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Issues-Based STEAM Education: A Case Study in a Hong Kong Secondary School

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Abstract

A curriculum that integrates Science, Technology, Engineering, and Mathematics (called STEM education) has been implemented in K-12 schools in the United States for several years. The purpose of this article is to explore the further integration of issues-based art education into STEM education (hereafter-called issues-based STEAM education) to expand the benefits of STEM education for school children. Adopting issues-based art education into STEM education provides students with a more authentic learning experience because its interdisciplinary pedagogy emphasizes inquiry-based, real-world learning, and critical thinking. In this article, we discuss the recent educational movement from STEM to STEAM,

followed by an introduction to issues-based STEAM education. We then provide a relevant lesson implemented in a Hong Kong high school to shed light on the significance of issues-based STEAM education and as rationale for the importance of issues-based STEAM education that engages art students by exploring social issues.

Introduction

Science, Technology, Engineering, and Mathematics education (STEM) encapsulates an interdisciplinary approach to learning by integrating these four individual disciplines in a meaningful way. STEM education is a project or problem-based approach to solving practical problems in a real-world context (Holmlund et al., 2018). This article first acknowledges the recent educational movement from STEM to STEAM and proposes issues-based STEAM education to empower students to investigate social issues through an inquiry-based learning model. Issues-based STEAM education builds on the foundation of STEM Education and issues-based art education as well as the inquiry-based learning model.

This article then provides a rationale for incorporating issues-based art education into STEM education to assist students in discussing critical social issues with a relevant example. Starting with a review of the current educational reform from STEM to STEAM, we then discuss an issues-based STEAM lesson carried out in a secondary school in Hong Kong, hoping to provide insights into issues-based STEAM education. Like any other school subject, art education has a social responsibility to guide students to examine various social issues in order to adequately prepare them for 21st-century life (Desai, 2020; Hochtritt et al., 2018; Kalin, 2018).

Educational Movement: Adding A into STEM Education

The National Art Education Association (NAEA) in the United States has recently advocated for incorporating Art into STEM education (STEAM) and has established four criteria to do so, which are “valuing all STEAM disciplines equally, implementing a wide variety of approaches, encouraging creativity and innovation, and acknowledging the rigor found in visual art” (Hunter-Doniger, 2018, p. 23). All of these criteria ensure that art equals the importance of science, technology, engineering, and math. Geng, Jong, and Chai (2019) argue that a unique feature of STEAM education is its ability to increase students’ creative, innovative, and problem-solving abilities, a point echoed by Hunter-Doniger (2018): “The benefits of STEAM include increased interest and engagement in STEM subjects and connectivity with artistic behaviors” (p. 23).

Connected learning provides a more authentic learning experience, emphasizing systematic thinking, creativity, persistence, and self-reflection. Bender and Pepler (2019) describe that connected learning should focus on students' interests and connect their inquiry to their future professions. In class, students show more interest in the content when they explore the issues they care about. Connected learning is peer-supported, interest-powered, and academically oriented. Learning can occur at home, in class, and in the community. Drawing from the connected learning theory, Quigley and Herro (2019) argue that the two facets that underline STEAM as a problem-based curriculum are: 1) learning scenarios that engage students in problem-solving through student interest; and 2) creative problem-solving through video production, digital drawing, and use of collaborative visual tools.

Educational reform typically reflects the needs of a society. The introduction of STEM education comes as no exception; it reflects a surge in demand for STEM-related jobs globally. Arguably, STEM was created to boost the 21st century "4Cs" skills, namely, "creativity, collaboration, critical thinking, and communication" (Saraniero, n.d.). When the STEM concept was brought into schools, the investment in STEM was dramatically enhanced through "providing mobile devices for students," offering "after-school STEM clubs or programs," advocating BYOD (bring your own device) initiatives, organizing "STEM days," and developing "robotics programs" (What is STEAM?, n.d.).

STEAM builds on the foundation of STEM, further providing authentic, inquiry-based, and project-based learning experience to students. "A" represents both the arts and humanities. The purpose of adding "A" to STEM is straightforward, namely, providing a more engaging and authentic learning experience for students to learn STEM (Herro et al., 2017). STEAM education is contextual learning incorporating science, technology, engineering, arts, and mathematics while teaching concepts needed for 21st-century skills (e.g., creativity, innovation, communication, collaboration) via relevant curriculum, instruction, assessment, and enrichment (Gettings, 2016). Specifically, Dell'Erba (2019) defines STEAM education as an innovative, critical thinking, and creative problem-solving process, where students engage in experiential and inquiry-based learning to meet objectives across all subject areas.

