Chapter 6
The Emergence of the Creativity in STEM: Fostering an Alternative Approach for Science, Technology, Engineering, and Mathematics Instruction Through the Use of the Arts

Michael Marmon

Introduction

Science, technology, engineering, and mathematics (STEM) has become a ubiquitous term by which to describe the necessary skills that are essential for workers in a twenty-first century global economy. Moreover, the term has been used to equate these skills with success in both the private and public sectors. To put it more succinctly, there is the belief that students educated in STEM subjects tend to exhibit the following characteristics: "critical thinking, creativity, innovation, communication, collaboration and entrepreneurship" (Jolly, 2014 para. 1). Yet, there is an emerging movement to end the separation of science and the arts and to include the latter into the concept of STEM to further some of the aforementioned characteristics typically associated with science, technology, engineering, and mathematics.

Specifically, STEAM represents an evolution from the concept of STEM in that the inclusion of the arts is centered around stoking or bolstering the "imagination through innovation" of students as they approach STEM-related issues (Feldman, 2015 para. 4). A STEAM-centric curriculum offers an opportunity to inject creativity into courses that have traditionally been more scientific in nature. The inclusion of creativity, more specifically the arts, requires that the participating learner approach STEM activities in a distinctly different manner. Namely, STEAM establishes an intersection between disciplines while emphasizing elements of "design, performing arts (technical communication) and creative planning" (Jolly, 2014 para. 12).

This chapter seeks to fully examine the role that the arts and creativity play within the discipline of science, technology, engineering, arts, and mathematics (STEAM). This focus will investigate this role and its effectiveness within

M. Marmon (✉)
University of North Texas, Denton, TX, USA

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completing traditional STEM-related activities. To better understand the effectiveness of teaching courses with STEAM elements, student satisfaction for this approach will be both examined and discussed. This chapter will conclude with a discussion about STEAM-related theories and practices as well as the future of this emerging discipline from a technological perspective.

The Evolution of Science, Technology, Engineering, and Mathematics (STEM) to Include the Arts

The conceptual background of this chapter is the subject of STEAM with its emphasis on leveraging creativity in higher education; however, it would be beneficial to establish a foundation for this subject. The evolution of STEAM begins with its precursor, science, technology, engineering, and mathematics, colloquially known within the realm of academia as STEM. The clear difference between STEM and STEAM is that the latter extends past the apparent absence of art from the former. The prevailing definition of STEM as a concept is relatively high level in that it refers to instructional activities involving the aforementioned STEM fields occurring across all grade levels, whether the student is currently in kindergarten or getting their doctorate (Gonzalez and Kuenzi, 2012a, b).

The decision to include a radically different concept such as art within the realm of STEM acknowledges that the original field definition was lacking an important facet. The perceived value of STEM education lays within the reality of an ever-changing twenty-first economy. The belief is that there is a shortage of human capital, that is to say, individuals educated skilled in the STEM fields, where these skills are transferable to a myriad of different occupations (Marginson, Tytler, Freeman, & Roberts, 2013). The argument could be made that the inclusion of the arts and, more abstractly, creativity into STEM is to serve the noble purpose of saving the arts in education thereby putting an intrinsic value on this concept in a twenty-first century economy.

The addition of art into the realm of STEM offers a means by which to connect these concepts. White (2010) asserts that these connections enabled by the arts in STEM are essential as it facilitates the various elements within this concept to ensure that this economic future is bright.

The connections that comprise White's (2010) position are the following:

- Arts education is a key to creativity.
- Creativity is an essential component of and spurs innovation.
- Innovation is agreed to be necessary to create new industries in the future.
- New industries, with their jobs, are the basis of our future economic well-being. (para. 2).

The implication to be made from this discussion of connections afforded by the arts is a concept of value placed on the role of creativity in an economy such as this would be viewed as valuable. By placing an emphasis on innovation through art and

creativity within our economy, it would lead individuals to value their presence within education given that it stimulates economic growth (White, 2010). Moreover, creativity, which was discussed earlier, is an essential element to establish innovation and, thus, is quickly being recognized as a characteristic that is desirable for a worker in this type of economy.

