shown in scientific studies (Kagan, 1967).

For this reason, integration of STEM and the fine arts can stimulate this creativity even more in students during their educational experiences. Kagan (1969) discusses the three cultures model. The three cultures focus on natural science, social science, and humanities. Although it is often argued that these areas are different in their approaches to research and scholarship, Kagan argues that these three cultures can and should work together. In collaboration, all three regions can encourage creative strategies for problem-solving and advance innovation (Kagan, 1969).

Koutstaal and Binks (2015) take the necessity for creativity in all aspects of the workforce even further. Their research outlines that each individual has creativity in them no matter what their field of study. They believe that it is vital that each person optimize their full creative potential and make them more successful in their studies and careers.

They apply leading questions and activities to promote creative thinking amongst individuals (Koutstaal & Binks, 2015). This innovative approach mirrors Kagan's (1967) creativity in the classroom ideas and displays the importance of active and creative approaches to problem-solving. Koutstaal and Binks (2015) and Kagan (1967) offer a path to opening up the creativity in each person and offering innovative approaches to each field of study both in an educational and a work setting.

Corporations and government agencies have frequently placed creative thinking as an essential asset in their everyday operation (Dillelo et al., 2009). Dillelo et al. (2009) focus on the importance of employees' creative skills to stimulate new ways to approach many problems faced in day-to-day operations in both the private and public sectors. Their research reviewed how creativity was encouraged in both industries. The study delineates the vital importance of nurturing creativity in employees (Dillelo et al., 2009). This same creativity must be cultivated in educational settings so that students can carry creative thinking into the workplace.

Kim (2018) discussed the necessity of employing the fine arts across disciplines to enhance students' creative thinking. Kim's (2018) research was conducted from 2013 to 2014 amongst sixth graders. The students were assessed using the *Torrance Tests of Creative Thinking (TTCT).* This test was used to show the effects on creativity amongst these students across all subject areas. The sixth graders showed that applying the fine arts and a creative approach across every study area developed the students' overall creativity in every assignment, no matter the subject. The study demonstrated the program's positive effects, indicating a statistically positive impact on the students who participated. Students showed significant leaps in their creative thinking, which affected all aspects of their overall learning (Kim, 2018).

Katz-Buonincontro et al. (2020) studied creativity in STEM students in higher education. The study applied quantitative research in STEM students taking statistics and reviewed the connection of creativity in their current studies. A qualitative portion of the study was also used utilizing focus groups of these same students to reflect their perceptions about creativity and learning. In the research, students believed creativity was necessary for their future careers but were not sure about their STEM courses' creativity.

Murdock (2010) takes these ideas further. She discusses how creativity can be applied to college-level programs, which applies to career preparedness. She examines each discipline's effect when creativity is used and the significant leaps in engaging students in their general coursework. These creative skills become lifelong benefits to students' future careers in various fields (Murdock, 2010).

The idea of creativity opening up doors in education can be seen in a program used by the University of Sheffield. Allam (2018) reviews this program. The program focuses on filmmaking. The program applies some STEM methods and fine arts methods as well. The program's focus is to promote creativity amongst its students allowing them to tap into their imaginations. This creative approach has found great success amongst its students, and this success has carried on in their careers. The creative skills they learned have served them well as they work in the film industry, outlining the need for creative thinkers in all aspects of work (Allam, 2018).

Van Broekhoven et al. (2020) examined how creativity is applied practically in STEM courses and fine arts. In reviewing each discipline, Van Broehoven et al. (2020) discussed the differences in creative assignments and creativity applied in STEM courses across 2,277 undergraduate students in Germany and Australia. The study also examined the similarities and connections to these STEM students in the creative skills used and learned by studying fine arts. They showed that creativity was a vital skill for these students in their majors. This research focused on measures of creativity. The study reflected the need to embrace creativity in all subject areas and the benefits of the fine arts in pushing creative thinking skills in STEM fields (Van Broekhoven et al., 2020).

Escalante (2020) reiterates these findings. She discusses that creativity can be applied in the fine arts and sciences. She displays that an integrated curriculum can be beneficial to enhance creative thinking skills. In using creativity across all disciplines, studies find that it helps the following in students: openness, creative self-efficacy, and divergent thinking. These were the foundation for establishing creative skills applicable in any discipline (Escalante, 2020).

Boy (2013) focuses on the vital importance of integrating the fine arts into all disciplines and specifically STEM. His research reiterates the idea addressed earlier that STEAM education offers a more creative approach to thinking in STEM fields. Boy (2013) argues that experiments and theories must be studied as a complete unit encompassing various disciplines rather than separate studies. He proposes that schools should develop a well-rounded educational experience that contains STEM and the fine arts. This combination of STEM and fine arts could promote creativity in all fields and allow future leaders to tackle complex problems faced by the world and provide unique and innovative solutions (Boy, 2013).

Clark (2012) takes the ideas expressed by Boy (2013) even further, showing a practical application of the fine arts learning that fosters students' creativity. Clark (2012) discusses that fine arts pedagogy can nurture creativity in the learning environment and enrich students across every discipline. Clark (2012) believes that teachers in the fine arts can harness learning approaches that construct activities that engage students across multiple intelligences and harness their creative skills. These approaches can be applied across disciplines, including STEM. The study shows that active learning through various intelligences allows students to approach each subject with creativity and develop a well-rounded student and well-rounded citizen (Cark, 2012).

Summary

Studies continually demonstrate the positive results of overall student success and develop creativity in STEM students who take fine arts courses during their K-12 and college tenure. This positive influence is seen when the fine arts are incorporated into a student's education and, in particular, that of STEM students. (Jolly, 2014). The skills discovered in the fine arts have a significant impact and could be used in math and science (Gardiner and Knowles, 1996). However, the fine arts continue to be pushed aside in favor of STEM-only education. It has been shown that students involved in the arts are four times more likely to show an interest in STEM studies and participate in math and science fairs. It has also been shown that these same students are three times more likely to be leaders in numerous capacities on their campuses (Adamson, 2014).

This concept further reiterates the inherent value in STEM education integrated with the fine arts in developing global citizens who find tremendous success in their studies and careers and employ creative thinking far more frequently (Adamson, 2014).

