Of Imagination and Self-Expression: Fusing Creative Technologies with Project-Based Learning

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ABSTRACT
Our program is a year-long after-school maker-centric program, hosted in an urban public elementary school in New York City. This program spans from September 2018 to May 2019, thus it is ongoing at the point of presentation at FabLearn 2019. Eleven fifth-grade students participate in our program. Their ages range from 10- to 12-years-old. Two students are White, three are Hispanic, and five are Black. We intend to give a 10-minute presentation during the Roundtable session at FabLearn 2019. We will share our experiences designing curricula and projects that connect STEM concepts and Art fundamentals, and designing different STEAM units that build upon one another to culminate in a major final project that students would have worked on over the course of a year. Our STEAM units include: Circuitry & Mapping, Stop Motion Animation, Introductory Computer Programming with Scratch, and 3D Printing & Game Design.

Keywords
Creative technology; STEM; STEAM; Art; Art and technology; Project-based learning; Elementary education; Technology education

1. DESCRIPTION

1.1 Description of the educational setting
The educational setting we work in is an urban, inner-city public elementary school in New York City. This school is fairly new, but it has faced multiple setbacks in school administration over the past couple of years. Most students in this school are of lower socioeconomic status, nearly half of the students are on reduced/free lunch, and 80% of the students are Black or Hispanic. In our class, there are 11 fifth-grade students participating in our program. Their ages range from 10 to 12 years old. 2 students are White, 3 are Hispanic, and 5 are Black.

Our after-school program focuses on creative technology, media and interactive art, but our 11 students come from a wide range of technical, mathematics and reading abilities. For example, a few students have tinkered on Scratch and Code.org at home on their own and thus understand some fundamentals of computer programming, but some students are completely new to computer programming. Some students also have access to stable internet and have a desktop computer or laptop at home, whereas others may not have such access. Most students have been introduced to science concepts (such as electricity, which we touched on in our first unit) during their science classes at school, but they have challenges recalling fundamental concepts related to the science topics they had covered. Most students have minimal formal visual art background, but are interested in exploring various visual art forms.

1.2 Description of the educational experience
We, as teachers, organized STEAM curriculum units that range from 1 to 2 months long. So far, for the Fall 2018 semester, we have covered Circuitry & Mapping, Stop Motion Animation, and Introductory Computer Programming with Scratch. 3D Printing and Game Design would be covered during Spring 2019. We chose these units as we wanted to merge artistic concepts with STEM. From our prior experience teaching workshops in these areas, coupled with advice from last year's after-school creative technology teachers, we decided that these topics would be most relevant for the fifth-grade students who will be able to build on existing STEAM knowledge they have, yet challenge themselves with newer concepts and skills we would explore during the course of the year.

For all units we covered, we applied a constructionist pedagogical style [1] with guidance and scaffolding as much as possible. There were of course certain sections of the units that took on a more instructionist style, due to the nature of the content we had to cover before the students could begin their projects. For example, during the Circuitry & Mapping unit, we reviewed the students' knowledge of electricity and electrical components first. As we found gaps in their understanding of how electricity works, we did several embodied activities that reinforced their knowledge of how electrical components interacted, and how to differentiate between series and parallel circuits. We had students sketch what they understood about electrical circuits in an artistic manner, but also made sure to go through scientific conventions of drawing circuit diagrams and expose them to how the electrical components looked in real life by purchasing supplies of basic electrical components (LEDs, wires, batteries, battery packs etc.). On the more artistic end, we introduced Mondrian's abstract art, "Broadway Boogie Woogie," to our students, and guided them through an imagination activity to imagine how a city map might look from a bird's eye view. This was an attempt to connect basic elements of lines and Mondrian's geometrical style to how electrical circuit diagrams are made, then we guided students to sketch (2D) or tangibly create (3D) their imaginative maps that interwove both artistic and electronic concepts.

The constructionist sections of these experiential-based activities we led involved much personal attentiveness from us, as we had to comprehend our students' unique perspectives to give helpful feedback based on their creations.

For the Stop Motion Animation unit, this was highly team-based. Our students split into 3 groups, and each group brainstormed their own narratives to construct a story using the maps they had created from the previous Circuitry & Mapping unit. We introduced students to storyboarding and persona formation, before the students dove deep into creating their characters using Play-Doh. Then, we demonstrated other methods of creating characters, for example by sewing, and improving on their characters' body language and facial expressions to enhance storytelling. We encouraged students to use a stop motion animation mobile application to take frames of photographs, and develop a script that they could use to narrate and record for their story. This process turned out to be more time-consuming than expected, as students ran into technical difficulties or disagreements with one another over design decisions.

For Introductory Computer Programming with Scratch, we first began the unit by going through features and programming blocks in Scratch, but quickly discovered that students were significantly more engaged if they tinker on the platform on their own. Since we found that some students had more experience on Scratch while others were complete beginners, we decided to make this unit more student-led than teacher-led, in order to accommodate each individual student's preferences and programming abilities. We encouraged students to try different types of programming blocks, such as blocks from Motion, Looks, Sounds, Controls, and also experiment with making variables and passing data to different parts of their code. We also guided students to view other community members' projects and starter project provided by the Scratch team, and had them re-tell to us and to one another what they understood or did not understand in code that others on Scratch had built.

For all units, we encouraged students to keep a sketchbook journal to document any ideas for various stages of their projects, and notes they had taken or drawn in class.