Approaches to STEAM Education

STEAM education entails a creative process, where students identify an issue, collect and analyze data, brainstorm ideas, make products, and reflect on their products. Gettings (2016) recommends applying scientific inquiry, Project-Based Learning (PBL), and Studio Habits of Mind to develop an effective STEAM curriculum. All of these pedagogies direct students to plan, create, articulate, and reflect. Scientific inquiry aims at acquiring knowledge from evaluating evidence, analyzing data, constructing explanations, and communicating findings. All these steps help to assist students in learning and scientific inquiry (Donohue et al., 2020).

Project-Based Learning (PBL) is a student-centered, cooperative, and hands-on approach to learning from examining real-life issues. PBL focuses on exploring, analyzing, and creating tasks (Sivia et al., 2019). Applying the Studio Habits of Mind to art classes benefits all students by helping them to think like an artist. Hogan et al. (2018) argue that this thinking process allows elementary students to be more reflective, well-rounded art makers, as well as developing their positive thinking habits. The Studio Habits of Mind approach includes three questions: “Can students do this?” [skill], “Will the student invest the time and effort needed to do this well?” [inclination], “Are students aware of the right times to do this and why to do it?” [alertness] (Hogan et al., 2018, p. 8). Specifically, art teachers can foster eight habits of mind in art classes: develop craft, engage and persist, envision, express, observe, reflect, stretch and explore, and understand art worlds (Hogan et al., 2018).

Moreover, Miller (2017) points out that the STEAM curriculum and PBL share a similar track. Both help students develop 21st-century skills: collaboration, creativity, critical thinking, and problem-solving. Additionally, student voice and choice are the two key elements in the STEAM curriculum. For instance, students may bring challenges they want to solve to the classroom. The STEAM curriculum prepares students to be future scientists, mathematicians, engineers, artists, and technological entrepreneurs. A promising STEAM curriculum is PBL, encouraging students to take ownership of their learning and apply it to their lives.

Additionally, Liao (2016) argues that creative problem solving through art is essential to STEAM education as it encourages “students to see connections among their knowledge, skills, and abilities and to draw on these connections in advancing their own education...” (Liao, 2016, p. 46). STEAM provides students with an opportunity to inquire into contemporary visual art practices, which emphasizes dialogue, collaboration, and interdisciplinary connection. Curiosity about learning increases through thoughtful reflection on personal creative processes. Inviting students to write a visual journal is an approach to help students reflect on their creative processes. A focus group can further assist students to articulate their perspectives through interactive conversation (Guyotte et al., 2015).

Considering the student-centered pedagogy advocated by Dewey (1934) and Freire (2000), Gross and Gross (2016) recommend adopting Visual Culture Art Education (VCAE) and constructivist learning approaches to STEAM education. VCAE involves critically analyzing visual culture rather than merely appreciating the aesthetic aspect of visual culture. Constructivist learning focuses on learners actively constructing knowledge. Herro et al. (2017) prescribe a transdisciplinary STEAM curriculum, where team members including educational scientists, educational researchers, and psychometricians collaboratively create a

problem for their students to solve. The transdisciplinary lens employs problem-based learning, technology, and multiple ways to solve problems (Herro et al., 2018).

Design Thinking (DT) is another approach to STEAM education. DT furthers the current inquiry-based pedagogies by incorporating an empathy component, namely, creating for others, in the engineering design process, where engineers consider the needs and values of the products they are making. Among different kinds of design methodologies, Berk (2016) mentions that the DT method is widely adopted by STEAM educators, following a DT process of learning includes these activities: empathize, define, ideate, build, test, and iterate.