To shape a more balanced educational experience, educators must integrate STEM and the fine arts into a blended curriculum rather than two separate disciplines (Harris, 2017). Payton (2017) details that a STEAM model can help with budgets as well. When the two areas work together, they can apply for more grants and combine their financial resources to establish a holistic learning experience for students (Payton, 2017). Harris (2017) discusses STEAM and how it can be integrated into the existing STEM education to create a well-rounded graduate who thinks outside of the proverbial box.

The benefits of STEAM are numerous. Students can use their skill sets from the fine arts in each STEM field. Creating a STEAM model makes more innovative approaches to STEM studies and STEM careers (Ward et al., 2020).

Favorable success rates and increased creativity amongst STEM students exploring the fine arts courses' can be seen (Root-Bernstein, 2015). Root-Bernstein's research displays that greater creativity can be found in people focusing on a blended curriculum during their education. Root-Bernstein (2015) discusses that these positive effects continue beyond formal education. Those people pursuing STEM careers who continue to participate in the fine arts find tremendous success in their overall careers. They can apply what they learned in STEM and fine arts through the STEAM model into each aspect of their work (Root-Bernstein, 2015). Root-Bernstein discusses some of the most outstanding STEM practitioners who have studied and shown a lifelong devotion to the fine arts (Root-Bernstein, 2015).

Creativity in the classroom allows students to approach problem-solving in innovative ways (Kagan, 1967). Similarly, it is vitally important that people develop their full creative potential. Exploring creativity enables more significant success in their studies in all subjects and future careers (Koutstaal & Binks, 2015). Creativity is a crucial component of STEM and the fine arts. However, STEM students who also study fine arts show a more remarkable ability to apply creative thinking in their STEM studies and STEM careers. Van Broekhoven et al. (2020) examined STEM and the fine arts, thoroughly reiterating this concept. They showed that creativity could be found in both fields but that studying both fields enhanced creative thinking (Van Broekhoven et al., 2020). In reviewing the fine arts while studying STEM, students can find innovative and creative approaches to solve STEM problems. Boy (2013) stated that well-rounded education in STEM and the fine arts offer a more creative approach to thinking in STEM fields, and these innovative ideas are carried over when pursuing STEM careers.

The literature offers a glimpse into the significance of the fine arts and its effect on STEM students. The research outlines the overall impact on student success rates and also on developing creative thinking skills. However, most research is focused on primary and secondary schools. Research focusing on the fine arts' effect on STEM majors in higher education can be found, including STEAM-based education models. However, the literature clearly shows a gap in studying the impact of the fine arts on community college STEM students.

CHAPTER III

Method

The current study examined students taking STEM (science, technology, mathematics, and engineering) majors at a Midwestern urban community college. The study compared STEM students who had taken at least one fine arts course at the college with those who had not taken fine arts coursework during their studies. Through a detailed comparison of both sets of STEM students, the research focused on the effects of the fine arts courses for students in applying creative approaches to their STEM courses instead of those who didn’t have fine arts exposure while pursuing their degrees. The study compared STEM majors' success rate amongst STEM students who had taken at least one fine arts course at the community college in juxtaposition to those who had not taken fine arts courses during their community college tenure.

First, it was hypothesized that STEM majors who had taken one or more fine arts courses would report a higher GPA than STEM majors who had not taken fine arts courses. Grant's study (2106) demonstrated that students reported more significant success in their STEM courses when their studies were enhanced with fine arts curriculum during their college tenure. Root-Bernstein's (2015) study showed that students took the skills in their fine arts work and applied these to tremendous success in their grades in STEM assignments and courses. It was believed that students will succeed in their STEM courses by employing skills used within their fine arts coursework.

Second, it was hypothesized that there would be a positive correlation among STEM majors between the number of fine arts courses taken and grade point average. Root-Bernstein's (2015) study explored the long-term effects of fine arts exposure on STEM majors. These effects were seen while pursuing their studies and continuing their careers in the STEM field (Root-Bernstein, 2015).

Third, it was hypothesized that STEM majors who had taken one or more fine arts courses would demonstrate greater creativity than STEM majors who had not taken fine arts courses. Integrating the arts into STEM coursework showed that students can apply more creative approaches to their STEM courses (Jolly, 2014). Brady (2014) emphasized this idea offering improved success rates of STEM students who study fine arts and focus on how fine arts coursework allowed students to avoid burnout in pursuing their STEM majors by using their brain's creative aspects.

Fourth, it was hypothesized that there would be a positive correlation among STEM majors between the number of fine arts courses and creativity. Grimberg et al. (2018) explored the Celebrating Einstein Festival. The festival examined the collaboration of the fine arts with STEM to implement creative approaches to scientific problems. Kang (2019) investigated STEM students' success in South Korea, applying creative methods to a question while integrating the arts into their STEM coursework.

Subjects

Participants for this study were recruited from STEM majors at a Midwestern metropolitan community and technical college that has a population of 11,271 students (Phelan, 2020). The participants were taking one-thousand and two thousand-level STEM courses in the fall of 2021. The community college is located in the heart of a Midwestern city. The student population was predominantly based in the Midwest but comes from various backgrounds and cultures (Phelan, 2020). There is also an even mix of male to female students at the college (Phelan, 2020).

This particular community college features a wide range of ages as well (Phelan, 2020). Within the demographics of this urban community college, all students taking STEM courses were invited by the author in cooperation with the Dean of Institutional Research at Saint Paul College to complete the survey focusing on creativity as outlined above. The participants were undergraduate STEM students pursuing an associate degree across all cultural backgrounds, racial backgrounds, and gender identity. Participants in the study had to be a minimum of eighteen years of age, but there was no age maximum applied to the participants studied.

Measures

To measure GPA, students self-reported their course grades in the current and other STEM courses if applicable. Students also self-reported their current grade point average. Information on ethnicity, gender identity, and class status were not gathered as a part of the survey (see Appendix A).

The Cognitive Processes Associated with Creativity Scale (*CPAC*; Miller, 2009) was used first in the study (see Appendix B). The *CPAC* (Miller, 2009) scale was developed and validated throughout two studies. The study was built using a collection of previous work to formulate a detailed creativity scale applied in measuring creativity in academic fields, studies, courses, and activities (Miller, 2009). Through two detailed studies, The *CPAC* scale, featuring 47 items, was created. The scale focused on creativity featuring the following categories: Incubation, Metaphorical/Analogical Thinking, Brainstorming, Imagery, and Flow.

