Catalyzing a student-centered learning culture shift in schools

Rodrigo R. Silva
Rio de Janeiro, RJ
Brazil
http://escolaeleva.com.br
rodrigo.silva@escolaeleva.com.br

Renata Paraense
Rio de Janeiro, RJ
Brazil
http://escolaeleva.com.br
renata.lima@escolaeleva.com.br

Artur Moreira
Rio de Janeiro, RJ
Brazil
http://escolaeleva.com.br
artur.moreira@escolaeleva.com.br

Jean Menezes
Rio de Janeiro, RJ
Brazil
http://escolaeleva.com.br
jean.menezes@escolaeleva.com.br

ABSTRACT

Makerspaces, hackerspaces, medialabs and fablabs are inspiring novel student-centered learning environments in schools around the world. This report aims to share experiences, challenges and lessons learned from implementing non-traditional curricular subjects in the creative learning spaces at a school in Rio de Janeiro, Brazil.

The authors consist of a team of teachers that lead makerspace and coding classes at a bilingual, Brazilian, privately held, for-profit day school. As educators, we believe in providing learning environments that emphasize collaboration, autonomy and curiosity.

Our everyday experiences, dotted with hands-on project strategies, student engagement, project- based learning, celebration and public display of student work, will be discussed, with a special focus on assessment as a tool to empower the desired culture shift among students. Afterwards, we will wrap up with reflections and future challenges in our field of work. Targeted at educators willing to implement such strategies or with ongoing experiences in their respective schools.

Keywords

“project-based learning” ; “hands-on learning” ; “self-assessment” ; “makerspaces” ; “creative spaces”

1. DESCRIPTION

1.1 Description of our setting

The authors are a team of designers, engineers, programmers and, above all, educators, in charge of delivering a “maker curriculum” (and after school activities as well) to lower, middle and high school students in Rio de Janeiro, Brazil. Before becoming full-time teachers, the team members were involved with the fashion, software and digital fabrication industries. Some of us were members of or staffed community-minded makerspaces, hackerspaces and fablabs. As educators, we believe in providing learning environments that emphasize collaboration, autonomy and curiosity. Our main pedagogical references are Seymour Pappert's Constructionism[1] and Paulo Freire's Pedagogy of Autonomy[2].

The school is a privately held, full-time, Brazilian bilingual school. It was founded in 2017 with the mission to connect what students learn to what they live through strong teaching, associated to new practices, new tools, new knowledge. One of the key aspects of that mission is the fact that the school provides students with two Maker Spaces and one Media Lab, among other creative spaces.

As part of our ongoing technology program, we offer “Makerspace”, Coding and Design Thinking as curricular subjects to students of different ages. We will focus our report on those experiences.

1.2 Description of the educational experience

Being a recently founded school, 100% of our students (and teachers) came from different settings at the start of the school year. In their previous schools, most of our students had teacher-centered educational experiences delivered to them. Many of our teachers used to give teacher-centered instruction to their students.

Providing a student-centered approach is one of the core aspects of the Maker Education, and initially we thought that it would be an easy task. But, as with every novel approach, it was met with resistance. After a few months of work, we realized that students, specially the older ones with more consistent past experiences, were the most resistant to the educational approach we were trying to set in motion. We realized that students were often uncomfortable with being given a lot of autonomy over their learning, with being assessed by projects (as opposed to tests) and self-grading their work.

In order to help them feel comfortable with this new scenario based on student autonomy and project assessments inside a new school, we decided to use our space as the starting point for this change. We took this challenge on as our mission inside the school. We believe that the environment we provide in our classes is the ideal opportunity to make students self-aware of their responsibilities as part of a community. In our classes they need to seek for knowledge on their own, they share what they’ve learned with each other (students are

often teaching one another) and they need to take care of the space. The sense of community is easily found inside the makerspace and that's why it is a good opportunity to work on responsibility, autonomy and reflection in order to create this learning culture shift.

With that in mind, we've come up with a driving question that's been guiding our work since: "How can we help students evolve from a teacher-centered to a student-centered culture?" We understand that shifting to a student-centered culture goes way beyond just spending less time on lecturing and letting students do most of the work in the classroom.

Therefore, building into previous experience[3] and aggregating our own, we've come up with a few strategies that we would like to share with a like-minded audience:

- Hands-on learning experiences
- Makerspace as the project-based learning driver in the school
- Assessment through projects and self-assessment
- Associating the learning process with the school spaces
- Celebration and public display of student work

1.2.1 Hands-on learning experience

Makerspace lessons are the perfect opportunity to create an environment based around hands-on activities. During these lessons, students learn hard skills like holding a tool and also soft skills like learning how to communicate with their peers, for example. They learn how to take care of the space, how to clean up and organize all the materials and tools. And more importantly, they learn how to deal with frustration and work on their resilience. This is really important for the younger ones.
Once a student from 4th grade started crying in class because even though he was following the step by step to create the project, his project wasn't working at all. He was really angry and his argument was that the project was too hard for him to do it. After some talk with the teacher, he tried again, then he failed again, then he tried once more and "Wow!" the project worked! What this student learned was so much more then how to build something following a step by step process, but how to fail and not to give up, and that's something that is going to help him in every aspect of his life.

