TEACHERS WITHOUT BORDERS

DESIGN THINKING

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Introduction

Transforming Learning: From STEM to STEAM with Design Thinking

In today's rapidly evolving educational landscape, educators are continually exploring and seeking out innovative culturally responsive approaches and strategies that engage and empower students in their own learning journey. We propose looking to art.[1] and design via STEAM (science, technology, engineering, ART and math) as a way of foregrounding the needs of learners today.[2]

Why add the "A" in STEM?

- Artists and designers are "researchers who investigate topics, develop theories, conduct experiments, and convey 'findings' in the context of art"[3]. Students can explore artists and designers from a range of cultural contexts as well as practices including, for example, computer programmers, game designers, set designers, story-quilters, pod casters, sound artists, data-visualizers, architects and so many more[4].

- Integrating art and design into STEM can spark the creative interplay between convergent and divergent thinking. Convergent thinking, often associated with STEM teaching and learning, is related to "solving well defined, rational problems that have one correct answer"[5]. Divergent thinking, most commonly found in art and design classrooms "leads to no agreed upon solution" (ibid), often associated with creativity. Both are valued in a STEAM approach to teaching and learning.

- The arts have the ability to "provoke thinking, provide multiple experiences and responses" and foster heightened awareness of the world around us, in turn, facilitating and supporting student engagement in a STEAM oriented classroom[6].

1. Arts and culture works across a multitude of expressive tools and forms, inside and outside of traditional arts. This can range from traditional visual and performing arts to oral history, digital media, crafts and other less formal elements of community building and activism that incorporate arts.
2. https://makered.org/
3. Marshall, J. (2021). Contemporary Art. In Eds. Marshall, J., Stewart, C., & Thulson, A. Teaching contemporary art with young people: Themes in art for K-12 classrooms. *Teachers College Press*, p. 10.
4. Ilfeld, E. J. (2012). *Beyond contemporary art*. Vivays.
5. Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention*. HarperCollins, p. 60.
6. Marshall, J. (2021). Contemporary Art. In Eds. Marshall, J., Stewart, C., & Thulson, A. Teaching contemporary art with young people: Themes in art for K-12 classrooms. *Teachers College Press*, p.11.

STEAM teaching and learning in the classroom can encourage your students to "become more aware of the design of the world around them and begin to see themselves as people who can tinker, hack and improve that design"[7]. Emphasis is placed on the creative process involved in tinkering and experimenting with ideas, i.e. inventing to learn rather than learning to invent[8]. Design thinking, a complimentary framework, mindset and set of tools that supports STEAM teaching and learning is one approach to consider for your classroom.

Design Thinking

Design thinking is a human-centered problem-solving methodology that encourages creative thinking, collaboration, and empathy. By embracing design thinking, you can unlock a world of possibilities within your classroom walls, transforming your students into active participants, critical thinkers, and innovators.

By integrating design thinking principles into your classroom practice, you can not only elevate your STEM teaching but also make a seamless transition to a STEAM approach, enriching your students' educational experiences.

So, how can design thinking support you in your classroom practice?

- Fostering creativity: Design thinking nurtures students' innate creativity by encouraging them to explore diverse ideas, take risks, and think outside the box. It provides a framework for students to embrace their imagination and develop innovative solutions to real-world problems.

- Cultivating empathy: Design thinking prompts students to empathize with the needs and perspectives of others, instilling in them a sense of social responsibility. This empathy-driven approach helps students develop a deeper understanding of the impact their solutions can have on individuals and communities.

7. https://makered.org/
8. Martinez, S. L., Stager, G. S. (2019). *Invent to Learn: Making, Tinkering, and Engineering in the Classroom*. Constructing Modern Knowledge Press.

- Promoting collaboration: Design thinking places a strong emphasis on collaboration, encouraging students to work in interdisciplinary teams. Through collaborative projects, students learn to value diverse perspectives, harness collective intelligence, and appreciate the power of teamwork.

- Enhancing critical thinking: Design thinking equips students with essential critical thinking skills as they navigate through complex problems. It encourages them to analyze, evaluate, and iterate their ideas, fostering a mindset of continuous improvement and resilience.

Now, let's explore how design thinking can assist you in moving from a STEM to a STEAM approach, integrating the arts seamlessly:

- Incorporating creativity: The arts, with their emphasis on creativity (fluency, flexibility, originality and elaboration[9]), provides a natural synergy with processes involved in design thinking. Encourage students to apply design thinking principles when engaged in creating.