The scales were rated on a Likert scale from 1 to 5, with one designating never and five designating always. This research indicated that the *Cognitive Processes Associated with Creativity Scale* has many sound psychometric qualities and directly and efficiently assesses creativity as a process variable. Throughout two studies, the *CPAC* scale showed validity in measuring creativity among adult learners. Using two studies in providing the validity and reliability of the *CPAC* score, there was a positive correlation between *CPAC* scores and grade point average (r = .680, p < .001 (Miller, 2009).

The STEM students' level of creativity was further measured using *Yoon's Critical Thinking Disposition Instrument* as developed initially for Nursing students to test creativity and critical thinking and validated by the College of Nursing study at

Kyung Hee University (Shin, Park, & Kim, 2015) (see Appendix C). The *YCTD* was used to measure STEM students pursuing an associate degree at an urban Midwestern community college within a Midwestern college and university system and their engagement in creativity and creative approaches to their learning. The instrument focused on twenty-seven items using a five-point Likert scale. The Likert scale range ranges from one (strongly disagree) to five (strongly agree). The *YCTD* focused on seven subscales reflecting objectivity, prudence, systematicity, intellectual eagerness/curiosity, intellectual fairness, healthy skepticism, and self-confidence. The validity was measured using Cronbach's coefficient alpha with a score of .84 (Shin, Park, & Kim, 2015).

Design

To recruit subjects who fit the inclusion criteria, the author administered the survey to students taking STEM courses at an urban Midwestern community college. Permission to distribute the test was granted to the author by the Dean of Institutional Research at this community college. Each student was given the option to opt out (see Appendix A). Data was collected using Qualtrics (www.qualtrics.com). The data was analyzed then be analyzed using JASP.

The author worked directly with the community college's Dean of Institutional Research to administer a comprehensive survey focusing on creativity and success rates to students taking STEM courses. The study was initially administered via email. The students participating in the survey included students who have taken or are taking fine arts courses while simultaneously pursuing STEM studies, along with students taking STEM courses who had not taken fine arts courses.

After being granted access to STEM students at the college via the Dean of Institutional Research, the author administered the test via email to students currently taking STEM courses at the community college. An introduction to the survey focused on consent for the students who chose to participate in the research. This consent form could be accessed and saved by the student to acknowledge consent in the research process. If the student decided to continue the survey past the consent form, the student would agree to participate in the research by completing the survey. Students would be allowed to opt out and not participate in the survey at any time. No incentive was given to the students by the researcher or by the college's Dean of Institutional Research.

Due to an initial low response rate from the email sent to STEM students through Qualtrics, the author also visited STEM courses in person. The Dean of Institutional Research and the Dean of STEM at the community college granted permission to visit the STEM courses. Seven STEM faculty allowed the survey in twelve of their classes. An introduction to the study was read and handed out to the students focusing on consent to the research. The student could also access and save a copy of the consent to acknowledge consent in the research process. If the student decided to complete the survey past the consent form in their class, they agreed to participate in the research. Students were also allowed to opt-out and not participate in the survey at any time. No incentive was given to the students by the researcher or by the college's Dean of Institutional Research during the in-person surveys as well.

Data Analysis

T-tests were used to identify statistically significant differences between fine arts and non-fine arts STEM majors to test hypotheses one and three. The study measured hypotheses two and four using an intercorrelation matrix to explore potential relationships between the number of fine arts courses taken and the use of creativity in their STEM majors. The data gathered was also used to examine the overall success rates of these students. An intercorrelation matrix was applied to Pearson's r to review the statistical variables amongst the two groups and their distributions across both samples.

Chapter IV

Results

This study explored students taking STEM courses at a Midwestern two-year college analyzing the effects of fine arts courses on STEM students' creativity and their overall academic success. The study tested four hypotheses. First, it was hypothesized that STEM majors who took one or more fine arts courses will report a higher GPA than STEM majors who have not taken fine arts courses. Second, it was hypothesized that there will be a positive correlation among STEM majors between the number of fine arts courses taken and grade point average. Third, it was hypothesized that STEM majors who have taken one or more fine arts courses will demonstrate greater creativity than STEM majors who have not taken fine arts courses. Fourth, it is hypothesized that there will be a positive correlation among STEM majors between the number of fine arts courses and creativity.

Demographic Characteristics

Subjects were recruited from a total of 122 students at a metropolitan community college who responded either online (47 students) or in-person in their STEM courses (75 students) to a survey featuring two measures along with demographic questions. The community college is located in a Midwestern metropolitan urban community and had an enrollment of 11,271 students. Amongst these students, 26 of them submitted incomplete surveys that were eliminated. A total of 86 complete responses were used to analyze the data (See Table 1).

Thirty-nine students (45.35%) self-identified as male, and forty-three students (50%) self-identified as female. Four students (4.65%) self-identified as non-binary. Students surveyed were also asked to select their race/ethnicity. Thirty-six students (41.86%) selected White/Caucasian as their race/ethnicity. Eleven students (12.79%) selected Latino/Hispanic as their race/ethnicity. One student (1.16%) selected Multiracial as their race/ethnicity. Twenty-three students (26.74%) selected Black/African as their race/ethnicity. Fourteen students (16.27%) selected Asian/Pacific Islanders as their race/ethnicity. One student (1.16%) selected Other as their race/ethnicity. Students reported an average age of 24.64 (SD = 7.69) years old.

Students surveyed were asked to select the number of semesters completed. Eleven students (12.79%) stated that they were in their first semester of college. Seven students (8.14%) stated that they had completed one semester of college. Fourteen students (16.27%) reported that they had completed two semesters of college. Lastly, fifty-four students (62.79%) selected that they have completed three or more semesters of college.

Students were asked to report their major at the community college. For this study, student courses of study were separated into two categories: students pursuing a particular STEM major in any STEM-related field and students who are undeclared and pursuing general STEM studies at the community college to pursue a STEM major at a four-year college or university. Eighty-two students (95.3%) reported that they declared a STEM major. Eight students (9.3%) were pursuing their general STEM courses towards an associate degree to pursue a STEM major at a four-year institution.