Issues-Based STEAM Education

STEAM education teaches students to tackle life issues on an interdisciplinary journey of exploration to solve authentic problems happening in their immediate communities (Guyotte et al., 2015). Emphasizing the ability to solve real-life issues, STEAM curriculum aims at fostering 21st century skills of problem-solving, collaboration, and creativity, and prepares students to succeed in their future careers. Chung (2007) argues that issues-based art education is aligned with social reconstructionism, visual culture art education, and critical pedagogy. Social reconstructionist art education guides students as activists to reconstruct society through the study of visual culture, multicultural art forms, and contemporary social issues. Chang et al. (2012) argue that an issues-based art classroom is not an isolated place; rather, it is a place of empowerment where students feel connected to what they have learned in school because they explore real-world issues.

Including an issues-based art pedagogy within STEAM education is the next step for art education to be relevant and have a critical impact on future generations as they strive for social justice and equitable living in a democratic society. Issues-based art education incorporates students' real-life experiences into their learning and addresses social issues to foster critical thinking abilities. It challenges the "art for art's sake" pedagogy that art is merely for aesthetic pleasure. Li (2018) argues that issues-based art education views learning as socially constructed and a process of meaning-making. Social issues in which students may be interested include: "Ecology and environment, school violence and bullying, sexual orientation, racism, sexism, feminism, self-image, capitalism, immigration and refugees, war, censorship, and lesbian, gay, bisexual, transgender (LGBT) issues" (Chang, 2012, p. 22). Issues-based art education emphasizes a critical thinking process, whereby students critically examine biased attitudes, beliefs, and values displayed in visual culture such as advertising and popular media programming (Chung, 2008).

Teachers should engage students in meaningful art practices, balancing art skills, and critical issues presented in contemporary visual culture. Issues-based instruction can guide teachers to

understand that art has a more profound meaning to motivate them to discuss relevant social issues (Halsey-Dutton, 2016) such as gender, popular culture and consumerism, environmental concerns, racism, violence, censorship, terrorism, and homosexuality (Chung, 2004). Creative risk-taking emphasizes risk as a challenge and a personalized plan for preservice teachers to confront it (Halsey-Dutton, 2016). Taking creative risks means stepping outside of a personal comfort zone, acknowledging the inherent anxiety experienced during the creative process. The instructor would help students safely explore during the process of taking creative risks.

Zwirn and Libresco (2010) discuss art education from a social justice perspective. The authors argue that such an approach helps students view historical events from an alternative perspective. They state that art can help students to relate past issues with those in their daily lives. In addition to conventional art imagery, television, film, and social media platforms can be useful resources since all are part of students' everyday visual culture. Issues-based art education has a strong connection with critical media literacy which focuses on assisting students in "understanding and disrupting media/corporate constructs that have a tremendous influence on what they consume and experience in their everyday world" (Chung & Kirby, 2009, p. 38). People use different forms of social media to address social issues such as tagging, mash-up, and simulated environments, to challenge the authenticity of the art object, the authorship of the artist, and the authority of the museum or art institution (Sweeny, 2009). In teaching art through social media, "we should view the teacher and student as not residing in any one individual, but as participants in a dynamic and collective system of meaning" (Castro, 2012, p. 165).

Issues-based STEAM education integrates social justice issues with STEAM classes. It is theoretically sound to incorporate issues-based approaches to STEAM education, given that both center on project-based inquiry. Issues-based STEAM education offers authentic learning experiences as it empowers students to voice issues of disenfranchisement or under representation, including people living in poverty, people with disabilities, and people of color. By asking students to solve real-life issues and allowing art educators to address social justice issues, issue-based learning strengthens the foundations of STEAM education which are exploration of STEAM subjects and developing 21st-century skills. For clarity of this article, Figure 1 shows the relationship between 21st century 4Cs skills, STEM, STEAM, Issues-based STEAM, and different approaches discussed in this article (see Figure 1).

More and more contemporary artists are illuminating current social and political issues. Gaudelius and Speirs (2002) maintain traditional art pedagogies like child-centered art education and discipline-based art education (DBAE) are inadequate for discussing urgent social issues that students encounter every day. To better assist students in understanding

contemporary arts and developing life skills, art teachers need to re-conceptualize art pedagogies from postmodern theories, critical pedagogy, social reconstruction, feminism, and visual culture art education. The pillar of issues-based art education is to foster students' critical thinking abilities through exploring difficult societal issues. Similarly, STEAM education teaches different areas such as design, computer graphics, performing arts, visual arts, and creative problem-solving (Quigley et al., 2017). According to McGregor (2019), the STEAM learning process is engaging, creative, and innovative, and it enables students to understand the implication of their work on humanity.