- Design challenges: Introduce design challenges that require students to merge their STEM knowledge with artistic and aesthetic elements. Art's aesthetic value to "entertain, dazzle, or please" also has the power "to grab, provoke, and immerse" participants[10]. Ask students to imagine and design a specific visually engaging sustainable structure that is not only functional but also connected to community needs or task them with creating a data visualization to communicate a current local challenge to local leaders. By incorporating the arts into your STEM lessons, you can tap into students' personal expression, empathy, and meaning-making in the learning process, encouraging them to think holistically.

- Cross-disciplinary projects: Collaborate with arts educators to design cross-disciplinary projects that combine STEM and arts concepts. Engage students in creating interactive installations, designing wearable technology, or developing multimedia representations of scientific phenomena they identify in the world around them.

9. Starko, A. J. (2013). Creativity in the Classroom: Schools of Curious Delight. Routledge.
10. Parsons, M., & Blocker, H. (1993). Aesthetics and education. University of Illinois. Marshall, J. (2021); Contemporary Art. In Eds. Marshall, J., Stewart, C., & Thulson, A. Teaching contemporary art with young people: Themes in art for K-12 classrooms. Teachers College Press, p.11.

By embracing design thinking and transitioning from STEM to STEAM, you will unlock a wealth of opportunities for your students, promoting holistic learning experiences that integrate science, technology, engineering, arts, and mathematics. Remember, you don't have to be an expert in all STEAM disciplines. Instead, foster a culture of curiosity, exploration, and collaboration, empowering your students to become active learners and innovators. In conclusion, design thinking provides a powerful framework for supporting your classroom practice and transitioning to a STEAM approach. By infusing creativity, empathy, collaboration, and critical thinking into your teaching, you can nurture students' innate potential and equip them with the skills they need to thrive in the 21st-century world.

Design Thinking in Action

With any curriculum design and classroom practice, connecting to community and cultural relevance is essential. Projects can be designed to address real world challenges that are experienced at the local level. One secondary school in Sri Lanka, working with ArtsAction Group, used design thinking to prototype ocean crafts to pick up pollution in response to ongoing trash and medical dumps on their local beach. Students learned about scientific sampling, mind-mapping, classification systems and the design thinking process before moving into constructing the ocean crafts using basic materials such as craft sticks, cardboard, tape and objects found during the trash clean up.

Contemporary artists and designers whose work is in response to climate change and ocean and beach pollution were also shared with the students. Final reflections included diagrammatic drawings of the inventions, written details regarding how the craft worked and a final micro museum designed to share the different elements of the experience with the broader school community.

Photo credit: ArtsAction Group Sri Lanka: 2019 | A Wicked Problem: Rising Tide of Pollution at Ilavalai Beach

Scaling Design Thinking

In an ever-changing world, the Maker Movement and Design Thinking are proving that they're not confined to the classroom. At the height of the COVID pandemic, when youth the world over were often homebound, inspirational young minds from Burundi, Malawi, Nigeria, and Tanzania used these methodologies to design innovative solutions that supported their communities to combat the challenges posed by COVID-19.

The Maker Movement, with its emphasis on hands-on creativity and problem-solving, is perfectly aligned with the needs of these communities. Young people in Africa, where those under 35 make up a significant portion of the population, have been facing a multitude of challenges due to the pandemic. From job insecurity to disrupted education and even basic necessities like clean water, they've been forced to think outside the box.

These enterprising young minds entered the COVID-19 Design Innovation Challenge for UNICEF, facilitated through Cartedo, a platform that encourages and supports experiential learning. They didn't just limit their thinking to classroom settings; they ventured out into their communities

Photo credit: UNICEF Burundi/2020/Barikumutima

when possible, embracing the principles of Design Thinking. Design Thinking's core mindsets—empathize, define, ideate, prototype, and test—became their roadmap for action. They immersed themselves in understanding the real needs of their communities, defined the problems, brainstormed creative solutions, and built prototypes. The final step, testing, was crucial as it allowed them to refine and improve their ideas based on real feedback.

The impact has been profound. From Nigeria's pilot challenge, a wave of youth participants joined the movement. The top solutions ranged from using solar panels to ensure sustainable water supply, creating digital applications for continued learning, to establishing online marketplaces for income generation during the pandemic. These ideas not only address immediate issues but also hold promise for a more resilient future.

It's a testament to the power of these movements: the Maker Movement encourages innovation and hands-on learning, while Design Thinking promotes user-centric problem-solving. What's remarkable is that these approaches are not limited to affluent or classroom environments. They've flourished in the heart of communities that face some of the toughest challenges.

