A Journey of Learning:
A playful take on autonomy and self-assessment

Rozeani Pricila Ferreira de Araujo
SENAI Institute of Technology Automation and Simulation
Rio de Janeiro, Rio de Janeiro
Brazil
firjansenai.com.br
roparaujo@firjan.com.br

ABSTRACT

This paper describes how methodologies like gamification, SCRUM and design thinking can enhance the learning environment in makerspace lessons. Five different versions of the program were tested in a vocational school in Rio de Janeiro in order to analyze what parts of the process were relevant in the development of the students' abilities regarding their self-management, motivation and self-assessment. Some of these versions were conducted with the teachers themselves to make them experience and understand firsthand what the methodology targets and what their focus as teachers should be. With this paper, we want to contribute with insights of how to evaluate activities in the makerspace in a more personalized manner and how to enhance and evaluate the students' self-criticism, autonomy and responsibility.

Keywords

Autonomy, Evaluation, Self-assessment, Maker Education, Project-Based Learning, Gamification, SCRUM, Design Thinking.

1. DESCRIPTION

1.1 Description of your setting

This work began being developed in a vocational school called the SENAI Institute of Technology Automation and Simulation in the neighborhood of Benfica, located in the suburbs of Rio de Janeiro, Brazil. This school has a Fab Lab that is available to their students. The first version of our method was developed with the first class of the "Fab Lab project assistant" course, which had 12 students within the young adult age range. The idea behind this course was to form a multidisciplinary team of students in a maker space and mediate their project by developing experiments using Design Thinking. The following experiments included teenagers, young adults and even elderly students in different classes.

1.2 Description of the educational experience

The workflow used in these experiments was designed to guide a project-based learning experience in a makerspace. The objective of the workflow was to help the teachers organize their lessons centered around projects; giving them ideas about how to organize their goals, supervisions and learning evaluations in a playful manner. The learning evaluation was done in an individual and customized approach to help the students see themselves as a unique person rather than "another roll-call number", therefore stimulating their self-criticism and self-development. Design Thinking, Hero's Journey, Gamification, SCRUM and digital manufacturing references were used to create this workflow. The model below is the result of five experiments that were done in the last three years in different classes.

1.2.1 Decide a project with your students and make goals

To begin the workflow, the class is divided in groups and they start a dialog about their interests. What would they like to do? What do they think is interesting? They are oriented to think about a project that they have an interest and a curiosity to create. The curiosity would be the strength of their development. The teacher lists the contents that the project must have as a prerequisite - like geometry and accounting, for example - in order to be evaluated at a later date.

After reflecting on the groups' interests and the prerequisites presented by the teacher, the groups pick a project. For instance, they can decide to build furniture, which would teach them about geometry. They would also learn about the study of materials, digital drawing, carpentry and calculating production costs, which would give them a basic knowledge of accounting. The teacher then talks to each group to divide the project into smaller steps and tasks. In the furniture example, they would be measuring the available physical space for the furniture, picking materials, researching costs and quantities of material needed, drawing the model, building a miniature test, etc. This is so that the students can visualize what they would need to do in advance, which would allow them to reflect on how to use their available time.

1.2.2. Show it graphically divided in two sections: group goals and individual learning

We began testing playful and visual ways to show the students the path that they needed to follow, so as to allow them to see by themselves where they were, where they should go and what they should do to get there. We used gamification to organize the goals and their learning in a simple, visual and compelling way. We used visual references from board games to create a path with squares that represented the goals they needed to achieve. This game board would give them a visual idea of how far into the progress they were.

In order to organize the evaluation of their work, our game board drawing had two different areas: the "group project tasks" area and the "individual learning" area (Image 1). The group area was made up of each step of the project that would need to be completed. Each empty square in the game board was filled in when the group completed a step. The filled in squares acted as a loading bar that made the process evolution clear. The individual area was customized according to each student's profile and would be comprised of their individual learning. The circular shape was used to break the idea that the process is linear and to show the meeting points of the different types of knowledge.