Gaudelius and Speirs (2002) argue that schools ought to provide students with a safe place to investigate different social issues. Using contemporary art as an inspiration for art education can fully engage students in a discourse of culture, race, gender, class, ethnicity, ability, religion, sexual orientation, age, and community. In an issue-based art curriculum, Chung and Li (2020) guide elementary school students to explore homelessness issues through examining a series of murals by contemporary artist, Skid Robot. Teaching art elements and design principles alone would potentially overlook the meaning of Robot's art. Chung and Li's curriculum emphasizes the significance of social context in creating and understanding socially engaged art. Buffington (2019) argues that one of the goals in education is to help students understand their world as they participate in a democratic society. Art teachers need to address social issues to involve students in understanding and changing their world through art. Schlemmer et al. (2017) insist that socially engaged art activities can guide students to understand the function of art that often goes beyond merely aesthetic appreciation. Socially engaged art education balances dialogue and art creation, decenters the relationship between students and teachers, and encourages diverse solutions for constructing a livable world. Facing various social issues happening in our society, art educators have a responsibility to bring these pressing social issues into art classes to engage students in critical discussion and creative activities so that they are aware of these issues as they construct a democratic and equitable society.

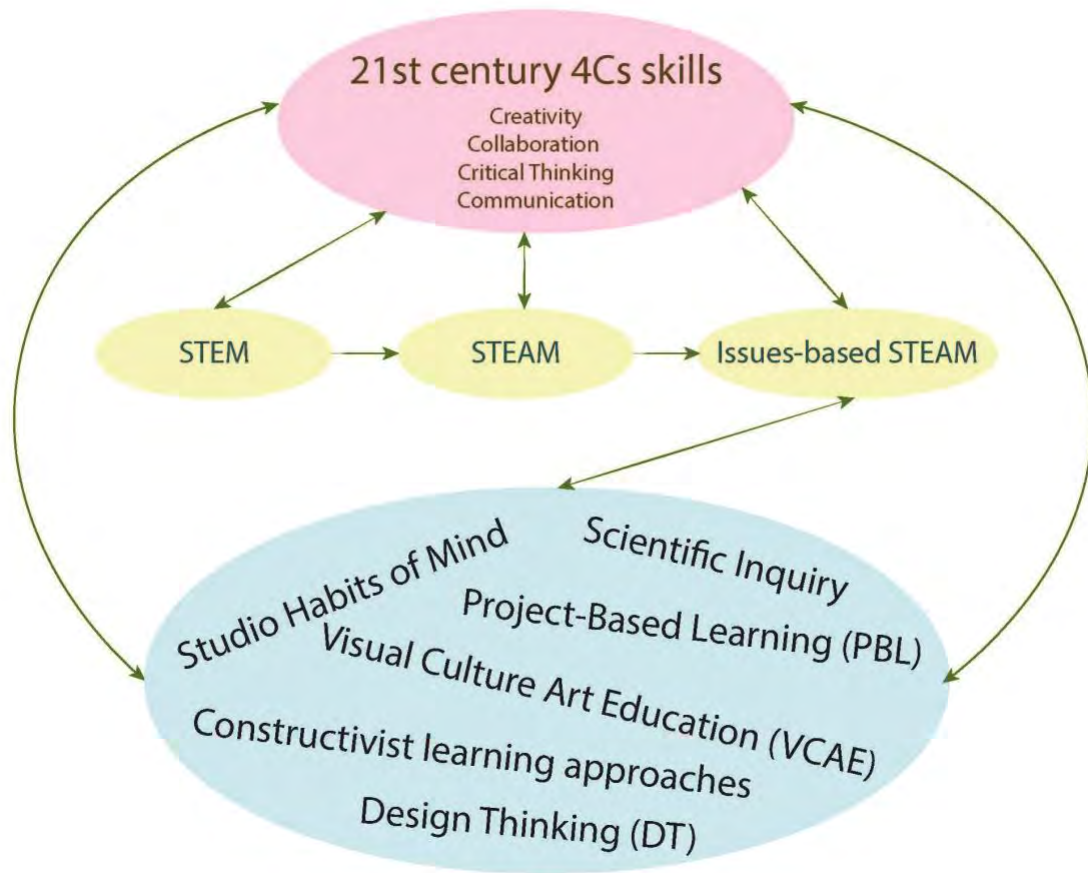


Figure 1. The relationship between 21st century 4Cs skills, STEM, STEAM, Issues-based STEAM, and different approaches discussed in this article.