The role of the arts in the creative process is one of the factors that individuals cite as the foundation for perpetuating innovation in the workforce of the future regardless of the particular industry. One of the long-standing opinions for 50% of the employers surveyed in the report *Ready to Innovate*, a report compiled by Lichtenberg, Woock, and Wright (2008), is that the "arts is the most significant indicator of creativity" in the individuals that pursue positions with their firms. Furthermore, these types of individuals entering the workforce will have a hybrid mindset that will be more valuable because of their approach to problem-solving and ability to innovate new ideas because of their distinct design process. Namely, the inclusion of arts in STEM will result in individuals who view the world through a different lens that establishes a creative method by which to design processes supplemented with a whole host of technical skills as well (Feldman, 2015).

The intent of this chapter is to examine the role of STEAM in the realm of higher education instruction; however, to fully examine this subject, it is required to understand the evolution of STEM into STEAM. Moreover, by examining the role that STEM has on the economic prospects of learners and the purpose of higher education to construct/inform an individual's viability in an economy, a discussion of the role of creativity and the arts is essential. The clarity of how the arts fit within STEAM provides a necessary implication about its purpose and value within the economy of both the present and future for graduates who possess these skills while also asserting its need within higher education.

The Emergence of Science, Technology, Engineering, Art and Mathematics (STEAM) in the Field of Higher Education

The evolution of STEM to STEAM provided a brief explanation in the relevance of the arts within the traditional STEM fields of science, technology, engineering, and mathematics. This discussion yielded some context about the value of art and by extension creativity in an economy that many observers feel will be shaped by the intellectual sphere of STEM disciplines. This chapter will provide a more thorough examination into the concept of STEAM and creativity within the context of higher education to better understand the ability of art to transform the thought processes typically associated with a STEM curriculum. To accomplish this examination and the resulting understanding of creativity within the arts, a discussion will occur in this section that highlights STEAM learning programs and instructional design theories.

A short definition for the concept of STEAM was provided in the previous section that spoke of the term from a perspective of its purpose; thus, it is beneficial to

provide a more technical definition that provides the theoretical underpinning of this concept. The term of STEAM originated in 2010 and is attributed to Harvey White, a founder of Qualcomm, who felt that the STEM field could benefit from the "habits of mind of the artist" with an emphasis "creative problem solving" cultivated from a defined approach to instruction (STEAM Programs, n.d.). The position of Harvey White as the preeminent proponent of STEAM provides the foundation to what the concept would evolve into years later. STEAM within the context of this chapter will be defined through the intersection of STEM and the function that the arts will play within this emerging discipline.

Interjecting the Arts into STEM to Create an Interdisciplinary Education

STEM as a concept refers to the "integration of science, technology, engineering and mathematics in a new cross-disciplinary subject in schools" (Dugger, 2010 p.2). The working definition of STEM provided by Dugger leads one to wonder how the arts can integrate within the structure of these four fields. The answer to this thought is that the arts act as a connector to all of these concepts, which results in an understanding about how each can be leveraged and their purpose in society. In particular, the arts acts as the method by which society is able to construct, convey, and comprehend "attitudes and customs in the past, present and future" (Yakman, 2008 p.16). The position of Yakman offers a context for how the arts can be utilized to present complex STEM-related concepts in a way that is understood by individuals who are not pursuing a degree within a major from one of those fields. It is with this thought in mind that provides the perspective by which to understand how the arts and creativity are used within traditional STEM-centric higher education programs.

