AFRICAN MASKS WHITE PAPER

CEISMC EVALUATION

GoSTEAM

AUTHORS

Katie Boice King, Research Associate II, CEISMC
Ed Gnatiuk, STEAM Innovation Facilitator, CEISMC
Jayma Koval, Senior Research Associate, CEISMC
Sabrina Grossman, Program Director, CEISMC

RESEARCH & DEVELOPMENT TEAM

Meltem Alemdar, Associate Director for Educational Research & Evaluation, CEISMC
Katie Boice King, Research Associate II, CEISMC
Talia Capozzoli Kessler, Research Associate I, CEISMC
Jasmine Choi, Research Scientist II, CEISMC
Sabrina Grossman, Program Director, CEISMC
Ed Gnatiuk, STEAM Innovation Facilitator, CEISMC
Justina Jackson, Research Scientist II, CEISMC
Jayma Koval, Senior Research Associate, CEISMC

SPECIAL THANKS

The lesson described in this paper was developed as part of the GoSTEAM@Tech Program, a collaborative partnership between Georgia Tech's Center for Education Integrating Science, Math, and Computing (CEISMC), K-12 school districts, and local community organizations. The GoSTEAM@Tech Program is generously funded by a private funding organization. This work would not have been possible without the dedicated teachers who designed and refined these lessons in their classes.

Suggested Citation: King, K. B., Gnatiuk, E., Koval, J., & Grossman, S. (2024). African Masks White Paper. https://steam.ceismc.gatech.edu/research-and-evaluation/

WHAT IS STEAM?

STEAM stands for Science, Technology, Engineering, Arts, and Mathematics, but can mean many different things. For example, some use the "A" in STEAM to represent different arts disciplines (e.g., visual arts, music, or theatre), while others use the "A" to represent broader ideas, like creativity, problem solving skills, or making [1, 2]. Some use STEAM as a way to engage students in STEM through arts projects, such that the arts play a supporting or "subservient" role [3]. Others see STEAM as a transdisciplinary approach to integrating different disciplines, with each discipline valued equally and receiving equal attention in instruction and assessment [4]. We recognize the validity of different ways of defining STEAM, their unique purposes, and the important role of teachers in defining the STEAM approach that works best in their classroom.

Because there is no cohesive definition for STEAM or established set of STEAM best practices [5, 6], we looked for "high-quality lessons learned" in the STEAM literature [7]. We drew on existing models of integration, including Bresler's model of arts integration [3] and the National Research Council's STEM integration framework [8] to develop our own working definition of STEAM. For us, high-quality STEAM instruction involves student-centered instructional pedagogies (e.g., project-based learning, problem-based learning, inquiry learning), group learning, and real-world application to increase cross-disciplinary content knowledge through learning goals for students in both STEM and arts disciplines [9]. We understand that implementing STEAM can be complex and challenging. Thus, we envision STEAM as a continuum, moving from low to high levels of integration, collaborative practices, and complexity of STEAM projects.

WHY STEAM?

STEAM is being used across the globe in an effort to improve student outcomes in STEAM disciplines [10]. Studies in K-12 settings have shown that STEAM can increase students' STEM content knowledge, increase their intent to continuing studying or participating in STEAM, generate positive attitudes towards STEAM, and improve gender dynamics in the classroom [11-15]. With training and support, studies find positive pedagogical benefits for teachers, such as using authentic assessment, integrating technology in instructional approaches, and forming connections with resources and experts outside the school building to support STEAM instruction [16-18]. STEAM aligns well with approaches that allow teachers to step into a facilitator role, supporting student-led exploration, and to engage in collaborative relationships with their colleagues.

GoSTEAM@TECH

GoSTEAM@Tech is a professional development program designed to promote authentic integration of the arts into K-12 computer science, engineering, and invention instruction. The primary goal of GoSTEAM is therefore to create safe, interdisciplinary spaces where meaningful, cross-disciplinary collaborations can occur. Teachers from different disciplines, with the support of university-based coaches and Innovators-in-Residence, come together to design and implement novel STEAM lessons and initiatives in their schools. You can read more about the GoSTEAM@Tech program here: https://steam.ceismc.gatech.edu/.

AFRICAN MASKS

LESSON BACKGROUND

This lesson integrates math, technology, and visual/media arts to answer an overarching question:

Driving question:

What can we create to dispel misconceptions and express our understanding of African culture and civilization?