Issues-Based STEAM High School Lesson

An experienced secondary school art teacher in Hong Kong, Mr. Tsui, collaborating with a group of teaching artists from the Wheel Thing Makers, has implemented STEAM curricula in recent years. Inspired by automatons, he designed an issues-based STEAM lesson incorporating engineering and visual arts to discuss various social issues from students' real-life experiences. An automaton generally refers to "a moving, mechanical device, usually constructed to look like a human or animal figure. Automatons are built to give the illusion of acting as if by their own power, despite comprising only of mechanical systems" (The MAD Museum, n.d., para. 1). People call moving pieces of art sculpture automata. Automata follow a predesigned set of instructions to create movements to imitate humans or animals (Jordan & Cai, 2019). In this issues-based STEAM lesson, students learned about and applied the moving principles of automation to make artwork to express their concerns about social

issues. The students used materials such as wood, cardboard, bamboo skewers, chipboard circles, glue guns, scissors, gears, pulleys, hammers, and nails.

In this issues-based STEAM lesson, Tsui's students learned about math (measurement, estimation, and proportion), engineering (cams, levers, and linkages), and art (moving sculpture). In math, students learned to cut and measure materials according to the sketch of each design. Students estimated how much and what kinds of recycled materials would be needed for the whole project. They also considered different proportions of the items to achieve visual appeal.

Regarding engineering, students applied mechanical elements such as cams, followers, levers, linkages, and other mechanisms. They learned each of these terms as Tsui showed students several automata and explained how artists apply mechanical engineering to make the object moveable. According to KidSpark Education (n.d.), a cam is "a rotating or sliding part in a mechanical linkage used to transform rotary motion into linear/reciprocating motion" (p. 3). The follower is "a rod or beam that rests on the edge of the cam. As the cam rotates, the follower can move up and down" (p. 29). Linkage means, "an assembly of bodies connected to manage forces and movement" (p. 3). Lever refers to "a lever arm (link) and a fulcrum (joint). Levers can be used to change the direction of motion or to create a mechanical advantage to make work easier" (p. 7).

In this lesson, Tsui collaborated with the Wheel Thing Makers, a creative group using recycled materials to create art. Recently, the group created art out of recycled mechanical parts from bikes, carts, and other items and displayed their artwork in the To Kwa Wan community and the Cattle Depot Artist Village in Hong Kong (Chan, 2017). Tsui directed his students to investigate social issues in their immediate communities and create moving assemblages (automation) to echo their concerns and through which they could engage the audience in a critical conversation. Students used art supplies and recycled materials available at school (e.g., wooden boards, paper clay, magazines, clothes, and gears) to make their objects move. Students selected materials appropriate to address social issues.

The overall feedback from the school was positive. Tsui displayed the products of this lesson in his school hallway. Other students from his school were curious as they played with the displayed assemblages that engaged viewers in reflecting on social issues. Additionally, these moving sculptures served to break gender stereotypes about craftsmanship. Students who viewed the works were generally surprised that girls could make complicated moving objects by hand (Tsui, personal communication, 2018). This statement is in line with a study showing that girls and women face gender biases in their pursuit of STEM careers (Robnett, 2016). This gender gap may come from two factors including formal discrimination and

interpersonal discrimination. Formal discrimination is often more easily discernible and is related to unfair treatment in hiring and promotion practices and to unequal access to available resources. However, interpersonal discrimination usually is more subtle and connected to negative interpersonal encounters. Hand et al. (2017) report that the number of women in the United States who seek STEM careers is less than the number of their male counterparts. The lack of women pursuing STEM careers has gained international attention. One possible explanation for this disparity is gender bias, namely prejudice against girls' and women's ability to succeed in STEM fields.