The students were also asked if they had taken fine arts courses and if so, how many had they taken. Forty STEM students (46.51%) reported that they had not taken any fine arts courses. Forty-six students (53.48%) reported having taken fine arts courses. Of these students, 22 students (47.82%) reported taking one fine arts course. Twelve students (26.08%) reported taking two fine arts courses. Six students (13.04%) stated that they had taken three fine arts courses. One student (2.17%) said that they had taken four fine arts courses. Two students (4.34%) reported that they had taken five fine arts courses. Two more students (4.34%) said that they had taken eight fine arts courses. Lastly, one student (2.17%) stated that they had taken 10 fine arts courses (SD = 1.86).

Table 1

Demographics

Demographic Items	***Mean***	***SD***
GPA (All Students Surveyed)	3.40	0.647
GPA (Taken Fine Arts)	3.35	0.76
GPA (Not Taken Fine Arts)	3.44	0.48

Student Perceptions on Creativity

The students were asked to complete a 74-item questionnaire featuring two measures focused on creativity. These measures examined the students' perceptions of creativity and their views on the creative process. The *Cognitive Processes Associated with Creativity Scale* (*CPAC;* Miller, 2009). The *CPAC* was designed to measure creativity and is comprised of five subscales: Incubation (16 questions), Metaphorical/Analogical Thinking (6 questions), Brainstorming (8 questions), Imagery (8 questions), and Flow (8 questions). The *CPAC* scale items were rated on a Likert scale from 1 to 5, with one designating *never* and five designating *always*.

Yoon's Critical Thinking Disposition (YCTD; Yoon, 2008) was further used to measure creativity among students. This measure consists of 27 items examining creativity and critical thinking. The *YCTD* uses a five-point Likert scale ranging from one (*strongly disagree*) to five (*strongly agree*). The *YCTD* focuses on creativity and critical thinking and is comprised of seven subscales: objectivity (3 questions), prudence (4 questions), systematicity (2 questions), intellectual eagerness/curiosity (5 questions), intellectual fairness (4 questions), healthy skepticism (4 questions), and self-confidence (5 questions).

Students also self-reported their estimated grade point average (GPA) as well. Of the eighty-six students who fully completed the survey, the self-reported average GPA was 3.40 (SD = 0.66).

Grade Point Average and Fine Arts Courses

Hypothesis 1. It was hypothesized that STEM majors who have taken one or more fine arts courses would report a higher GPA than STEM majors who have not taken fine arts courses (See Table 2). Students who engaged in fine arts courses maintained an average GPA of 3.37 (*SD* = 0.77). Alternatively, students who had not taken fine arts courses maintained an average GPA of 3.44 *(SD* = 0.48). A t-test revealed that there was no statistically significant difference in self-reported GPA between the two groups (*t*= 0.502[83], p = .0.627. These results failed to confirm the first hypothesis.

Table 2

Independent t-test Hypothesis 1

Variable	**Student**	**N**	**Mean**	**SD**
FA	1	39	3.44	0.48
No FA	0	45	3.37	0.77

Hypothesis 2. It was hypothesized that there would be a positive correlation among STEM majors between the number of fine arts courses taken and grade point average. Among STEM students who had taken fine arts courses, the reported grade point averages did not show a meaningful relationship amongst students who had taken fine arts courses and the number of fine arts courses taken. Students who had taken one fine

arts course showed an average GPA of 3.36, those who had taken two fine arts courses showed an average GPA of 3.25. Students who had taken three fine arts courses reported an average GPA of 3.5. The one student who had taken four fine arts and the two students who had taken five fine arts courses self-reported a GPA of 3.0, and the two students who took eight fine arts courses had an average GPA of 3.5.

Creativity and Fine Arts Courses

CPAC

Hypothesis 3. It was hypothesized that STEM majors who have taken one or more fine arts courses would demonstrate greater creativity than STEM majors who have not taken fine arts courses. STEM students were measured on creativity using the *CPAC* as the first measure (*Cognitive Processes Associated with Creativity Scale*) to analyze their level of creativity in problem-solving; (see Table 3; Miller, 2009). A t-test confirmed that there was no statistically significant difference shown between the two groups (t= 0.143[82], p = .0.56) which failed to prove the third hypothesis.

The *CPAC* in relation to the third hypothesis was further analyzed by each subcategory of questions. In reviewing the sixteen questions connected to Incubation, a t-test showed once again confirmed there was not a significant difference between STEM students who had taken fine arts courses and STEM students who had not taken fine arts course (t= 0.490[83], p = 0.63) within the subset of Incubation. These results failed to support the first hypothesis.

In reviewing the six questions connected to Metaphorical/Analogical in the *CPAC* measure, STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses, a t-test did not show a statistically significant difference between the two groups (t= 0.029[83], p = .0.98. This data failed to prove Hypothesis 1.

In reviewing the subscale focused on Brainstorming in the *CPAC* measure, STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses did not show a statistically significant difference between the two groups. Concerning Brainstorming, the t-test showed (t= 1.136[83], p = .0.26), which failed to show more outstanding brainstorming capabilities between the two groups and failed to prove Hypothesis 1.

In analyzing the *CPAC* subscale focused on Imagery through a t-test, STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses did not show a significant difference between the two groups t= 0.664 (83), p = .0.71, which failed to confirm greater creativity in connection to Imagery between STEM students who have taken and those who have not taken fine arts courses.

The last subscale part of the *CPAC* measure focused on Flow. In reviewing the data with a t-test, STEM students who had taken fine arts courses and those who had not taken fine arts courses did not show a significant difference between the two groups in this part of the *CPAC* measure. The t-test, failed to show greater Flow in their creativity between STEM students who had taken fine arts courses (t= 0.670[83], p = .0.51).