The lesson was designed in 2021, during a GoSTEAM summer professional development collaborative planning session. In this planning session, two middle-school teachers and two GoSTEAM staff came together to brainstorm their goals for the year. One teacher proposed an idea involving African masks, aiming to integrate their math curriculum with African culture and history, centering culturally affirming practices to engage their student population, predominantly students of color, and to inspire them to make meaningful connections.

The teachers began drafting a STEAM PBL unit focused on African culture and civilization that integrated math, visual arts, and social studies through the design of African masks. GoSTEAM staff prompted teachers to think about innovative technology to integrate into the unit. Because GoSTEAM staff had access to a 3D printer, students could have their mask design 3D printed. This allowed teachers to incorporate additional technology standards and arts skills into their PBL. By the end of the summer, the teachers had prepared a STEAM PBL that they planned to implement over the span of a few months with the 7th-grade students.

LESSON IMPLEMENTATION

As often happens in education, the start of the 2021-2022 school year introduced unanticipated changes and challenges. The teachers who designed the lesson were assigned to teach different grade levels, meaning that they did not have common planning time and could not collaborate to implement the lesson together in one grade level. The teacher who was assigned to teach 7th-grade would need the support and buy-in of other colleagues on the 7th-grade team to successfully implement the unit as planned. This was particularly important given that this teacher taught math, a heavily tested subject that left little flexibility or time for implementing the PBL. The math teacher felt additional pressure to implement a new school-wide math curriculum "*with fidelity… so it takes time away from it [STEAM].... The curriculum map for the new curriculum for math didn't match [the African Mask lesson] at all*." Thus, the school's STEM Coordinator was brought onto the project to provide an additional layer of support and collaboration. In some cases, teachers described the STEM Coordinator pushing into class to work with small groups of students on the African Mask project while the teacher continued to teach the new math curriculum with the remaining students. In addition, the computer science teacher provided time during their class period

for GoSTEAM staff to work with small groups of students on the technological and media arts components of the project. This provided more flexible class time for students to work on the project, with less scrutiny and pressure to prepare for standardized tests in computer science compared to math classes.

The 7th-grade students were introduced to the PBL in their math class, with the GoSTEAM teacher and a GoSTEAM staff member demonstrating various forms of African art, including dance and a small model of a 3D printed African mask. In a focus group at the end of the school year, the teachers remembered their initial concern about this moment as they anticipated how students might react. One stated that the project would be "*a different kind of life for them and I was worried that they wouldn't be able to believe in themselves enough to see it through*." However, seeing the model of the 3D mask intrigued students and "*buy-in came in that moment*."

After introducing the project, the same GoSTEAM staff member visited the 7th-grade students twice a week to help them sketch and design their masks. This staff member also helped students transfer their sketches to the 3D design software, TinkerCAD. Roughly 70 students chose to design masks, exceeding teachers' expectations for student interest in 3D printing. A member of the GoSTEAM staff 3D-printed the masks off set, using multiple 3D printers to print the masks more quickly than the school's 3D printer would allow. When the masks were complete, the school's art teacher, along with a small group of students, painted the masks. The final project deliverables, including the masks, were displayed in the school's media center during a STEAM showcase at the end of the year, during which members of the community and school partners were invited to view projects and talk with students and teachers about the work.

The next school year (2022-2023), teachers implemented the STEAM PBL unit again, with a new group of 7th-grade students. The project had a similar structure, with a few adjustments in response to student feedback and teacher observations after the first year of implementation. All students were required to design a mask during the second year of implementation, though students were given more agency over the mask, choosing the design and painting the mask themselves after it was printed. Students primarily worked on the project in their homeroom, math, and social studies classes, with the STEM Coordinator and a GoSTEAM staff member joining these classes, as well as special education classes, to help teachers implement the PBL. The math focus of the project shifted to address standards related to scaling, which could be easily demonstrated as students worked on their mask designs in TinkerCAD. Connections to African culture were strengthened in the second year of implementation with the addition of a fieldtrip to a local museum with an exhibit on African art, including masks from various African cultures.

Students' 3D printed and painted African Masks displayed at a school showcase in 2023.

In a focus group conducted with six students at the end of the second year, students provided feedback on the project, highlighting their satisfaction with aspects that the teachers changed for the second year. The museum fieldtrip was a highlight for the students and they described what they learned about the use of masks in African cultures. For example, students learned that masks are traditionally worn only by men, that masks are used in dance, and that masks

are intended to convey different emotions. The information students learned on their trip to the museum inspired some students to change the design of their mask, with one changing their mask to convey a "*mad*" emotion and another making theirs look like a fox because they learned that the masks were sometimes modeled after animals. Students also reported enjoying working with the GoSTEAM staff member on their designs, who they said gave them "*compliments*" and feedback on their masks. The students enjoyed painting their masks and choosing the colors but recommended that students should be given even more artistic freedom to design and decorate their masks in the future. Students also wanted more time to work on the project. While students enjoyed the chance to do art in their "*core*" classes, they did not see the need to do so, stating that they already have a dedicated art class where they can do art. This suggests that students may have had a limited view of the applicability of art integration in their non-arts courses.