What follows are several student art examples. One student was concerned with poverty among the elderly in Hong Kong (see Figure 2). His piece depicts an elderly woman pushing a trolley loaded with discarded cardboard sheets that she might have collected from the streets or outside of stores. The stack of cardboard appears to be heavy, as shown by the dramatization of the woman bending over to push the trolley. This piece is very straightforward and concerned with the needs of the elderly (Tsui, personal communication, 2018).

In Hong Kong, it is quite common for the elderly living in poverty to collect and sell cardboard sheets and unwanted newspapers to recycling plants at a meager price to purchase their daily meals. The background of this piece features a wooden turntable covered with collaged newsprint images, signifying where the elderly woman may have collected these recycled materials. The moving sculpture raises awareness of the issues of aging and poverty and viewers may reflect on the reality that, despite their age or infirmness, the poor and elderly still need to work hard to make a living. One reason that elderly people may continue working is a personal drive to feel purposeful (Keegan, 2018). Therefore, a meaningful discussion of social security for the elderly should move beyond their benefits and pension to include how re-employment, spiritual satisfaction, and fulfillment are important for the elderly to live well.



Figure 2. *Cardboard Woman*. Artwork made by a high schooler. Photo of Artwork credits Mr. Kwok Kin Tsui.

Living in a competitive educational system, thousands of Hong Kong students are under enormous pressure regarding academic achievement. They generally spend long hours at school and complete a large amount of homework. Academic pressure comes from overwhelming homework, preparing for exams, and unsatisfactory academic performance/high expectations of academic result from parents (Chiu, 2018). Situating himself in a room, another student addresses his academic pressure by representing himself as a moveable figure living a hectic daily life – doing homework and preparing for standardized tests (see Figure 3). Stacks of books and reading materials are scattered all over the floor to illustrate his chaotic life, further accentuated by the three drops of sweat and the sour expression on his face. The movement of his arms indicates the acts of studying and writing. A movable calendar in the background indicates his daily study routine from Monday to Sunday without rest. Different emojis used in the background signals his varied feelings and emotions about undertaking a massive amount of homework. The crying emoji further represents his emotional state.



Figure 3. Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday. Artwork made by a high schooler. Photo of Artwork credits Mr. Kwok Kin Tsui.

Many Chinese parents are aware of the importance of early childhood education. Therefore, a “tiger mum” is a popular term used in Chinese communities—the image of a Chinese “tiger mum” surfaces when parents pressure their children to excel academically. Many parents encourage their children to take at least two after-school core-subject tutorial classes and music classes (Blundy, 2017). Tsui also points out that Hong Kong students have a busy schedule attending extracurricular art/music activities in addition to facing routine academic pressure, as illustrated in the previous student’s assemblage (Tsui, personal communication, 2018).

In Figure 4, the exam papers on the floor highlight the artist’s burden of preparing for exams. Different musical instruments placed on a big movable clock in the background illustrate the numerous extracurricular activities his mother has arranged for him to pursue. The student’s daily routine consists of different extracurricular activities that account for almost every hour of the day. He is depicted crying over the pressure of the exams and music classes. His mother stands behind him dramatically shouting at him to force him to work even harder to succeed within a highly competitive educational system.



Figure 4. *Monster Parents*. Artwork made by a high schooler. Photo of Artwork credits Mr. Kwok Kin Tsui.

The issue of climate change or global warming is a popular topic explored by high school students. Sea ice is a natural habitat for polar bears who use it as a platform to find food (i.e., hunting seals). Loss in sea ice is one of the biggest threats to the polar bear population (Pidcock, 2015). According to Tsui, one of his students is interested in environmental issues. In one example from her art portfolio, this high school student is concerned with prioritization of corporate greed over the devastated environment. In this work an industrial factory irresponsibly dumps wastewater to cause river pollution (see Figure 5). In the background of this work is a large board with an image of the globe. Random trash placed on the globe indicates how people throw away trash carelessly disregarding its damaging impact on the environment. The blue and green of the assemblage illustrate two contrasting scenarios. The blue represents the sea, with a polar bear standing on a piece of thin ice while holding a sign written “Stop Global Warming,” imploring people to stop environmental exploitation. The green represents the land, with a businessperson with a “dollar sign” for a head standing in the background of an urban city to illustrate the idea of urbanization. One resulting outcome of global warming is the threat of polar bear extinction. The giant polar bear on a tiny piece of ice accompanied by a whale connects the issues of global warming and the natural habitat of

polar bears and other sea creatures. Corporate greed and pollution of urban areas contribute to global warming.