Table 3

CPAC comparison of students who have taken and who have not taken fine arts courses

	No FA Courses taken		FA Courses Taken		
Measure	*M*	*SD*	*M*	*SD*	*p*
CPAC (Total)	3.441	0.481	3.422	0.690	0.058
CPAC - Incubation	3.301	0.316	3.268	0.315	0.626
CPAC-Metaphorical/Analogical	3.242	0.477	3.239	0.363	0.977
CPAC-Brainstorming	3.115	0.417	3.024	0.047	0.259
CPAC-Imagery	3.503	0.531	3.432	0.458	0.509
CPAC Flow	3.564	0.069	3.503	0.061	0.505

YCTD

This study also analyzed STEM students' creativity and critical thinking levels using *Yoon's Critical Thinking Disposition* (*YCTD;* Yoon, 2008); see Table 4). The T-test showed that STEM students who had taken fine arts courses showed a slightly higher level of critical thinking and creativity than STEM students who did not take fine arts courses. However, these results showed no statistically significant differences between the two groups, which failed to support the third hypothesis as well (*t*= -1.03[83], p = .0.30).

Each sale was further considered in the *YCTD* to review creativity and critical thinking through a series of t-tests. In reviewing the three questions connected to Objectivity, a t-test showed that once again that there was not a significant difference between STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses (t= -0.64[83], p = .0.52). These results failed to show greater Objectivity in connection to critical thinking and creativity between the two groups of students.

The next subscale within the *YCTD* measure focuses on Prudence and features four questions. STEM students who had taken fine arts courses and those who had not taken fine arts courses did not demonstrate a statistically significant difference between the two groups (t= -0.16[8]), p = .0.87, which thus failed to show greater Prudence in their critical thinking and creativity between STEM students who have and who have not taken fine arts courses.

In reviewing the two questions connected to Systematicity within the *YCTD* measure, a t-test confirmed that STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses did not show a statistically significant difference (t= -0.16[83], p = .0.87, thus failing to show a greater level of Systematicity amongst creativity and critical thinking between the two groups.

In reviewing Intellectual Eagerness/Curiosity as part of the *YCTD* measure, STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses indicated only a slight difference between the two groups. Concerning Intellectual Eagerness/Curiosity, the t-test results failed to show a statistically significant difference between the two groups (t= 0.149 [83], p = .0.14).

In reviewing Fairness within the *YCTD* measure, a t-test confirmed that STEM students who had taken fine arts courses and those who had not taken fine arts courses did not display a statistically significant difference (t= -0.64[83], *p* = .0.52), and failed to prove a greater level of fairness.

In reviewing the four questions connected to Skepticism within the *YCTD* instrument, STEM students who had taken fine arts courses and STEM students who had not taken fine arts courses did not show a statistically significant difference between the two groups via a t-test (t= -1.55[83], *p* = .0.12). These results failed to display a more significant level between the two groups for this subscale.

Table 4

YCTD comparison of students who have taken and who have not taken fine arts courses

	No FA Courses taken		FA Courses Taken		
Measure	*M*	*SD*	*M*	*SD*	*p*
YCTD (Total)	3.270	0.591	3.382	0.400	0.303
YCTD - Objectivity	3.444	0.950	0.565	0.766	0.518
YCTD-Prudence	2.763	0.702	2.739	0.603	0.868
YCTD-Systematicity	3.295	0.930	3.326	0.790	0.868

Table 4 (continued).

YCTD comparison of students who have taken and who have not taken fine arts courses

	No FA Courses taken		FA Courses Taken		
Measure	*M*	*SD*	*M*	*SD*	*p*
YCTD-Intellectual Eagerness	3.404	0.764	3.647	0.731	0.139
YCTD- Fairness	3.513	0.661	3.598	0.564	0.524
YCTD-Skepticism	3.224	0.122	3.462	0.095	0.123
YCTD-Self-Confidence	3.333	0.717	3.378	0.588	0.752

Hypothesis 4. It was hypothesized that there would be a positive correlation among STEM majors between the number of fine arts courses and creativity. In reviewing the *CPAC* scores for STEM students who had taken fine arts courses, there was a small and inverse correlation present relationship between creativity and the number of fine arts courses taken (r=-022, p=0.15). There did not appear to exist a significant meaningful relationship between creativity and the number of fine arts taken in response to the *YCTD* (r=-0.15, p=0.32) in connection to hypothesis four. These results failed to prove hypothesis four.

CHAPTER V

Discussion

Summary of Findings

The current study explored the effect of fine arts coursework on creative thinking and overall success among science, technology, engineering, and mathematics (STEM) students pursuing an associate degree at an urban Midwestern community college within a Midwestern college and university system. Curriculum in higher learning institutions focused on a well-rounded curriculum across various disciplines, including the fine arts, from the 1970s to 2010. However, in the 1990s curriculum shifted, focusing more exclusively on STEM courses (Colwell, 2018). The financial crisis of 2008 caused numerous institutions to eliminate the fine arts, foreign languages, and history because many students and parents felt that these courses were not necessary for jobs in our current world (Grimberg, et al., 2018). Previous research often cited the benefits of the fine arts on student success and creativity and detailed the positive impact of these courses on their STEM majors and careers. While pursuing higher education degrees, community colleges and four-year colleges and universities often recommended or required STEM students to take fine arts courses as part of their core curriculum. According to existing studies, students who participated in the fine arts utilized more diverse creative thinking methods in their STEM studies and careers (Grimberg et al., 2018). Studies showed that students who took courses in fine arts to pursue their STEM majors saw increased levels of success by degree completion (Grimberg et al., 2018).

STEM students who took fine arts courses during their college tenure also displayed increased creative thinking skills in their STEM coursework and careers (Grimberg, 2016).

Research from Michigan State University shows that STEM students who integrate fine arts coursework into their STEM major consistently display tremendous success in all of their courses. These STEM students displayed higher scores overall in every subject area while demonstrating exemplary creativity in problem-solving (Brady, 2014). Similarly, Grant's (2016) research showed that students reported more significant success in STEM courses when they studied fine arts. Root-Bernstein's (2015) research found that students applied the skills developed in learning the fine arts and applied them to greater success in STEM courses. In reviewing the current research, the current study examined community college STEM students to explore the benefits of fine arts courses on creativity and student success.

First, it was hypothesized that STEM majors who took one or more fine arts courses would report a higher GPA than STEM majors who have not taken fine arts courses. The current study demonstrated that there was no statistically significant difference in self-reported GPA between STEM majors who did or did not take fine arts courses. These results were unexpected as previous research often reflected the benefits of fine arts courses on student success rates. Root-Bernstein's (2015) study demonstrated the positive effects of fine arts exposure on STEM majors' overall grades. Similarly, South Korea's Ministry of Education, Science, and Technology adopted the STEAM model in education to great success. This model displayed more robust cognitive skills and overall learning experience in adopting fine arts courses and activities within STEM subjects. These effects had a tremendous impact on these students' success rates in all levels of their education (Kang, 2019). The previous research was not reflected in the current study's results.