1.2.2 Makerspace as the project-based learning driver in the school

In our program, we follow the Project-Based Learning (PBL) approach, that is a learning method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge. The focus of the work is always the student and the teacher acts as a mediator and mentor, helping students achieve their learning goals by themselves. In a PBL environment, students learn how to work in groups, how to present their work in public and how to split tasks among their peers. For example, one of our projects this year involved investigating and reporting, both orally and in writing, about chain reactions and the effect of gravity and other forces over objects. For that, students had to build contraptions inspired by the work of cartoonist Rube-Goldberg.

In order to achieve the desired engagement necessary for a student-centered class, we made sure that the project theme was in some way relevant to the world and authentic to the students. For example, the Rube-Goldberg project mentioned above was more than just building a machine that made simple tasks harder. The world was in the middle of a zombie apocalypse (relevant and engaging for 6th graders), and the students (now survivors) were challenged to use only the trash that was left in the world (authentic world issue) to create a machine that would release a computer animation with whatever they came up with (many thought about unicorns, for instance) to scare away the zombies and save the world. The students performed extremely well, and also they had a lot of fun in the process.

Meanwhile, our 8th graders were challenged to find the "Hidden Villains", little problems in their everyday lives that might as well affect other people. Afterwards, they used simple automations built with *Arduino* to solve them. Our 5th graders noticed that the 3D printing scraps left throughout the space could make the plastic recycling unit more colorful and fun, and manufactured small accessories that they sold to parents and visitors. The connection between topics that appeal directly to the students with real-world issues proved to be very effective in terms of student engagement throughout the school's divisions.

1.2.3 Assessment through projects and self-assessment

As Gary Stager[4] points out, "Assessment always interrupts the learning process." In that sense, many maker educators refrain from any sort of formal assessment. We thought that it was possible to formally assess projects without disrupting the learning process if the right assessment strategies were undertaken. Inspired by Ken O'Connor's[5] work and taking into consideration the High Quality Project-Based Learning[6] approach, we came up with a "maker" assessment framework that evaluates soft skills, content learning goals and language targets as well. We use various techniques[7], ranging from project checklists to oral presentations and a considerable amount of

self-assessment. Our 9th graders, for example, were given an answer sheet with some questions related to their work, asking them to evaluate themselves and each member of their group explaining his/her contribution to the work. This type of assessment lead them to a reflection and a discussion that made them realize what they needed to get better at and what their strengths were.

1.2.4 Associating the learning process with the school spaces

We use the same space for Coding and Makerspace lessons and usually work on the same project in both subjects so when a student starts a project she'll learn content from Makerspace curriculum and coding curriculum and use all of it to create her project. Both subjects are taught and assessed concurrently. Once, we asked students to describe content that they've learned during makerspace classes and some of them described coding contents and even multimedia content taught at the same space, but within different subjects, at least in formal terms. In this moment we realized that students related their learning with the space and the projects rather than with the individual teachers or the subject matter. Now, we are trying to use this to our favor even more, planning interdisciplinary classes and projects for next year.

1.2.5 Celebration and public display of student work

An important strategy to engage students is to showcase their work. Therefore, we organize every year a public event called "Making Makers", where parents and other visitors come to celebrate and enjoy the work that the students have been working on. We've had students presenting their work and also students giving workshops teaching other students and even parents something they've learned about during the year. This celebration moment is important not only to allow students to be proud of their work but also to enable them to share knowledge with others, the higher demonstration of learning.

2. CONCLUSION

Making the shift from a teacher-centered to a student-centered culture is not an easy mission and we are still working on it. But in this ongoing work we've realized that when the theme of the work is authentic and relevant, students are engaged and the learning environment becomes richer. Along with the theme, the project rubrics need to be more open-ended and the assessment need to be embedded and continuous. It is important to give students room to reach their maximum possibilities. If we give them a closed rubric, they will probably do as written and reach an expected result. On the other hand, when we leave open-ended rubrics they often surprise us with results way beyond our expectations.

2.1 Results

In 2017, our team delivered Makerspace lessons to around 300 students from 1st, 2nd, 3rd and 6th grades. In our yearly creative technology show and tell event, "Making Makers", around 200 projects the students worked on throughout the year were exhibited, with two groups totalling 8 students presenting self initiated projects or workshops.

In 2018, with the school starting at almost-full capacity, our team delivered lessons to around 900 students from 1st through 9th grades. The students from 2017 were moving to their second year of taking the program, but new students were suddenly immersed into the already established maker culture. Even if the initial culture shift was even more intense for them than for their 2017 peers, the results were worth it: 500 lower school students exhibited their works, 400 students presented (and worked on) their projects in an auditorium turned into a makerspace. 8 sessions (of a total of 30) were independently organized and presented by students.