2. DISCUSSION

2.1 Results

Our students are the main beneficiary of our program, and it is our sincere hope that they not only learn skills in creative technologies, coding, mixed media, new media, and interactive art that engender a hybrid form of practices, but also practice social-emotional learning when collaborating with their peers. We organized a mid-semester check-in, where we asked each student to give us feedback about our teaching so far, and what they had learnt in class. Many students responded and reflected about emotional management and self-control, such as controlling anger, overcoming hyperactivity and figuring out any communication issues with peers. Students generally replied that they liked the activities and felt that they were learning something new, and several also gave more concrete examples about certain physical activities they preferred over other more passive activities.

Our overarching objective is to foster a "culture of deep projects" [2], following the framework that Worsley and Blikstein had delineated, by having teachers from multiple disciplines (us) work together to curate successful digital fabrication curricular units that can be open-sourced, and by ensuring that project ideas have personal meaning to the students' lives, passions and communities.

On our end as educators, classroom management was a challenge, and probably it was more pronounced because we were both new to the school environment and had nominal experience teaching students from underserved backgrounds. We used stickers as an incentive behaviorist mechanism to encourage students to write or draw ideas in their journals or lower their voices when we were explaining important concepts, but discovered that this was not the most effective method in encouraging all students to follow our instructions. We discovered recently that students were more interested in receiving specific gifts as rewards for good behavior, or collecting points on ClassDojo (a learner management system that their school uses already), but to which we as after-school educators do not have access. We could potentially look into these incentive mechanisms for our program next semester.

Another area of improvement for us lies in how we could better tailor our curriculum to the students' abilities in various academic subjects. We started our program with little knowledge of where the students are at in their fifth-grade formal syllabus, thus certain mathematics and science concepts we presented to them could have been completely new. There were times where we realized that the students did not even know what to ask about something they did not understand, because the concept was completely foreign to them, and they were afraid of being perceived as "dumb" , or nervous, or simply did not bother about their knowledge gap. Although we strive to make this after-school program fun and unlike how how a formal school lesson operates, we also feel that asking our students' schoolteachers for information about their mathematics and science syllabi would help us modify our curriculum to better suit their ability levels. In terms of art, we taught metaphors between art and life, solidified students' foundational knowledge such as primary colors, lines, and geometric shapes. We also introduced aspects of art history, such as important modern and contemporary artists, and associated their work and concepts with science and new technology.

2.2 Broader Value

We feel that our experiences are very relevant for other educators, especially educators who are new to maker and interdisciplinary STEAM education, project-based learning, and/or working with students in underserved communities. Our experiences recount our honest reflections, and we highlight three main takeaways to share with the broader FabLearn community:

1. Keychain Syndrome [3]

The “Keychain Syndrome”, which Blikstein describes as the yearn to produce quick aesthetically pleasing output and shying away from more challenging endeavors [3], is evident and inevitable in maker-oriented learning. Students often are drawn to repetitively generate features or products that look interesting to them or their peers, due to its novelty, but when they reach the stage of repeatedly doing something they already know how to do, then their individual learning reaches a plateau. As educators, we have to be cognizant of this “Keychain Syndrome”, and we have noticed this occur in our students during this program. However, we have also learnt that we need to maintain an equilibrium between immediately persuading our students to work on more challenging features and giving them space and time to be proud that they had achieved a pleasing output. For students who had achieved a pleasing output, we observed that they were more willing to show their peers what they had learnt, and in turn teach their peers, thereby reinforcing the new concept or method they had learnt. Therefore, although the Keychain Syndrome may emerge, it is not necessarily all negative if educators are able to balance between moving students to the next level and giving them a breather to show off their accomplishments.

2. Power of Despair [3]

Because our projects are iterative and students often have to undergo several versions of designs, they experience various levels of frustration and excitement. These emotional ups and downs could potentially impact how they design and how they communicate, or their interest level in what they are doing. We have definitely noticed emotional roller-coasters in our students during the course of our program. Although it may be intuitive or spontaneous for us educators to want to dissipate any negative emotions, these moments of despair and frustration should be viewed positively, as these feelings are part and parcel of project-based, maker-oriented learning. Hence, we as educators have to attempt to talk through any negative feelings the students may have, to help them figure out the tools they may need, and to nurture a healthy growth mindset when they face challenges.

3. Sociocultural Impact [4]

Currently, our projects have been interdisciplinary in terms of subjects explored, but we hope to expand our curriculum to define it to be more community-centered. We acknowledge that we are primarily working with youth of color from disadvantaged backgrounds, and building on the findings from Barton & Tan’s longitudinal study on equity-oriented STEM-rich making [4], we aim to implement more explicit scaffolds to guide our students in exploring their identities and communities. Co-making is a particularly interesting concept to us that Barton & Tan suggested, whereby students would co-make with community members to put different planes of knowledges and experiences to create a more holistic maker experience.

2.3 Relevance to Theme

This year’s FabLearn theme questions what role maker education plays when there are growing social and environmental challenges. We feel that our submission coincides more with the sub-theme surrounding social challenges in maker education. Because it is an after-school program, the incorporation of fun activities such as physical embodied learning “warm up” exercises and games motivate students and allows them to treat the sessions as a space of liberation. After rearrangement of the tables and chairs, the typically crowded and stagnant space becomes a freer area for new and inventive acts to happen. The social dynamics transformed from everyday scheduled classes to a relaxed and lively one. Students become not only aware of themselves as learners, but are aware of their peers too, and develop deeper understanding towards each others’ needs, attitudes, and disposition.

2.4 Acknowledgements

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3. BIOS

(Authors’ Bios)

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