Second, it was hypothesized that there would be a positive correlation among STEM majors between fine arts courses taken and grade point average. The present study did not show a correlation between the number of fine arts courses taken and overall student success via self-reported grade point average. This result was an unexpected result of this study after examining previous research in the literature review. For example, Root-Bernstein's (2015) study displayed the long-term benefits of the fine arts on STEM students. These benefits were reflected in their studies and careers in the STEM field (Root-Bernstein, 2015). They applied greater creative thinking skills in their STEM studies and careers (Grimberg, 2018). Similarly, STEM students displayed greater success rates when taking fine arts courses. The fine arts courses also eliminated burnout issues while pursuing STEM degrees in higher education (Brady, 2014).

Third, it was hypothesized that STEM majors who have taken one or more fine arts courses would demonstrate greater creativity than STEM majors who have not taken fine arts courses. STEM students were measured on creativity using the *Cognitive Processes Associated with Creativity Scale* as the first measure (*CPAC;* Miller, 2009)) to analyze their level of creativity (Miller, 2009). No statistically significant difference was demonstrated between the two groups. The *CPAC* was investigated by each subcategory (Incubation, Metaphorical/Analogical Thinking, Brainstorming, Imagery, and Flow). Once again, each subcategory did not show a statistically significant difference between the two sets of students. These results were also not expected. Previous research reflected how the fine arts impacted STEM students positively, allowing them to employ creative approaches to their STEM studies and careers. Kagan's (1969) research focused on the three cultures (science, natural science, and the humanities). These areas should work together to encourage creative strategies for problem-solving and advance innovation (Kagan, 1969). Kim’s (2018) research focused on the importance of the fine arts across disciplines to enhance students' creative thinking in every subject area. Sixth-grade students were assessed using the *Torrance Tests of Creative Thinking (*Miller, 2009*)*. The results reflected that studying fine arts enhanced students' overall creativity in every aspect of their studies. These developments in their creative thinking had positive effects on their overall learning experiences (Kim, 2018). Kim's (2018) study focused on students in elementary education. The current study did reflect on students at a two-year institution which may have been one reason for the unexpected results for this hypothesis.

The third hypothesis was further analyzed concerning creativity and critical thinking using *Yoon's Critical Thinking Disposition* (*YCTD;* Yoon, 2008). However, the results of the *YCTD* failed to show a statistically significant difference. The *YCTD* was also analyzed using each subscale of the measure (Objectivity, Prudence, Systematicity, Intellectual Eagerness/Creativity, Fairness, Skepticism). Each subcategory in the *YCTD* failed to show a statistically significant difference between the two groups. This information was surprising as the level of creativity in fine arts courses would anecdotally signify that these skills would be transferable into STEM courses and majors. Murdock's (2010) research discussed how creativity could be used in college programs. She discussed that creative skills become lifelong benefits to students' future careers in various fields (Murdock, 2010). Escalante (2020) took this research further and showed that an integrated curriculum could enhance creative thinking skills that became the foundation for establishing creative skills applicable to any discipline and career (Escalante, 2020). Once again, much of this research was done either at primary or secondary schools. Most research for higher education has been conducted at four-year schools and focused on students pursuing a bachelor's degree. The current study focused on STEM students at a two-year school, which could have been the reason for the difference in the findings.

Fourth, it was hypothesized that there would be a positive correlation among STEM majors between fine arts courses and creativity. In reviewing the *CPAC* scores for STEM students who had taken fine arts courses, there was a small but inverse correlation between creativity and the number of fine arts courses taken. This finding does not reflect previous research focusing on the effects of fine arts courses on creativity in STEM courses and STEM students. There did not appear to be a significant correlation between creativity and the number of fine arts taken in response to the *YCTD*. These results did not show a significant difference in creativity between the two groups of students. Once again, it was surprising as previous research has shown a significant benefit to STEM students when they follow a STEAM model in their studies. Gardiner and Knowles

(1996) detailed the effects of the fine arts on elementary school students in the United States in their study. These students took giant steps forward over two years in mathematics, and it also found that fine arts skills significantly impact and could be used in math and science (Gardiner & Knowles, 1996). Once again, most of the previous research connected to this hypothesis focused on primary and secondary education. Few studies focused on higher education, and none specifically focused on two-year college STEM students as this current study did.

Implications

The results of the current study suggest that STEM students at a metropolitan community college within a Midwestern college and university system do not show relationships in creativity and student success when taking fine arts courses as part of their studies. However, these results contradict an extent body of research. Further studies are necessary to explore further the effects of fine arts courses on STEM students' creativity and overall student success.

It is conceivable the results of this study were affected by the small sample size of STEM students surveyed. The COVID-19 pandemic influenced the number of STEM courses offered at this two-year college for the fall 2021 semester, and lower enrollment existed in almost every section of the STEM classes offered in the fall 2021 semester affecting the number of students who completed the survey. All STEM students at the Midwestern community college were emailed the survey initially, however, the email survey responses were limited. Additionally, only 122 students responded with complete response sets to the survey. Although a respectable sample size for statistical analysis, it represented only 11% of the community college's student population. Forty-seven students responded online, and 75 students completed the study in person. Of those that responded either online or in-person, only 86 students fully completed the survey and were able to be a part of the two groups compared within the study. This smaller sample size impacted the results of the study. Without the current enrollment issues, a larger sample size could have been achieved. The larger sample size would have impacted the results of this study.

The present study focused on STEM students taking STEM courses at a community college. Students were not examined who were pursuing four-year degrees or graduate degrees. STEM students in four-year institutions and graduate programs are much closer to degree completion and are moving into STEM careers. The difference in the type of student might have impacted the results. Similarly, the study only focused on students from one two-year institution within the Midwestern college and university system. A greater sample size from a more significant number of institutions might have impacted the overall results discovered in this study as well.