The foremost aspect of STEAM in higher education is the fulfillment of an important concept within the realm of higher education, a well-rounded and comprehensive approach to learning that is interdisciplinary in nature. The relevance of an interdisciplinary STEM curriculum that has been infused with the arts is that students are taught concepts and information from the arts and engineering courses that are relevant to the students pursuit of a degree in either discipline. An example of this notion is engineering students completing an "arts or drafting course" to understand the "practical aspects of perspective in drawing and the structural elements of construction" (Robinson & Baxter, 2013 p. 3). The interesting element of Robinson and Baxter's example is that it highlights a recurring belief discussed throughout this chapter; thus far, the presence of arts courses within a traditional STEM curriculum will establish a new method by which to visualize and approach their work in the said courses. In particular, the position of Robinson and Baxter highlights the belief of commonality or common processes that could be utilized by students in either of these programs. For instance, individuals within a science program seek to understand the inner workings of the world through the collection of

data, whereas arts approach their creative works by replicating the world through similar visual observances (Fulton & Simpson-Steele, 2016).

The principles that Fulton and Simpson-Steele are proposing is that commonalities in processes emphasized in a STEAM curriculum or a course that is based on either science or the arts minimizes the barriers to constructing knowledge from a practical perspective. The connection of these common elements in the mind of the learner will emphasize "engagement with ideas rather than teaching of concepts" (Fulton & Simpson-Steele, 2016 p. 10–11). The purpose of the emphasis on the ideas rather than the method of instruction implies that a student would be receptive to how the content can be utilized to support their own research interests as opposed to approaching it from an specific academic perspective. For instance, there is less value for individuals to have extensive memories comprised of mathematic equations or scientific information as technology such as computers can provide this information; thus, creativity offers a method by which to solve questions of this type (Callahan, 2014).

Leveraging Connections and Information in STEAM Courses to Improve Learning Outcomes

It is important to note that the role of creativity and the arts as means to establish the connections by which to resolve complex issues in a STEAM-centric curricula is through the construction and utilization of information. This approach to constructing knowledge in STEAM courses offers a glimpse by which to understand the improvement of a STEM curriculum through the learning outcomes for the individuals completing these classes. A study conducted by Mishra and Henriksen (2013) found that these STEAM instructional methods yield "more motivated and engaged students" that were capable of increasing their "learning within these disciplines" (p. 4). While all instructors seek to ensure that their learners are achieving positive learning outcomes, it is necessary to delve further into the subject of these outcomes and how these artistic/creative instructional methods have improved upon traditional STEM courses.

While the discussion of critical thinking has been discussed previously in this chapter, it would be beneficial to delve into the concept further as it relates to STEAM. The ability for a learner to process their thoughts creatively results in an enhanced ability to solve the problems presented to them which is a required skill in higher education courses (Art, 2013). The prevailing belief to be gleaned from this assertion speaks to the inclusion of creativity resulting in learners becoming "better problem solvers," who are able to better understand these subjects as a result (Art, 2013 para. 8). The question that arises from statements such as this is the validity of the claim that lie within them. The answer to this question resides within the research findings of studies conducted about the influence and effectiveness that the arts and, by extension, creativity have within STEAM education.

There have been a multitude of studies that have sought to better understand the impact that artistic elements have within higher education courses. In particular,

these studies have found that the influence of creativity on learners results in higher level thought, which include an ability to navigate difficult and stressful situations, in addition to enhanced life and social skills (Autry & Walker, 2011; Clinton & Hokanson, 2012; Hargrove, 2012). As one can ascertain, there is a clear and positive impact on learners that extend past the classroom. While this is certainly a positive aspect from integrating creativity in a course, it is best to refocus onto its role in a STEAM context.

The context of STEAM in a twenty-first century world is predicated on the ability to leverage creative solutions to the problems that are facing individuals living at this particular moment in history. Creativity, in its most simple or mundane form, has the opportunity to change how the layperson sees critical problems such as climate change or controversies involving vaccinations through the framing of data obtained through research (Thurley, 2016). The assumption to be made is that the "layperson" will obtain these skills from a higher education experience that is centered around STEAM. Thurley (2016) proposed the value of instilling creative endeavors such literature or creative writing in academic communication or scholarly articles which will result in findings that are easier to understand by those unfamiliar with the subject. Granted, the proposal offered by Thurley is one of a multitude that could be discussed in many volumes; thus, the focus of this chapter will turn from potential applications of STEAM in higher education to student satisfaction in these courses.