CHALLENGES & RECOMMENDATIONS

The success of the African Mask PBL relied on strong collaboration amongst teachers, school administrators, and GoSTEAM staff. Despite challenges with new curriculum mandates, increased testing, and a lack of common planning time, having the support of the school's STEM Coordinator helped enable teachers to implement the PBL and allowed additional teachers and support staff to join the collaboration. Though GoSTEAM staff were heavily involved in the implementation of the PBL, by the end of the second year of project implementation, the STEM Coordinator had developed a strong understanding of the PBL, such that GoSTEAM staff anticipated the school could sustain this STEAM project without GoSTEAM support.

> *Art can show other people that math is in everything*

As teachers reflected on the disciplines integrated within the African Mask project, they were able to clearly articulate skills that students could develop in various disciplines, such as sketching (visual arts), identifying shapes (geometry), or the design process (technology and engineering). However, teachers were less explicit about the instructional standards incorporated into the lesson. One teacher noted that in the first year of implementation, "*it [the project] was very artistic… but no, there were no specific art standards*" addressed. Teachers may have needed more support making explicit connections to instructional standards within different STEAM disciplines. Thus, the African Mask Lesson Plan, designed to support other teachers interested in implementing this project, outlines the specific STEAM standards addressed in the lesson.

One of these teachers had no prior experience with art integration, but the other did and expressed a long-standing belief that "*art can show other people that math is in everything*." Teachers valued the opportunity to integrate art into other subjects through the STEAM PBL unit, and students reported enjoying doing art in other non-arts classes. However, they also expressed some confusion about why this was necessary since they also have art class, suggesting that the value of integration was not as apparent to students as it was to their teachers. Over the two years of implementation, teachers adjusted the disciplinary integration within the project. For example, in the first year, students could choose to work on final deliverables that integrated science (through a diorama of African biomes) or English/Language Arts (through a written product). In the second year, these aspects were not incorporated into the project, but there were explicit connections to Social Studies content through the museum fieldtrip.

Though the school had access to a 3D printer in the building, printing was outsourced to an offsite location and completed by GoSTEAM staff. This was necessary to deal with the volume of masks that needed to be printed. This PBL could still be implemented effectively without a 3D printer at the school, using

companies (for example, XOMETRY) that will 3D print CAD files and mail you the completed product. Thus, teachers interested in implementing a similar PBL would just need a working knowledge of TinkerCAD to guide students through design and printing. This was an initial challenge for the GoSTEAM teachers who began the PBL with limited knowledge of how to use TinkerCAD, though they developed these skills through the support of GoSTEAM staff. In addition, allowing students to decorate their masks after printing requires additional time and supplies (e.g., paint, brushes, etc.).

KEY TAKEAWAYS

The African Mask PBL is an integrated STEAM lesson that supported student learning in math, arts, social studies, and technology. Through collaboration amongst teachers, an administrator, and GoSTEAM staff the project was successfully implemented twice over the course of two school years. This collaboration was notable for teachers, who felt that, when working on STEAM projects, "*the adults are the hardest to get to buy in [from]*." The teachers were able to expand and modify the project in the second year to adjust the learning standards, include all students in the 3D mask design and printing, and add a fieldtrip to a local museum. The fieldtrip in the second year of the project helped students make connections between social studies content and their artistic design choices as they worked on their masks. The project allowed students to express their creativity while learning about new technologies for design. Students' engagement and success completing their masks exceeded teachers' expectations for the project, dispelling their initial concerns about students' ability to engage with the project.

Through their work on the PBL, teachers and students developed their technical capacity for using 3D design software. GoSTEAM staff helped build teacher capacity for using TinkerCAD software, witnessing growth in teachers' ability and confidence using the software. Notably, this project allowed many different types of students to interact with STEAM technologies, like TinkerCAD, instead of focusing only on gifted or advanced classes, as sometimes happens with innovative STEAM lessons. The teachers valued the ability to expose students in "*an urban setting or a title one school… to something they normally wouldn't see*" through integrating innovative technology in their STEAM lesson.