STEM students at community colleges will continue to take fine arts courses while pursuing their educational goals. There should be a more focused effort to explore the value of the fine arts and meaningfully reflect on how they can enhance STEM studies. As Murdock (2010) states, creativity can be applied to college-level programs and used in future careers. Murdock (2010) showed that creative skills provided long-term benefits to future careers in various fields. Exploring the effects of fine arts courses on creativity and student success would hopefully create a more well-rounded and robust

STEAM model of education, allowing students to apply creativity in all areas of their studies and careers.

Strengths and Limitations

A significant strength of the present study is that it surveyed students at a metropolitan community college within a sizable Midwestern college and university system rather than students at a four-year college or university. Previous research in this area mainly focused on primary and secondary institutions. Similarly, previous research focused on higher education institutions on STEM students pursuing four-year degrees. The current study offers a unique glimpse into community college students pursuing STEM degrees.

Another strength of the study was the diverse student population at this community college. First, the current study had more diversity regarding gender identity, with 45.35% of the students surveyed self-identified as male, 50% as female, and 4.65% as non-binary. Previous studies have reflected more male-dominated STEM classes and degrees—the current study surveyed over 50% of community college STEM students who did not self-identify as male.

In addition to the present study, the participants observed diversity in race/ethnicity. 41.86% selected White/Caucasian, 12.79% picked Latino/Hispanic, 1.16% selected Multiracial, 26.74% selected Black/African, 16.27% chose Asian/Pacific Islanders, and 1.16% selected Other as their race/ethnicity. These demographics afforded a unique look at one of the Midwest's most diverse community colleges.

Several limitations were also present in this study. The first limitation of the study is that it used a smaller sample size. The COVID-19 pandemic influenced the number of STEM students enrolled at this particular two-year college for the fall 2021 semester. Across the country, community colleges are seeing a serious decline in enrollment. Students are opting out of continuing their studies after high school and many adult learners are not continuing their education in the midst of the pandemic. These students are focusing on career options and family life (Anderson, 2022). A larger sample size might have afforded a more robust analysis.

Another limitation was that the study focused on STEM students taking STEM courses at one Midwestern community college. The study did not encompass a larger number of community colleges. Furthermore, students who pursued bachelor’s degrees or graduate degrees in STEM fields were not examined. It could be suggested that the study might have had different outcomes if focused on a larger sample of community college STEM students or focused on students pursuing a bachelor's degree or graduate-level degree in a STEM discipline.

The measures used the *Cognitive Processes Associated with Creativity Scale* (*CPAC;* Miller, 2009) and *Yoon’s Critical Thinking Disposition (YCTD; Yoon, 2008)* may have also played a role. Further study could use other measures of creativity that exist. Different measures might produce different results. It would also be interesting to compare results from various measures with those found using the CPAC and YCTD. These results could then be used in further study to examine their consistency and the measures' effect on the study's overall results. These two measures combined also created a lengthier survey featuring 74 questions. The length of the survey and the time it took to complete it may have affected the sample size and the completion rate. More STEM students may have felt compelled to complete the survey if it was shorter.

Recommendations for Further Research

Several recommendations can be offered for further research. The first recommendation is to replicate the present study with more students at the community college, allowing for a much larger sample size of two-year STEM students. Another recommendation would be to examine another college and university system. It would allow an examination of each system's curriculum and core course approach. It would also reflect the role of student demographics and geographical location in the results. Another recommendation would be to study STEM majors pursuing a bachelor's degree at a four-year institution. The students are further along in their educational journey. It could create additional data that examines results from students who are further along in their studies. In the same way, it could also study graduate students.

It is also be recommended to replicate the current/present study subsequent to the COVID-19 pandemic when enrollment numbers hopefully increase at two-year institutions and colleges and universities. Larger enrollment could significantly impact a larger sample size of students and affect the overall findings.

A final recommendation would be to examine the *CPAC* and *YCTD* measures to see if they fit the study best. With a further examination of the results and overall sample size that completed the survey, it may be best to examine if there are two measures with fewer questions that might focus on creativity. A shorter survey might generate a much more robust sample size.

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Appendix A:

Effects of Creativity and Student Success on Community College STEM Students Taking Fine Arts Courses

I-Informed Consent

INTRODUCTION

You are invited to participate in a research study regarding your experiences while working on your current STEM courses. The goal of this survey is to understand community college students' experiences taking STEM courses and fine arts courses and their effects on students success and creativity. This research is being carried out by Professor Jason Kaufman, Ph.D., Ed.D. and Jimmy LeDuc, MFA. (Minnesota State University, Mankato).

PROCEDURE

If you agree to participate as a subject in this research, you will be asked to complete an electronic survey. This survey has two measures. The first measure is the *CPAC (Cognitive Processes Associated with Creativity Scale)* focused on creativity in academic studies. The second measure is *Yoon's Critical Thinking Disposition Instrument* focused on creative approaches in learning in STEM courses. It is expected that you will need less than 30 minutes to complete both of the measures.

POTENTIAL RISKS OF PARTICIPATION

The risks of participating in this study are no more than in daily life. Nonetheless, it is always possible that you might experience some discomfort from reflecting on your own thought process about your studies.

POTENTIAL BENEFITS OF PARTICIPATION

There are no direct benefits for participating. You may benefit through the increased understanding of fine arts courses on creativity and student success.

VOLUNTARY NATURE OF THE STUDY

Participation is voluntary. All surveys will be anonymous, and the researcher will not be able to see who participates. You have the option to choose not to participate in this research. You may stop taking the survey at any time by closing your web browser. Participation or nonparticipation will not impact your relationship with Minnesota State University, Mankato, and refusal to participate will involve no penalty or loss of benefits.

STATEMENT OF CONFIDENTIALITY

All data will be stored without identifying information. Responses will be stored electronically for three years and then any data will be destroyed. It will only be available to Professor Kaufman and Mr. Jimmy LeDuc. No names or identifying information other than the name of the respective college will be recorded. Survey responses will be anonymous. However, whenever one works with online technology there is always the risk of compromising privacy, confidentiality, and/or anonymity. If you would like more information about the specific privacy and anonymity risks posed by online surveys, please contact the Minnesota State University, Mankato IT Solutions Center (507-389-6654) and ask to speak to the Information Security Manager.