Determining the Impact of STEAM by Examining Student Satisfaction in These Courses

The emergence of STEAM as a method by which creativity and the arts are utilized in a course has an impact on the level of student satisfaction. Namely, these courses could be extraordinarily designed by an instructor or instructional designer, but if the content and processes do not resonate with the participating students, then there is a problem with the course's impact or effectiveness. With this in mind, it is beneficial to better understand how STEAM-centric courses are received by the students that have participated in them. Moreover, there is value in discussing the methods that STEAM instructors find to be particularly effective and tends to evoke the most from their students from the perspective of learning outcomes.

STEAM and Student Satisfaction

The primary method by which it is possible to measure student satisfaction in a STEAM curriculum is through the course elements and structure that comprise these courses. One such method is to present the content in such a way that it is possible to motivate learners through an "inquiry-based approach to learning,"

where knowledge is constructed through an experience shaped by creativity and coalesced from a "broader understanding of all the parts" of the subject (Helfferich, Dawe, & Tarnai, 2014 p. 2). To obtain the insights necessary about student satisfaction with regard to the inquiry nature of these STEAM courses, satisfaction surveys assume the foremost method by which to evaluate the sentiment levels of each learner within these courses. The results obtained from these surveys will not only provide insights into the feelings of individuals within these courses; they will offer a means by which to measure the level of success for the STEAM course as a whole (Advancing, n.d.).

Increasing Student Satisfaction Through a Framework That Engages and Challenges Students

As satisfaction surveys offer a means by which to evaluate the success of the learners participating in a higher education STEAM course, it is necessary to understand how to shape the emotional and intellectual response in the mind of the participants. Arnold and Reeves (2014) highlight the necessity of an instructor to develop a framework that is "effective" in "increasing student retention and persistence" in these courses through the constant engagement of the learner (p. 2). The type of framework that should be designed for a STEAM course should leverage the environment that the course takes place in (online or face-to-face) and utilize diverse activities that lend themselves to advancing the knowledge through the aforementioned active learner engagement (Lo, 2010). After all, it should be logical that the challenge and academic rigor of the activities within these courses would accurately reflect the satisfaction of the learner as these activities stimulate their desire to learn and participate.

The approach or framework for designing an experience in STEAM courses should be multidisciplinary in nature, which means that it fits the core ideals of STEAM and include within its structure activities found in the real world. One of the prominent frameworks in higher education is the teacher education program at the State University of New York at Potsdam that has taken this multidisciplinary message to heart and developed a curriculum that engages learners with examining concepts from the arts and sciences and developing real-world problem-solving skills from the information in these courses (Madden et al., 2013). The Potsdam model for the use of STEAM in higher education is fascinating from both its philosophical foundation and its practical implementation of these ideas that resulted in a comprehensive degree program that leverages content from a multitude of diverse academic programs.

The implementation of this framework is predicated on the idea of developing a curriculum centered around the notion of STEAM theory and its practice, which requires a measure of cooperation between stakeholders in the academic departments creating these courses. This cooperation between these individuals requires

extensive communication as it is illogical for a subject matter expert in one academic discipline to have an expertise in another STEAM field as well. After all, a STEAM course represents a multidisciplinary approach for instruction, and each of these elements should not be presented to students as separate concepts or content elements but rather be treated as one concept highlighting the connections between each element (Land, 2013). This collaboration between course stakeholders as explained by Land is a necessary activity that also yields an essential value for the program by two different departments and makes them more likely to participate in conjunction with each other outside of a single STEAM course.