In the second quarter of the year, our 3rd graders worked on making catapults with popsicle sticks and hot glue guns. Apart from building knowledge on how elastic and gravitational forces affect objects, they were challenged on their dexterity and building skills. In 2017, with most students having no prior exposure to a makerspace, it took our 3rd graders around 3 meetings to build the catapult. They followed instructions on the projector, with detailed pictures at every step. Most students required a lot of help from teachers and assistants.

Surprisingly, in 2018, it took the now 3rd graders - most having already been exposed to 1 year of the makerspace curriculum in the previous year - only one meeting to build the same object and run the proposed tests, with substantially less teacher intervention. Talking to the teacher in charge of the activity later, we learned that the step by step instructions were skipped, and only a few previously finished catapults were left around the classroom, therefore adding another layer of complexity to the activity.

A series of comments by 9th graders about their summative assessments also highlight the ongoing culture shift:

"I thought that the summative [assignment] was quite boring. I had some issues with the canvas and with the graphic. I think that we should have written tests which are interesting, like the Makerspace lesson." (F.E., 2018 Q1)

"I think that in the future we could have some assessments that would give something to the society. Using the space and opportunities that we have to contribute to the rest of the school's environment or even Rio's. I learnt about construction mechanisms work and how to manage tools that I didn't imagine that I could. I want to learn about how to create a project in the laser cutter and deepen my knowledge

in the 3D printer. I think that we could review some rules about the space, because many people don't contribute with organization and what they're able to do or not." (F.E., 2018 Q2)

"Failure is essential when you are developing a project. You won't finish it correctly if you don't fail. Our failure in the beginning was essential for us to continue our project. Maybe when failing we got better than before. (...) [it was] very good! We could use 100% of the makerspace and its materials, great ending of season." (F.E., 2018 Q4)

"The classes have been really great. Assessments have become better and less formal, therefore I became more enthusiastic about the formative and summative." (U.S., 2018 Q3)

"I believe it would be the BEST if some kids, like younger than us, could teach us! They are so cute and have so much patience and experience!" (U.S., 2018 Q4)

We recognize that those results are still very early and can't be taken from a scientific point of view, but they show us that our work is going in the right direction in terms of taking ownership over their learning and developing soft skills like self-confidence, collaboration and resilience.

2.2 Broader Value

The broader impact is that the students now perceive the Makerspace as just another space in the school, like the library, for example. They just show up and work on their next Geography or Language Arts project. They don't see the space as a Makerspace/Coding class but also an open space where they are welcome to work on whatever they need. As a result of this, around 30% of the Science Fair projects were developed totally or partially inside the Makerspace.

Also, we've noticed that assessment is frequently seen as negative (Invent to Learn). But if done right, assessment can be positive and even improve the learning experience. As Makerspace and associated subjects are not tied to "traditions" as in subjects like Maths or History, we have more freedom to innovate not only with our lesson plans but also with how we assess students.

3. BIOS

Rodrigo Rodrigues da Silva (panelist) is currently an Educational Technology Leader at Escola Eleva. He is a programmer, engineer and educator with a strong background in digital fabrication and maker culture. Silva co-founded Metamáquina, Brazil's first open hardware 3D printer manufacturer. He is also a co-founder of Garoa Hacker Clube, Brazil's first and biggest hackerspace.

Renata Paraense is an educator who has already worked as a designer for major Brazilian fashion brands. She has attended and exhibited works at Expo Milano, Rio+Design, Dubai Design Week and Maker Faire Rio. Paraense is currently a full-time Creative Technology teacher at Escola Eleva.

Artur Moreira is currently a Creative Technology teacher in training at Escola Eleva. He has previously worked at a major automobile company in Northeastern Brazil and as a space manager and facilitator for Joy Fablab.

Jean Menezes is the Lower School Coding teacher in training at Escola Eleva. He has previously worked as a software developer for major companies until he discovered his passion for teaching.

4. REFERENCES

[1] Papert, S.; Harel, I. 1991. Constructionism. Ablex Publishing Corporation, New York, NY, USA.

[2] Freire, P. 2002. Pedagogia da autonomia: saberes necessários à prática educativa. Paz e Terra, São Paulo, SP, Brazil.

[3] Chang, S. 2018. Assessing Learning in Maker Education. Edutopia, George Lucas Educational Foundation, Marin County, CA, USA. https://www.edutopia.org/article/assessing-learning-maker-education. Retrieved December 3rd, 2018.

[4] Martinez, S.; Stager, G. 2013. Invent to Learn: Making, Tinkering, and Engineering in the Classroom. Constructing Modern Knowledge Press, Torrance, CA, USA.

[5] O'Connor, K. 2011. A Repair Kit for Grading: 15 Fixes for Broken Grades. 2nd ed. Pearson, Boston, MA, USA.

[6] A Framework for High Quality Project Based Learning. 2018. Buck Institute of Education, Novato, CA. https://hqpbl.org/wp-content/uploads/2018/03/FrameworkforHQPBL.pdf. Retrieved December, 3rd, 2018.

[7] 7 Types of Assessments for Maker Projects. Teaching Salary in California. Blog entry. USC Rossier School of Education, Los Angeles, CA, USA. https://rossieronline.usc.edu/maker-education/7-assessment-types/. Retrieved December 3rd, 2018.