> *We're not just going to give them paper/pencil tests or computerized tests to, you know, to be able to say they've mastered it, but give them different ways of showing it.*

In the midst of increasing pressure after the COVID-19 pandemic to boost test scores, this STEAM lesson allowed a break from test preparation and a return to the type of teaching that teachers felt would allow students to learn more effectively. One of the teachers stated, "*we're not just going to give them paper/pencil tests or computerized tests to, you know, to be able to say they've mastered it, but give them different ways of showing it. And when you can show kids that STEAM, all of it is involved in everything that we do, you know, to me, it just makes it where it's not another activity or chore, but it brought their understanding of it all together*." The impact on student engagement as they worked on the STEAM project was notable. This was powerful for the teachers, who said, "*you can't put a price on that. That, to me, is better than a test score*."

RESOURCES

Below are links to resources that may support implementation of similar STEAM projects:

STEAM Pedagogical Approaches: A brief compilation of different pedagogical approaches for STEAM teaching. https://steam.ceismc.gatech.edu/pedagogical-approaches/

Lesson Guide for African Mask PBL: A lesson guide including the learning overview, project description, learning goals and standards, and lesson plan to use with 6th-8th grade students. https://steam.ceismc.gatech.edu/gosteam-learning/african-mask-project/

XOMETRY 3D Printing Online Services: An example of a website where you can upload your design file and receive the final 3D printed object in the mail.

REFERENCES

1. Ge, X., D. Ifenthaler, and J.M. Spector, *Moving forward with STEAM education research*, in *Emerging Technologies for STEAM Education*. 2015. p. 383-395.
2. Perignat, E. and J. Katz-Buonincontro, *STEAM in practice and research: An integrative literature review.* Thinking Skills and Creativity, 2019. **31**: p. 31-43.
3. Bresler, L., *The subservient, co-equal, affective, and social integration styles and their implications for the arts.* Arts Education Policy Review, 1995. **96**(5): p. 31-37.
4. Quigley, C.F., et al., *STEAM designed and enacted: Understanding the process of design and implementation of STEAM curriculum in an elementary school.* Journal of Science Education and Technology, 2020. **29**: p. 499-518.
5. Colucci-Gray, L., et al., *Reviewing the potential and challenges of developing STEAM education through creative pedagogies for 21st learning: How can school curricula be broadened towards a more responsive, dynamic, and inclusive form of education?* 2017.
6. Katz-Buonincontro, J., *Gathering STE(A)M: Policy, curricular, and programmatic developments in arts-based science, technology, engineering, and mathematics education.* Arts Education Policy Review, 2018. **119**(2): p. 73-76.
7. Patton, M.Q., *Evaluation, knowledge management, best practices, and high quality lessons learned.* American Journal of Evaluation, 2001. **22**(3): p. 329-336.
8. Honey, M., G. Pearson, and H.A. Schweingruber, *STEM integration in K-12 education: Status, prospects, and an agenda for research*. Vol. 500. 2014: National Academies Press Washington, DC.
9. Boice, K.L., et al., *Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program.* Education Sciences, 2021. **11**(3): p. 105.
10. Lee, B. and E. Chang, *A cross cultural study on STEAM education in Korea and United States.* Korea Science & Art Forum, 2017. **30**: p. 277-288.
11. Engelman, S., et al., *Creativity in authentic STEAM education with EarSketch*, in *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*. 2017. p. 183-188.
12. Hayman, *Investigating STEAM: Integrating art and STEM to spark innovation.* Curriculum and Instruction Undergraduate Honors Theses, 2017. **16**.
13. Jeong, S. and H. Kim, *The effect of a climate change monitoring program on students' knowledge and perceptions of STEAM education in the republic of Korea.* Eurasia Journal of Mathematics, Science and Technology Education, 2015. **11**(6): p. 1321-1338.
14. Kong, H., & Hwang, *The effect of theme based STEAM activity programs on self efficacy, scientific attitude, and interest in science learning.* International Information Institute, 2014. **17**(10(B)): p. 5153-5159.

15. Peppler, K., *STEAM-powered computing education: Using e-textiles to integrate the arts and STEM.* Computer, 2013. **49**(9): p. 38-43.
16. Herro, D. and C. Quigley, *Exploring teachers' perceptions of STEAM teaching through professional development: Implications for teacher educators.* Professional Development in Education, 2016. **43**(3): p. 416-438.
17. DeJarnette, N.K., *Implementing STEAM in the early childhood classroom.* European Journal of STEM Education, 2018. **3**(3).
18. Herro, D., C. Quigley, and L.A. Jacques, *Examining technology integration in middle school STEAM units.* Technology, Pedagogy and Education, 2018. **27**(4): p. 485-498.