The SUNY Potsdam model is one specific example of a dual degree program that is comprised of the arts and other STEAM disciplines. The purpose of this type of dual degree program is the comprehensive nature of the curriculum that is not found in a single STEAM course that exists in a vacuum by itself. Thus, these courses are not merely offering an isolated requirement on a degree plan; it becomes an example for the previously discussed notion about the economic value of these STEAM courses. More appropriately, these dual degree programs allow difficult content types to transition from STEM-related skills into "implemented and fielded capabilities which require more creative skills" (Land, 2013 p.552).

Most importantly, a curriculum centered around STEAM courses and concepts would also have the added benefit of a more comprehensive design rather just being a single course that fits as an elective in another program. Specifically, programs such as this one take an approach that not only sets its own cumulative learning outcomes, it will approach the construction of knowledge within a program of this type progressively and will be addressed by benchmarks or artifacts such as portfolios for learners (Madden et al., 2013). Ultimately, the benefits of a STEAM framework and curriculum such as this in higher education plays to the advantage of the student as it provides a comprehensive experience that not only build upon itself, it also presents a multitude of similar concepts within one academic department rather than across a myriad of other ones, thereby making it easier for them to access these courses.

Charting the Future of Creativity and Arts in a Forthcoming STEAM Course

The academic discipline of STEAM is not one that remains static from either a conceptual or theoretical perspective, it will continue to evolve and remain applicable well into the future as it is centered around the notion of innovation. Moreover, creativity exists as a means of critical thinking to facilitate the type of innovation required to resolve the problems of the future. The future of STEAM education has to be as flexible and timely as the skills and expectations associated with them. These curriculum decisions must be made by isolating the technologies/skills required to fulfill a particular educational and economical need of a society at that

particular moment in human history. This is the foundation for the future of STEAM education, the ability to evolve and create the necessary connections from a conceptual and theoretical context.

The Foundation of STEAM's Future Resides with Learner Engagement and Instructional Design Processes

The future of STEAM education resides within its ability to attract and engage students in courses that leverage instructional design elements in such a way that the learners can relate the content to a real-world context. This relationship of STEAM concepts, technologies, and instructional theories will result in a comprehensive knowledge that can best be described as a functional literacy. More appropriately, learners completing these STEAM courses will be capable and confident enough to draw the connections between each of these elements, thereby enabling them to evolve intellectually within their chosen profession through the act of observation, critical thought, and action as required (Yakman, 2008). The novel aspect of a functional literacy in STEAM is not merely the knowledge acquired on an individual subject but rather the ability to creatively utilize it in an ever-changing economic or social environment.

In particular, this functional literacy is a direct result of approaching curriculum development with the holistic mindset discussed earlier, which lends itself to learner's engagement through the method of instruction and the furthering of the learner's intellectual capacity. The implication here is that STEAM education seeks to develop individuals dedicated to the value of lifelong learning through engaging their sense of "logical thinking and problem-solving abilities" borne from the aforementioned holistic learning rather than the "fragmentation of knowledge and memorization processes" (Developing, n.d., p. 3). The benefit of a holistic STEAM curriculum is the knowledge acquisition that is approached from a collective position rather than merely a recitation of facts, which will result in an understanding of the content from a natural perspective. The next aspect of the future of STEAM education is technology, which aids in engaging the learner and providing a method by which to apply the knowledge acquired in a course of this type.

Shaping Critical Thought Processes with New Media Literacies

It is possible to build upon the importance of learner engagement by either developing or utilizing emerging technologies within a STEAM course to cultivate the learner's interest or even facilitate their ability to participate in these courses as well. The foremost method by which to engage the learner's interest is to incorporate new

media literacies in these courses as they connect to the economy that they will enter upon graduating from an institution of higher learning. The cost of implementing these new media literacies is relatively low for the instructor as most students have the ability to transfer their thoughts and research into a visual mode (Land, 2013). Land (2013) further explains that these foundational skills to translate concepts from one medium to another will occur by incorporating "performance, simulations and collective intelligence" into their courses via prompts (p. 550).