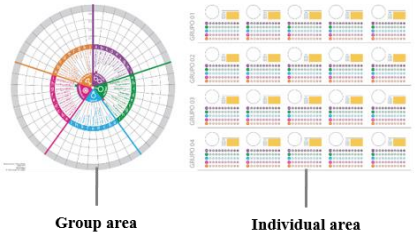

Image 1 Game Board divided in two sections. This version was used in the second experiment.

Following the previous example, if the group completed the "digital drawing" step, the group square would be filled in. However, only the team member who had this experience would get the badge. This individual evaluation would be transparent with the student, the group and the teacher, as can be seen under topic *"Presentation and evaluation"*.

1.2.3 Start to work with events

In order to structure the events, the agile methodology SCRUM was used as inspiration. In this method, the development of the project is organized through routine **events**, with daily and periodical meetings; **artifacts** that describe the project functionalities; and **roles** that each member would play in their team. Inspiration was taken mainly from the artifacts and routine events. The main artifact that holds all project functionalities was drawn as the game board. The events proposed in the agile methodology aim to give transparency, dynamism and maturity to the team's work. To fulfill these objectives during class, planning meetings were scheduled.

1.2.3.1 Planning

During these meetings, the group gathers to plan what would be done the upcoming week. Each student was encouraged to individually assume responsibility over the development of a specific part. This would be an autonomous decision, in which neither the group nor the teacher would decided for the student. It would be necessary for them to pick something that would make sense with the group's goals. This decision would then be written down on a sticky note and glued beneath the person's name. It is that person's responsibility to make sure that the work will be finished by the deadline, but this does not mean that other people can't help them or that they can't get involved in other activities. By having this decision displayed visually, the person responsible for it makes a pledge in front of their group and classmates that motivates them to fulfill it.

The individual decisions make up the list of things to be developed by that group during the week. In SCRUM, it is suggested that the development periods should last from two to four weeks. However, in the classroom dynamic, we noticed that what worked best was to have these cycles happen weekly with a set date for the meetings - e.g., every friday.

1.2.3.2 Development

For the students to develop their projects, the teacher organizes the available time according to what he feels is best for the class. For instance, during a specific week, he would allot two hours a day for guided concept presentations and two hours for free time, or whatever he may consider necessary at that moment. The important thing was to inform the students about this decision during the planning meeting, so they can organize themselves accordingly.

After planning, the students would gain autonomy to manage their available time. The decision of how much time they would use to read, research, or discuss would be solely the group's responsibility. The teacher stays in the class with them to guide them if they feel lost and to help them with any doubts they might have, but he would not have any authority over their decision-making. It was not uncommon for the students to procrastinate initially, but, after some time, they started to improve their use of time. The Retrospective meetings helped the students reflect over the effect their attitudes had in their development and ingroup relationships, while also encouraging them to think up different strategies in order to avoid negative effects.

During the development, some Design Thinking dynamics were used to help the groups loosen up and look at their progress with a lighter mood. Rapid prototyping with cheap materials, like cardboard, was one of the dynamics adopted most frequently, together with the incentive to "fail fast". It was very important to change the students' vision on failing, since most of them were afraid to take risks, fail and have to start again. After some time, they learned that running tests is valuable and that documenting their failures and mistakes was important for their learning process.

For the projects development, we took full advantage of Fab Lab's structure. Students made contact with various different digital manufacturing tools, from 3D printers to laser cutters, milling machines and electronic equipment. An interesting prerequisite to use the machines was to bring a prototype made with cheap materials in order to encourage the students to attempt rapid prototyping.

1.2.3.3 Presentation and evaluation

In this meeting, the group would present their weekly results for five minutes. It is important that this presentation be prepared as a continuation of the previous week's presentation, focusing on the progress or setbacks. What tasks did they finish? Which students in the group worked with which tasks? The main objective was to monitor their evolution and map out the difficulties in order to work them out in the next meeting.

If the instructor believed that the development has reached a specific level in an activity, he would fill out the loading bar together with the student (Image 2). By talking to the group, they figure out which members should receive the badge for that presentation and which aren't on that level yet. Subsequently, they would write down their individual progress in the individual student's part on the board. The student that didn't reach the necessary level this week can redo this evaluation the following week.