Photo credit: UNICEF Burundi/2020/Barikumutima

These young innovators have not only provided immediate solutions but have also gained valuable skills and expertise that can enhance their future employability. This is crucial in a world where the pandemic has created barriers to job opportunities. Design Thinking and the Maker Movement are not just trends; they're transformative tools for empowerment and change.

Collaboration has been at the heart of these initiatives. Governments, private sectors, schools, churches, and youth organizations have come together to support these innovative endeavors. This isn't just a story of young people in the Global South; it's a testament to the global power of innovation and collaboration. These methodologies transcend borders and limitations, showcasing the incredible potential of the Maker Movement and Design Thinking when harnessed by creative minds to tackle real-world challenges. In the face of adversity, these young change-makers have proven that innovation knows no bounds.

Embrace design thinking, embark on a journey of innovation, and watch as your students become architects of their own learning. This approach to teaching and learning assists our young people with envisioning different realities in service to self, communities and the world.

Resources

Articles, websites, and resources that can help teachers explore the integration of design thinking into STEAM education:

A Systematic Literature Review of Design Thinking Application in STEM Integration
https://www.scirp.org/journal/paperinformation.aspx?paperid=110506
Investigate the integration of design thinking into STEM education to improve creativity and problem-solving skills among students, highlighting suitable teaching approaches like problem-focused teaching, design learning, and teamwork learning, offering valuable insights for educators and suggesting future research to assess the effectiveness of problem-focused teaching in STEM integration.

Design Thinking in STEM education: A review
https://www.sciedupress.com/journal/index.php/irhe/article/download/17460/10821
Explore the pivotal role of design thinking in fostering creativity, innovation, problem-solving, and critical thinking skills in STEM education, emphasizing its relevance across various disciplines and presenting key findings from existing research studies.

Stanford d.school's An Introduction to Design Thinking
https://dschool.stanford.edu/resources
A collection of resources from d.school classes and workshops to explore. Use these activities, tools, and how-tos as a starting point

Edutopia's Design Thinking: Lessons for the Classroom
https://www.edutopia.org/blog/design-thinking-betty-ray
This article includes six design thinking steps.

The Design Thinking Toolkit for Educators by IDEO https://page.ideo.com/design-thinking-edu-toolkit
A toolkit outlining the design thinking process overview, methods, and instructions that help you put design thinking into action

Design Thinking In Steam Education: A legacy from the Islands Diversity for Science Education Project https://idiverse.eu/wp-content/uploads/2021/02/IDiverSE_book-lowres.pdf
Practical support, guidance, and inspiration for teachers, who will have at their disposal several tools and complementary teaching methodologies in order to implement existing IDiverSE activities or design their own.

STEAM Education Using Design Thinking Process Through Virtual Communities of Practice https://files.eric.ed.gov/fulltext/EJ1304276.pdf
Study findings highlighting the appropriateness and effectiveness of STEAM-DT-VCoPs (Design Thinking Process through Virtual Communities of Practice) for education institutions, based on expert assessments, and aligns with principles such as empathizing with users, defining problems, ideating, prototyping, and testing for innovation in various disciplines.

Using Design Thinking to Create a New Education Paradigm for Elementary Level Children for Higher Student Engagement and Success
https://files.eric.ed.gov/fulltext/EJ1137735.pdf
Proposing a new design-based education paradigm that harnesses the skills developed through design education, including critical thinking and empathy, to enhance 21st-century skills and student success, particularly through early exposure to design education at primary school levels.

STEM + Arts = STEAM https://scholarship.claremont.edu/steam/vol1/iss1/34/
Science, Technology, Engineering and Math – the STEM subjects – alone will not lead to the kind of breathtaking innovation the 21st century demands. Innovation happens when convergent thinkers, who march straight ahead towards their goal, combine forces with divergent thinkers – those who professionally wander, who are comfortable being uncomfortable, and who look for what is real.

Introduction to Design Thinking, Stanford d.school
A process guide to Design Thinking.
https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf

Design Thinking in Education: A Critical Review of Literature
https://www.academia.edu/36441694/Design_Thinking_in_Education_A_Critical_Review_of_Literature A systematic, comprehensive and analytical strategy in mapping out and offering a critical review and analysis of over 68 journal articles, books and reports on design thinking in education.

Design Thinking for Educators 2nd Edition
https://www.academia.edu/7856850/Design_Thinking_for_Educators_2nd_Edition Using Design to Reimagine a second grade classroom through the lens of the students.