The area of expansion afforded by new media literacies is the relationship between an environment and technology but the experiences that result from the said relationship as well. There is a practical example for leveraging new media literacies and technologies to present information in ways that are more accessible for individual learners (Tsoupikova, Silva, Kostis, & Shah, 2014). It is this convergence of these essential elements (new media literacies and technologies) that results in a learning experience that produces authentic inquiry-based learning. Tsoupikova et al. (2014) explain that museums offer an example environment for this transfer of knowledge between mediums to establish the connections required for inquiry-based learning through the utilization of "augmented reality, challenges and adventure games" (para. 5–6). New media literacies are going to be an essential element for creating learning experiences as they conjure new methods by which to present content and information to learners in an engaging manner. As was mentioned earlier, the interplay between new media literacies and the environments that house them will be guided in the future by the technologies that are currently emerging within the field of STEAM.

The Utilization of Emerging STEAM Technologies

The position of Land (2013) offers a logical segue from a new media literacy perspective as its relate to STEAM, as physical technologies will not only engage the intellect of the participating learner, it also affords the students with another avenue by which to develop their respective knowledge of the content and a physical artifact as well. The emerging digital technologies that continue to evolve rapidly for learners include "artificial intelligence, DNA mapping, robotics, nanotechnology, 3D printing, biotechnology and the 'Internet of things'" and offer a variety of creative avenues by which to creatively develop responses to real-world problems (Taylor, 2016 p. 90). This exposure to multiple technologies with creative applications necessitates an understanding of how to utilize them in such a way that is not only creative but also functions outside the realm of a classroom setting. More importantly, this real-world application of the technology requires that the learners understand that these technologies are utilized by their peers in similar contexts (Lewontin, 2015). In this sense, the practical application of technology increases the learner's engagement with these tools through utilization, and thus, there is intrinsic value in leveraging them in a variety of different environments.

After giving insight into role of technologies and creativity from a theoretical perspective, it is possible for one to discuss the emerging tools in the discipline of STEAM. While there is a multitude of current and emerging technologies to examine, it is more beneficial to draw connections between a selected few technologies and the creative process as opposed to merely highlighting a list of various devices. One of the previously mentioned technologies that will become more prevalent in STEAM education because of its practicality and influence on the creative design process is 3D printing. The usage of a 3D printer within a STEAM course is twofold; the first aspect is its influence on the creative process from the perspective of design and the second is that these devices provide a tangible artifact that reflects the knowledge obtained from the activity (Lonka & Cho, 2015). The importance of this practical application of creativity and a design process results in a greater level of learning that occurs as the learner is capable of connecting the technology to the presented concepts in a realistic situation (Lonka & Cho, 2015). This is an interesting perspective as it implies that the technology acts as a method by which to facilitate or influence the application of knowledge gleaned in a course by guiding the creative thoughts of the learner.

Another emerging technology that contains builds upon this notion of facilitating the relationship between creativity and knowledge is augmented reality (AR). The basic premise of augmented reality is that it is meant to combine virtual elements in a real-world context. A more accurate definition is the "coexistence of virtual objects and real environments," which affords the learner or more abstractly the user the opportunity to learn within context in such a way that enhances their sense of reality (Wu, Lee, Chang, & Liang, 2013). Even within the realm of augmented reality's definition, it is possible to understand its application within STEAM education and the role of creativity in the design of these AR systems. The foremost benefit of this technology is that it increases the engagement of the learners that develop and utilize it within these courses through the process of active inquiry learning (Ahn & Choi, 2015). This crux of this technology and its relevance to creativity and the arts lay with its focus on creative design from a myriad of positions. Specifically, design begins with the "information and system quality," which refers to how the system will function to the aesthetics and a learner experience that deals with "the visual design and the physiological reactions" of the participant as well (Huang & Liao, 2015 p. 275). Huang and Liao (2015) highlight the undercurrent of STEAM within the context of augmented reality through the distinct relationship of system design (from a technology perspective) and creative design (aesthetics and user experience) working in concert to develop applications that would be for the benefit of society.