Usually, in group work, some students do the work and learn from it, while others in that same group only sign their name and don't learn anything. In the end, all the students get the same grade and it doesn't reflect their level of learning. With the individual tasks and evaluation, the student is shown that he is responsible for his own growth and his focus should be on what he learns and now what his grade would be. The report card should be a reflection of their learning, rather than the goal in and of itself.

This way, by talking to each student during the evaluations, even if the group successfully finished a part of the project, only the students who actually gained the experience would level up in it. If a different student wanted to level up as well, they were free to take their own time to work on their experience. By seeing the board with each student's "stars", the teacher would be able to see what content was being understood by the students in both an individual and collective manner. This way, they could propose different interventions to strengthen their learning. Therefore, the evaluation wouldn't be an anxious surprise by the end of the semester, but a constant feedback that the student receives during class so he can be aware of what he is learning and how to consciously evolve his abilities.

Image 2. Teacher filling the loading bar during the evaluation meeting in the first experiment.

1.2.3.4 Retrospective

After presenting and filling in the board, it is time for the group retrospective. This meeting should be done in such a way that everyone feels at ease to share their thoughts without being afraid to express their opinions and without being aggressive towards others. This is the moment in which they share their biggest problems during the week – from technical to behavioral issues. The objective is to help the group members get better acquainted with each other and improve their teamwork, participation and work organization. By the end, there should be a list of proposals to improve the problems they mentioned earlier that will be taken to the planning stage. It is important to keep these lists in order to check what problems were worked on every week. "Speak more calmly with my colleagues" or "Make a backup of our files" are a couple of examples of the possible proposals to keep an eye on during the week.

Many students are unable to see their learning process critically and, therefore, don't offer improvements. Because of that, in V4 we implemented the Retrospective table. In every meeting, the group should answer "What was good?", "What was bad?" and "How can we improve?". After every cycle, there would be a graphic organization of their progress as seen through tables.

1.2.3.5 Do it again

After the retrospective, a new planning was made for the upcoming week. This cycle should be repeated consistently so that the monitoring and learning evaluation can be done. Through this routine, the students can keep their focus on their goals and they learn to manage their time properly to grow every week.

2. TESTS

The structure described in Section 1 is a summary of the positive points taken from the five tests we made; V1, V2.A, V2.B, V3 and V4 (Table 1). Each test had a different configuration, involving two or more aspects mentioned previously, and showing the impact that its application or lack thereof had.

V1: The first test for the game board was made with cut up papers, tape and an acrylic sheets. The board was presented during the second month of the course "Project Fab Lab Assistant", when the teachers start to test this idea. Since it was still a prototype, we changed it numerous times during its implementation.

V2.A and V2.B: For the V2 test, we drew an iteration of the V1 board in a graphic software in order to print it out in A1 size. The goal of this print was to maintain a certain standard for the board so that it could be used easily by colleagues in other schools. The *V2.A* was tested in a course for six instructors, in three pairs, who would be responsible for the makerspaces in their schools. Three of them introduced the methodology in their schools. The *V2.B* was in the Fab Lab Assistant class, but from the beginning this time.

V3: We made another iteration and tested it in the "Methodology and prototyping in Fab Lab" teachers course. The idea was to test a version of the game in which the groups were seen individually and not in tracks. We also tested the use of a Retrospective table.

V4: For the fourth test, we tried to use an administrative tool common in the courses – Excel. At the same time, other schools used Online Cloud Tools to manage the goals. We wanted to confirm that it would be possible to develop the method with a tool that is commonly used

in schools. For the development of this work, we had the help of two colleagues that had been teacher-students of the methodology in versions V2.A and V3. They implemented tests that were conducted simultaneously in the following courses: Industrial Process Operator (Frequency Inverters module), Maintenance Mechanic (Machine Elements Technology module) and Fab Lab project assistant. Each teacher turned their formative itineraries into relevant goals, but, this time, the projects were given out by the teacher from the beginning.

