

# Fab for Kerala : how Teaching in Fablabs can help in the real world, the Making Of.

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## Abstract

Facing an uncertain and rapidly changing future, Fablabs are a great environment to teach social and technical skills that are relevant for the 21st century [1-3].

At Fablab ULB, we, a professor of architecture and a professor of physics, are experiencing and developing an agile teaching method to make students work with digital tools [4] in interdisciplinary teams and to make a real-world impact.

Starting with a "real world" problem, we guide the students to define their own assignment. To run the class, we use collective intelligence and tools from sociocracy [5-6]. We help the students to use the digital tools within a Fablab and have a conversation with authentic audiences from all around the world.

In this paper, written as a "Making Of", we are sharing our commented "Class Journal" that we built all along the class. We will go through all the steps on how we got 45 students coming from different faculties such as Architecture, Sciences, Engineering and Law, to work together developing open-source projects related to the humanitarian emergencies due to the Kerala floods that happened in India in August 2018 [7].

Building on this experience, we believe that Fablabs are a great opportunity to transform learning and to create resilient citizens ready for tomorrow.

## Keywords

Fablab, teaching, agile, interdisciplinarity, class journal

## 1. Introduction

It is through the third experience of this atypical studio/class given at the *Université Libre de Bruxelles* (ULB) in Belgium that we propose an innovative way of teaching through our university Fablab. This class is opened to advanced students from 4 faculties : the Faculty of Architecture, the Faculty of Science, the Faculty of Law and the Polytechnic School of Brussels.

The goal of this class for the students is to develop open-source projects within the Fablab with interdisciplinary teams of 2 to 4 students related to a "real world" problem. In this case, it was the Kerala floods in India of August 2018.

As teachers, we are driving this semester long workshop in a flexible and agile way to keep it dynamic and to allow optimal action.

The objectives of this class are to open students to new technologies, to digital fabrication tools, Fablabs and new practices enabled by them. All along this class, students work in an interdisciplinary environment, with a social and technical view through a creative and a dynamical process that is individual and collective.

Throughout the class, students learn to

- sharpen their observation skills, their autonomy, their reasoning and resilience skills;
- experiment and use rapid prototyping to explore and develop an experimental and creative project;
- exploit and sharpen their intuition, using trial and error (action before analysis);
- develop a global and a frugal approach based on observation and questioning at multiple scales;
- work as an individual in a group using collective intelligence tools;
- cross disciplines and take advantage of the specificity of each discipline in a collaborative and interdisciplinary project.

All along the class we kept a diary of what was happening during the workshop. That is what we wanted to share and to comment in this paper. This paper takes the form of a **Making Of** that highlight the concerns, the lessons, the questions, the trials and errors that could eventually lead to a possible teaching method.

## 2. Class journal

### An unexpected message from Kerala, India

It all started with a Telegram message from Sibu on a day of summer 2018. Sibu is a member of the Fablab community in Kerala, India. We are from Fablab ULB in Brussels, Belgium.

The Kerala region was under heavy rain, the monsoon was unusually intense. The water level was rising fast and the Kerala state authorities were forced to open 35 of its 54 dams to avoid further damage. This was a catastrophe, bridges collapsed, hundreds of people died, most of Kerala was under water, one million refugees.



Figure 1: Floods in the Kerala region (India) during the summer 2018.

Sibu with several other Indian guys were relating the events on Telegram. Houses were destroyed, snakes were swimming and biting people, mud was everywhere in electronics, furniture, mattresses, ...

People in Kerala needed to organize themselves. They needed to find ways to communicate, ways to save people, ways to feed refugees, ways to organize, ways to remove the debris that were everywhere, ways to create temporary shelters, ways to clean stuffs soaked in water and mud...

People from the worldwide Fablab network responded and some help was organized. Temporary shelters were sent, water purifiers were on their way although they needed some supply from outside the country that did not arrived...

We wanted to contribute and give some help. We were wondering :

- ***What could achieve 45 students in a Fablab (Fablab ULB, Belgium) from different disciplines and countries, working together with the worldwide Fablabs network to develop solutions to help people from Kerala ?***

### Getting to know the students

We gathered the students from our class *Digital Fabrication Studio Q1* that takes place during the first semester of the academic year and we exposed the situation. People were excited to be part of this adventure. Expectations were quite high from the students.

First, we wanted **to know the students** we have around the table. They are **from different disciplines** *architecture* mostly but also *physics, engineering* and *fine arts* students. We have students from all over the world : Belgium, France, Spain, Brazil, Poland, Quebec in Canada,... We wanted to know what their passions are, what they are made of... some already have experience with humanitarian aid, some are high level sports people, ... Everybody as something special that might be useful for the class at some point to help people of Kerala,...

- ***To tackle difficult challenges, it is important to know who we are as individuals and as a group, so we can share our skills and knowledge.***

### Playing to learn digital tools and the power of collaboration

The journey is going to be rough, full of uncertainties. So, the next step was for the students to learn the power of collaboration, how they can self-teach each other and how to use digital fabrication tools. To do that, we proposed to the students to build a collaborative game in group using 2D and 3D design tools and the laser cutter. This assignment was really something and it went really well. Playing, sharing and learning.

- ***To tackle difficult challenges, it is also important to learn powerful digital tools and experience the power of collaboration. If it's done while having fun, it's better.***



Figure 2: Students making and “testing” a collaborative game they designed and made with digital fabrication tools.