Technology represents an essential element within the realm of STEAM education, and a survey of the gamut of emerging technologies goes beyond the scope of this chapter; however, the discussion of a few promising technologies assists with understanding of the discipline's future. This section focused on two particular STEAM technologies, 3D printing and augmented reality, both of which allow for a connection between creativity and the other STEAM fields. The defining aspect of these technologies is not the technology itself nor the benefits of its usage; it is the

inherent nature of creativity afforded by them. It is evident that both 3D printing and augmented reality lend themselves quite extensively to the notion of the creative design process as discussed throughout this chapter. This exemplifies the purpose for including two such emerging technologies in this chapter as they offer a reference for a "functional design process" that ultimately informs the "aesthetic nature and utility of items" to resolve the problems that lay in front of the learner (Bequette & Bequette, 2012 p. 40).

Conclusion

The conceptual foundation of this chapter was the investigation into the role that creativity and the arts play within the emerging field of science, technology, engineering, art, and mathematics or STEAM. STEAM is borne from the principles of STEM with the added facet of integrating the arts into these courses, which offers instructors within higher education the opportunity to enhance the creative thinking and problem-solving abilities of their students. As humanity continues to progress through the twenty-first century, the economy has become centered around the traditional STEM fields and is quickly becoming a sought after and essential collection of skills for one navigating the future of our species. In particular, it has been theorized that these necessary "science and technology-based innovation" skills are required in the industries of the twenty-first century as they would be "impossible without a workforce educated in science, technology, engineering and math" (Atkinson & Mayo, 2010 p. 21).

While STEM-related skills are essential within this economy of the future, individuals began to notice the applicability of establishing the arts within the said skill sets. It has been stated earlier in this chapter that the arts offer a means by which to further innovation and creative thinking through establishing connections between disciplines. Specifically, STEAM provides the means to "connect disciplines that were previously perceived as disparate" and serves the purpose of "enhancing student interest and showing the value" in investigating these concepts from an interdisciplinary perspective (Guyotte, Sochacka, Costantino, Walther, and Kellam, 2014 p. 12). The intent of STEAM within higher education is to further the innovation "demanded by the 21st Century" and the addition of the arts to STEM endows the learner with the design skills necessary to "create the innovative products and solutions that will propel our economy forward" (Maeda, 2013 p. 1). The position of Maeda provides the necessity of halting the notion that the arts should remain separate from the fields of science and mathematics.

By establishing the rationale and need for adding the arts to STEM from an economical perspective, it is possible to entice the skeptical into understanding the economic promise of STEAM in the future. This understanding of the purpose and potential of STEAM will lead to increased enrollment in these courses, as well as graduates that are well-rounded both academically and intellectually. Throughout the course of this chapter, there was a discussion as to this impact of the arts and

creativity on STEM that reinforces the belief that these elements impact the creative thinking and problem-solving of the individuals participating in a STEAM curriculum.

It is through this understanding of the elements and activities that construct a STEAM course, which influence how the courses are received by the students that complete them. Student satisfaction in these courses is important because it is an active reflection on the instructional design theories performed in practice and the effectiveness of these choices that determine how the students respond to a STEAM course. The discussion of this topic during this chapter revealed that the implications of student satisfaction rely on a positive influence on the continued presence of the learner in these courses and their success in these courses as well.

STEAM represents the future of creativity and innovation within both a twenty-first century global economy and higher education, where individuals need the skills necessary to navigate these complex disciplines and intellectual concepts. Moreover, the presence and emphasis on the creativity afforded through the inclusion of the arts in STEM make it possible to achieve the following notion: the cultivation of learners who "approach STEM subjects creatively and make them real-world-relevant" (Feldman, 2015 para. 9). If we as a society continue to separate the arts from science and mathematics, we will not only be putting our learners at a disadvantage, we are putting the future of our species as whole at one as well. STEAM and creativity is our best chance to produce well-rounded learners and by extension workers that are capable of innovating in a multitude of disciplines into the twenty-first century and beyond.

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