Table 1. Experiment Details

	V1	V2.A	V2.B	V3	V4
Summary	Construction of the board with students and teachers that helped to develop the events	V1 iteration tested on a class of teachers for a model that could be replicated in other Maker Spaces	Test applied on a class of students, without routine events	Iteration of V2 for small-scale printing and using the retrospective table	Testing events and project goals predefined by the teachers and using online spreadsheets
Class	Young adults	Adults teachers	Young Adults/Elderly	Adults Teachers	Teenagers/Young Adult
Project	Decided by whole class	Decided by each group	Decided by each group	Customized by the students	Decided by the teachers
Game Board	Constructed in paper like a board game	Printed in A1 size to hang on wall	Printed in A1 to hang on wall and A4 for notebooks	Printed in A3 to hang on wall	Spreadsheet and digital app
Events	The class did the events helping to construct meeting models	The class did the events and were surprised by the reflection moments	The class did not have routine events	The class had events and used the retrospective tables	The class did not have routine events

3. CONCLUSION

3.1 Results

Out of all the experiments we conducted, we saw that the ones that worked best were the ones that included the game board and the routine events. The students who did not have routine events felt lost most of the time because of their excessive freedom. With a constant orientation, we noticed a significant growth in their technical and behavioral abilities.

In the next iteration, we are going to begin by discussing with the teachers the benefits and hazards of following the steps described in this paper. Many times, the teachers left the routine events aside due to their rush to sort out the technical problems. To them, skipping over the meetings gives them more time. However, this has a negative impact in the long run over the students' maturity and their social and behavioral abilities, which are very important in their growth. The best results came from the appreciation of their behavioral and technical abilities and from the time invested in their growth.

Once the students experienced this process in the makerspace, they took their learnings to other classes. Other teachers noted a difference in their posture, a higher interest in the lessons and better relationships between the students.

Overall, their self-criticism was underdeveloped. This part was always seen as difficult in our tests, since it's an ability that the students have never really practiced on. The times in which they were worked upon properly, our students matured greatly. When they were put aside, their learning was not as deep in the aspects of autonomy, responsibility and teamwork.

3.2 Broader Value

We described the step by step process of how we work, described on topic 1, to give our insights on how to organize project-based lessons in makerspaces and to conduct customizable evaluations with the students. We intend to contribute to a discussion about learning assistance through practical and customized activities for the students. We saw that, by using these strategies, we can help the students to develop autonomy, responsibility, critical thinking and creativity.

4. BIOS

Rozeani Araújo is a designer graduated from PUC-Rio and a post-graduate student in Methodologies, Trends and Student Focus at PUC-RS. She is currently an instructor at Firjan SENAI Benfica's Fab Lab, located in the SENAI Institute of Technology Automation and Simulation in Rio de Janeiro, Brazil. She works as a mediator for the students' project development in the institute and aids the multidisciplinary teams to organize the projects and digitally manufacture the prototypes. She believes that it is possible to make a difference in education in Brazil by helping students to focus and to treasure their learning as something more than just grades.

5. REFERENCES

[1] Sutherland, Jeff, 2014. Scrum: The Art of Doing Twice the Work in Half the Time (1st. ed.). Crown Business. New York, New York, United States of America.

[2] Freire, Paulo, 1996. Pedagogia da autonomia: saberes necessários à prática educativa. Paz e Terra. São Paulo, São Paulo, Brazil.

[3] Brown, Tim, 2009. Change by design: how design thinking transforms organizations and inspires innovation (1st. ed.). HapperCollins Publishers, New York, New York, United States of America.

[4] McGonigal, Jane, 2011. Reality is broken: why games make us better and how they can change the world. The Penguin Press, New York, New York, United States of America.

[5] McGonigal, Jane. 2010. Gaming can make a better world. Video. (February, 2010). Retrieved December 15, 2018 from https://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world?utm_campaign=tedspread&utm_medium=referral&utm_source=tedcomshare

[6] Campbell, Joseph, 2008. The hero with a thousand faces (3rd. ed.). New York Library. Novato, California, United States of America.

[7] Gershenfeld, Neil A, Gershenfeld, Alan and Cutcher-Gershenfeld, Joel, 2017, Designing Reality: how to survive and thrive in the third digital Revolution (1st. ed.). Basic Books, New York, New York, United States of America.