Figure 5. Polar Bear's Protest. Artwork made by a high schooler. Photo of Artwork credits Mr. Kwok Kin Tsui.

Another student is concerned with the issue of food safety, such as raising livestock with antibiotics (see Figure 6). According to Cheung (2017), "Some of Hong Kong's poultry farmers have admitted feeding antibiotics to chickens even when they are healthy, prompting fears about resistant superbugs among livestock and raising calls for more stringent use of drugs in the trade" (para 1). The upper left side of Figure 6 features the abuse of antibiotics in farming animals. The student uses a satire in this moving assemblage. That is, people inject antibiotics into livestock, which eventually cycles back to humans as they consume livestock. The same satire also applies to the relationship between chickens and humans. The student uses art to illustrate the role reversal between humans and chickens by placing human babies in a cage as if they were being raised in the cage.

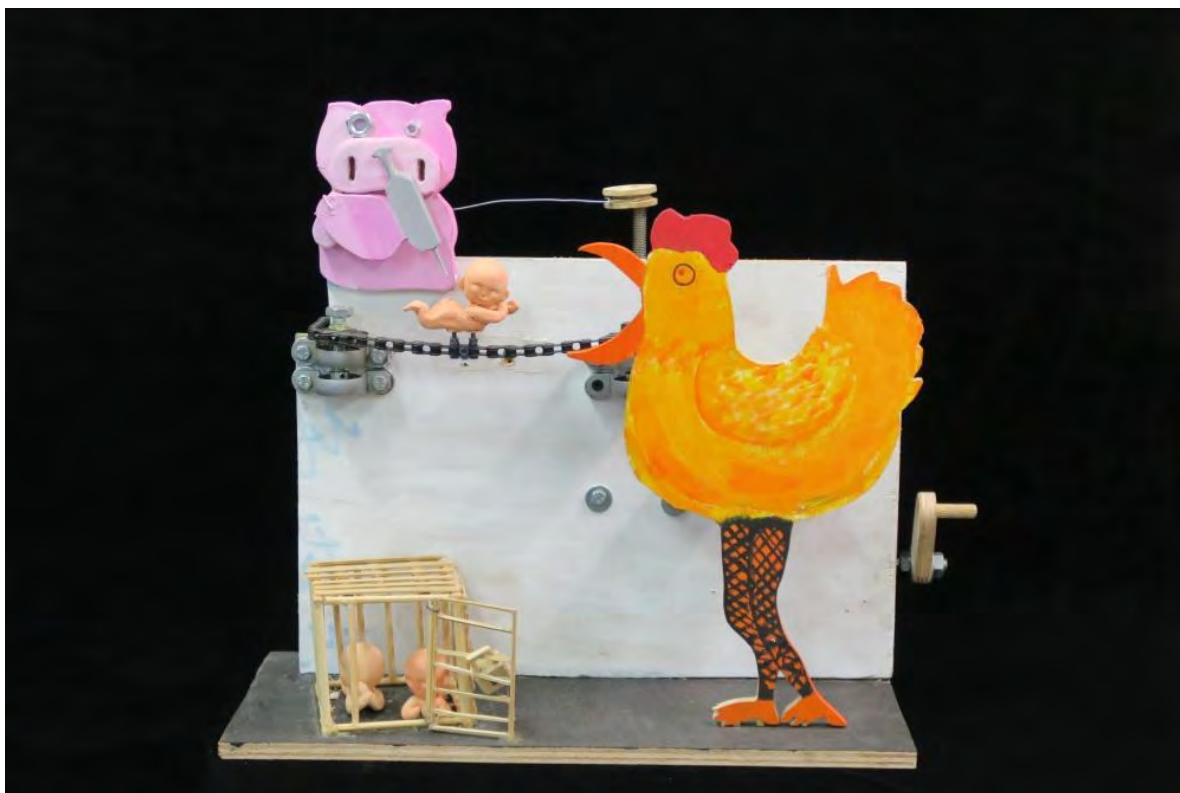


Figure 6. Food Safety. Artwork made by a high schooler. Photo of Artwork credits Mr. Kwok Kin Tsui.