CONTACTS AND QUESTIONS

This research is being directed by Professor Jason Kaufman, Ph.D., Ed.D. (Minnesota State University-Mankato). If you have any questions about this research study, please contact Dr. Jason Kaufman at 952-818-8877 or jason.kaufman@mnsu.edu. If you have questions about participants rights and for research-related injuries, please contact the Administrator of the Institutional Research Board, at (507) 389-1242.

STATEMENT OF CONSENT

Submitting the completed survey indicates your informed consent to participate in this study. Also, submission of this survey attests that I am at least 18 years of age or older. All questions that may have arisen have been answered by this document or the investigators listed above.

Please print a copy of this page for your future reference.

MSU IRBNet ID# Date of MSU IRB approval:

II- Please select your gender:

1. Male (1)
2. Female (2)
3. Nonbinary (3)
4. Prefer not to Identify (4)

III- Which best describes your race/ethnicity?

1. White/Caucasian (1)
2. Latino/Hispanic (2)
3. Multiracial (3)
4. Black/African-American (4)
5. Asian/Pacific Islander (5)

6. Other (6)

IV- Your age?

______ Use the slide bar to approximate your age. (1)

V- Number of semesters of college completed.

1 - 2 (1)
3 - 4 (2)
5 or more (3)

VI- Major/Intended Major?

VII- Estimate of current GPA?
______ Uses slide bar to approximate your grade point average. (1)
VIII- Experience with Fine Arts Courses

Have you taken or are you currently taking a Fine Arts Course?

(1) Yes (2) No

Appendix B

Cognitive Processes Associated with Creativity

Below is a 47-item Cognitive Processes Associated with Creativity scale

Following is a series of statements about personal preferences and behaviors. Please indicate how frequently you engage in each behavior.

Response Options:

(1)Never (2)Rarely (3)Sometimes (4)Often (5)Always

Incubation

1. When I get stuck on a problem, a solution just comes to me when I set it aside.

2. I get good ideas while doing something routine, like driving or taking a shower.

3. I get solutions to problems through my dreams.

4. I get solutions to problems when my mind is relaxed.

5. My mind must be completely active and focused to generate effective solutions.

6. If I get stuck on a problem, I look for clues in my surroundings.

7. If I can’t come up with a good solution right away, I quickly settle for a less effective one.

8. If I get stuck on a problem, I keep trying to solve it even if no solutions come to me.

9. A good way to solve a difficult problem is to stop working and reflect. Perspective-taking

10. If I get stuck on a problem, I try to take a different perspective of the situation.

11. Looking at a problem from a different angle can lead to a solution.

12. I find it hard to look at something familiar in a new way

13. Changing perspectives is a good way to "think outside the box."

14. Thinking about more than one idea at the same time can lead to a new understanding.

15. I find it difficult to make myself aware of my own subjectivity.

16. If I get stuck on a problem, I look for details that I normally would not notice.

Metaphorical/Analogical thinking

17. Looking for unusual uses of everyday objects is a waste of time.

18. If I get stuck on a problem, I try to apply previous solutions to the new situation.

19. While working on something, I can get bogged down on the irrelevant details of the situation.

20. Incorporating previous solutions in new ways leads to good ideas.

21. I find it difficult to transfer ideas from one situation to a new context.

22. If I get stuck on a problem, I make connections between my current problem and a related situation.

23. Joining together different elements can lead to good ideas.

Brainstorming

24. I generate few good ideas rather than many.

25. While working on something, I try to generate as many ideas as possible.

26. In the initial stages of solving a problem, I try to hold off on evaluating my ideas.

27. I rule out ineffective ideas as soon as they come to me.

28. Generating more solutions than I need is a waste of my time.

29. Wild and crazy ideas are a waste of time.

30. Combining multiple ideas can lead to effective solutions.

31. If I get stuck on a problem, I ask others to help generate potential solutions.

Imagery

32. While working on a problem, I try to imagine all aspects of the solution.

33. If I get stuck on a problem, I visualize what the solution might look like.

34. While working on something, I often pay attention to my senses.

35. It is difficult for me to imagine things that have not yet happened.

36. Imagining potential solutions to a problem leads to new insights.

37. Unique perceptions rarely inspire good ideas.

38. I try to act out potential solutions to explore their effectiveness.

39. Becoming physically involved in my work leads me to good solutions.

Flow

40. While working on something, I try to fully immerse myself in the experience.

41. I can completely lose track of time if I am intensely working.

42. When I am intensely working, I don’t like to stop.

43. R- It is difficult for me to become fully immersed in my work.

44. R- I am easily distracted, even while working on something I enjoy.

45. While working on something I enjoy, the work feels automatic and effortless.

46. If I am intensely working, I am fully aware of “the big picture.”

47. Even while working on something I enjoy; I am worried about failure.

Appendix C

Yoon's Critical Thinking Disposition Instrument

Below are 27 about personal preferences and behaviors. Please indicate how frequently you engage in each behavior on a 5-point Likert scale with (1) being Never (5) being always.

1. I turn my mistake into an opportunity to learn.
2. When I am questioned, I think twice before I give my answer.
3. I have a reasonable proof.
4. I tend to make a decision hastily without considering a matter carefully.
5. I willingly accept the proved truth though having different opinion.
6. I think any opinion needs to have a reliable reason to insist.
7. I prefer to think differently from others and routines.
8. I explain reasons if I don't agree with others.
9. When I judge a matter, I judge objectively.
10. Although something is already set firmly, I have questions on it.
11. I have a reputation of being a rational person.
12. I continually evaluate whether my thought is right or not.
13. I continually look for pieces of information related to solving a problem.
14. I tend to act rashly and carelessly when I face a difficulty.
15. I willingly solve a complicated problem.
16. When I see the world, I see it with a questioning mind.
17. I think I can get through any complicated problem.

18. I don't rush to judgment.

19. I'm handling complicated problems by my criteria.

20. When I have a question, I try to get the answer.

21. I'm trying to understand how the unknown thing works.

22. When I confront a problem, I try hard to find an answer until solving it.

23. I don't decide depending on others' opinion.

24. I willingly accept a criticism on my opinion.

25. When I solve or judge a problem, I utilized a collection of data by organizing it.

26. I evaluate fairly either my opinion or others' opinions.

27. I believe my inference to solve the problem.