Design Thinking Bootleg by the Hasso Plattner Institute of Design at Stanford
https://dschool.stanford.edu/resources/design-thinking-bootleg

Design Thinking and the Maker Movement
https://www.easchooltours.com/blog/the-maker-movement-and-design-thinking

Maker Ed Education Resources: https://makered.org/resources/
Playbooks, toolkits and guides from Maker Ed to guide incorporating maker approaches into your classroom

The Benefits of Design- and Maker-thinking, Harvard Graduate School of Education: https://www.gse.harvard.edu/ideas/news/13/12/benefits-design-and-maker-thinking

Designing (and) Making Teachers: Using Design to Investigate the Impact of Maker-Based Education Training on Pre-service STEM Teachers
https://par.nsf.gov/servlets/purl/10214810

The Maker Movement in Education
https://www.researchgate.net/publication/277928106_The_Maker_Movement_in_Education

Design Futures, State-of-the-Art report on Design Thinking and Maker Education https://designfutures.eu/wp-content/uploads/2021/07/State_of_the_Art-1.pdf This report captures and analyzes existing formal, informal, non-formal practices, which include a Design Thinking and/or a Maker Education approach within educational activities.

The Launch Cycle: A K12 Design Thinking Approach https://spencerauthor.com/the-launch-cycle/

Design Thinking, A Creative Approach to Problem Solving
https://www.researchgate.net/publication/335525885_Design_Thinking_A_Creative_Approach_to_Problem_Solving

Young Children's Design Thinking Skills in Makerspaces
https://www.sciencedirect.com/science/article/abs/pii/S2212868920300362

Comparison of Student Learning in Two Maker Spaces
https://peer.asee.org/comparison-of-student-learning-in-two-makerspace-communities.pdf

Impacts of Makerspaces and Design Thinking on Creativity in Third-Grade Students https://sophia.stkate.edu/cgi/viewcontent.cgi?article=1492&context=maed

Creativity Through "maker" Experiences and Design Thinking in the Education of Librarians http://d-scholarship.pitt.edu/21962/3/Creativity-Through-maker-Experiences-and-Design-Thinking-in-the-Education-of-Librarians-Bowler-14.pdf

Using Design Thinking to Support Maker Spaces https://home.edweb.net/using-design-thinking-to-support-makerspaces/

Makerspaces Promoting Students' Design Thinking and Collective Knowledge Creation https://eudl.eu/pdf/10.1007/978-3-030-06134-0_38

Makey Makey's Design Thinking for Educators: A Toolkit for Integrating Design Thinking into Your School's Culture https://makeymakey.com/pages/design-thinking-for-educators-toolkit

Maker-Centered Learning: Empowering Young People to Shape Their Worlds https://pz.harvard.edu/resources/maker-centered-learning-empowering-young-people-to-shape-their-worlds

Organizations offering opportunities for youth to showcase their ideas/innovations
https://iii.org.za/
https://www.ifia.com/
https://tll.gse.harvard.edu/design-thinking
https://innovationworld.org/gift-home/

Examples online
https://www.unicef.org/esa/press-releases/african-youth-offer-solutions-covid-19-challenges-their-communities

Sri Lanka Project
https://www.artsaction.org/sri-lanka.html

About the Authors

Cindy Maguire, PhD, is a professor in the Department of Communications at Adelphi University on Long Island, New York, USA. She teaches art and design education, digital media and the role of arts in personal and social transformation. Her research interests also include social justice education, STEAM, and the role of arts and culture in global development. Maguire is Co-Director of ArtsAction Group, a community-based collective of arts educators, art therapists, artist teachers, and educators committed to facilitating arts and education initiatives with young people in conflict-affected environments. She is also co-editor of Arts, Culture and Development, a peer-reviewed, annually published, open access journal out of Pennsylvania State University, State College, PA, USA.

Dr. Rael Futerman is the co-founder and chief learning officer at Cartedo, an experiential learning platform aimed at closing knowing-doing gaps in education. In his role at Cartedo he works at the intersection between learning theory, technology enablement and innovation.

He is also a partner at StoryThinking Academy, an organisation focussed on developing narrative mindsets to improve social problem-solving capacity.
With experience in Strategic Design Thinking, entrepreneurship and innovation, Rael continues to create educational and capacitation programmes in these, and associated fields.

Prior to launching Cartedo, Rael held positions as founding Programme Manager at the University of Cape Town's d-school and Programme Leader of Design at Cape Town Peninsula University of Technology.

About Teachers Without Borders

Teachers Without Borders (TWB) is a global network of volunteers that connects teacher leaders to information and each other in order to bring about social change and close the education divide — on a global scale.

All Teachers Without Borders resources and programs have been conceived and led by local teacher leaders who make it their passion to connect education with health, economic development, livelihoods, and overall well being.

Learn more about TWB at http://TWB.org and on social media:
Twitter, Facebook, Linked In.