Recommendations

Globally, today's youth are facing many social issues in their daily lives, such as racism, sexism, food safety, and environmental concerns. They need critical knowledge and skills to help them face these social challenges. Like any other school subject, art education has a social responsibility to guide students to examine various social issues in order to adequately prepare them for 21st-century life (Desai, 2020; Hochtritt et. al, 2018; Kalin, 2018). Science, Technology, Engineering, and Mathematics education (STEM) encapsulates an interdisciplinary approach to learning by integrating these four individual disciplines in a meaningful way. STEM education is a project or problem-based approach to solving practical problems in a real-world context (Holmlund et al., 2018). LaForce et al. (2016) identify eight elements in STEM programming including four instructional elements (Personalized learning; problem-based learning, rigorous learning, and career, technology, and life skills), two non-instructional elements (school community and belonging; external community), and two supporting elements (staff foundation; essential factors).

Issues-based STEAM education strengthens the core competency of STEAM education through its emphasis on inquiry-based and authentic learning. It builds on issues-based art education and project-based learning, a process that encourages students to solve social issues creatively and critically through STEAM projects. As shown in this article, an issues-based STEAM lesson integrating engineering and art explores social issues happening in students' immediate surroundings. Watson (2016) reminds art teachers that STEAM is not a subject; instead, it is a curricular approach. Watson (2016) encourages art teachers to serve as a creative chair in the STEAM instructional team.

This case study provides teachers with suggestions regarding the implementation of issues-based STEAM education. First, teachers should provide students with an opportunity to choose social issues in which they are interested. As in this issues-based STEAM lesson, Tsui's students chose issues that they encountered in their daily lives including such issues as the elderly living in poverty, global warming, and antibiotics used in livestock. Providing students with the autonomy to study these issues increases their motivation for learning in issues-based STEAM education, which is in alignment with project-based learning pedagogies that emphasize life issues in the curriculum.

Furthermore, permitting students to create by trial and error is important in issues-based STEAM education since this approach centers on project-based learning. In Tsui's class, he guides students to experiment with mechanical elements to make the sculptures movable. His students are encouraged to adjust or change any parts of their sculptures to reach desirable outcomes. Project-based learning like issues-based STEAM education emphasizes learning by trial and error. Learning from mistakes is a necessary step for students to experiment together on a learning journey of the issues-based STEAM curriculum.

Finally, seeking support from local non-profit organizations or foundations can enrich students' hands-on experience. In this case study, Tsui has collaborated with a group of teaching artists to design his issues-based STEAM lesson, which integrated engineering and art. Through hands-on experience, the teaching artists helped all participants learn about specialized techniques. Collaboration is essential to the successful implementation of issues-based STEAM education because STEAM requires integration of multiple disciplines. Art teachers should collaborate with STEM subject teachers or local teaching artists in designing and implementing an issues-based STEAM curriculum.

Conclusion

This article reviews STEM and STEAM education and offers a rationale for issues-based STEAM citing a relevant example carried out in a high school setting. All of these are valuable resources for art teachers interested in implementing STEAM education. Issues-

based STEAM education builds on the foundation of issues-based art education and STEAM education. As described in the literature review, STEAM education has a strong connection to the project-based approach, design thinking, interdisciplinary curriculum, and studio habits of mind. Graham (2020) argues that STEAM education and design thinking both advocate for designing innovative products, technologies, recruitment of scientists, and cognitive enhancement. Both feature interdisciplinary collaboration and problem-solving to foster students' 21st-century skills and entrepreneurial literacy. Dell'Erba (2019) points out that the purpose of STEAM education is to build the habits of mind for life and work in the 21st-century. High quality STEAM education should focus on cognition, emphasizing learning through new experiences and perspectives. Issues-based STEAM instruction should be grounded in clear learning standards, authentic issues, and integrating subjects seamlessly.

In issues-based STEAM education, art plays a vital role in explaining the complex concepts of Science, Technology, Engineering, and Math in an innovative way that helps solve problems encountered by the students in their everyday lives. It strengthens holistic inquiry and project-based learning for students to address real-life issues using different creative approaches. Issues-based STEAM education encourages art teachers to teach social justice issues in their art rooms, helping students to explore pressing equity issues for constructing a livable society.

Authors' note:

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