## Brainstorming and sharing food

The first step was to get to know the situation in Kerala about the floods, about the culture, about the Fablabs...

Along the team building, we asked the students to gather knowledge from the Kerala situation. Each students came with an image of the floods that he commented. For each image, the group of students had to propose 3 solutions that came directly to their head. This way we were **training the ability of the students to rapidly imagine a solution facing a problem** so they would become solution oriented. We were learning as we were moving. Questions were raised : how do we get reliable information ? What are the sources ? How to make the research ? Students explained how they did it. Some went on Instagram and collected testimonies, some other went directly to the Indian newspapers, some others used YouTube or social media such as WhatsApp, Telegram or Facebook. These kinds of sessions ended as often as possible with preparing and sharing lunch all together.

- ***We encouraged the ability of the students to imagine solutions when facing a problem.***
- ***Sharing food was one of the most important ingredients that we use to create a group spirit in the class.***

## Defining the class assignment with the students

But where are we going ? The students do not really like uncertainties, when the question or the path is not clearly written at the beginning. We did our best to be transparent with them. We played with no hidden cards...

How did we proceed to define the class assignment ? We started a debate by simply **stating the reality** : *people in Kerala are in need, we are in a Fablab connected to the worldwide network of Fablabs, we are 45 students with our knowledge, know-how, passions, we are in a university with a lot of experts and knowledge, we know national and international experts that can help us. What do we do ?* This was the beginning of the debate we had with the students.

- ***We helped the students to define their goals themselves. We were transparent on how we thought as professionals/teachers in these kinds of situations.***

## Reaching out to make a connection with Kerala

To be able to know what we can do, we have to know more about the situation in Kerala. We needed to be connected to local people in India.

The students decided to start trying to reach people in Kerala using several social media, emails, phone calls. On our side, we had sent a request on Telegram (Fab for Kerala) that was active until that point but no answer yet. Students tried to reach embassies, NGOs, ... but this is not easy. Some typical responses were “why do you want to help ? We don’t need help”. We started to be really frustrated and started to investigate why India was even refusing help from other governments. Indonesia was behaving the same with a tsunami that happened on their coasts. But why on earth, people in need do not want help ??? And then we started to have a possible explanation. We had a conversation with Kiran a professor architecture which originated from India. She explained how it was there. **We understood that the very reason we wanted to help them was to learn from them.** We were fascinated by what was happening there and how people were responding to the catastrophe. So, we turned our messages differently. We explained that *we were students from Belgium that have to develop low tech and open source solutions in the context of Fablabs and the Fablab network to address humanitarian emergency such as the one in Kerala. We needed counseling. In return, if our projects would be helpful for Kerala we would be more than pleased. So we were not going to offer direct help but we would help them to help themselves.*

By doing so, we managed to turn the Indian Fablab network attention on our project.

- ***This was a great lesson we learned. Facing a problem, what position shall we take ? The position or the role that we take is key for proposing relevant solutions in complex situations.***

## Meeting Michäël Gäthögö, a Kenya humanitarian maker

Michäël Gäthögö is a humanitarian maker that was in Belgium to train at an NGO *Doctors Without Borders* training camp. We learned that, in Brussels, there was a training refugee camp and people from all over the world were coming to be trained to respond in time of huge catastrophes that could happen anywhere in the world.

Michäël knows very well the field, the life in refugee camps. He came one evening to show us all that he was doing. We learned that, in these unconventional situations, we must set aside our certitudes (they are usually wrong) and be open to start to observe and understand clearly the origin of a problem. Sometimes we don't need highly technological intervention, but a simple and clever response could help a lot and radically change the life of people.

- ***A simple solution at the right place can transform a system.***

## Suddenly, we have an answer from Kerala with people ready to help us

And suddenly, while being a little desperate, several Indians were answering to our call on Telegram and rapidly we decided to organize a video conference.

Students were excited and at the same time scared to death at the idea of confronting their ideas to the real world and real people.

## Boosting the class project with collective intelligence

To prepare the video conference, we needed to define better what we wanted to do as a class. Each student had some idea of a project, but they were all over the place.

So, we asked Anissa to help us. **Anissa Ouertani** is a consultant in collective intelligence. She likes to say that she is just there to put “oil” in the social human machine [5-6]. We let her lead the class for one and a half day. We would accept to play the game. She did a tremendous job ! First, we reflected on **how to behave as individual in a group**, to respect everybody, we learned a code of conduct... Then we experienced **a way to make group decisions** by applying a method of “*management by consent*”. As teachers, after listening to what the class had to say, we proposed a class assignment and students would have the ability to ask for clarification, make remarks and objection. They were some objections that would be rapidly relieved after some explanations or little tweaks in the wordings of the assignment. As nobody had an objection, the statement has been accepted and we celebrated this very important step ! This process was a real relief for the students as for the first time we were going to build on a solid basis made by the group on which everybody agrees.

The next day with Anissa was about defining the students projects. An intense program where students learned the power of collaboration, we played different games for icebreaker or experience collaboration. Students brainstormed different projects, they grouped by thematics and made four larger groups that would organize and meet regularly to exchange state of the art, questions, problems... we learned a lot of different **sociocratic tools** that we would use for the rest of the class. After that day, students were exhausted, not sure about where they were but at the end, they were happy because they had made decisions and there were less uncertainties.

- ***Our position as teachers changed from that point, we became the guardians of the class assignment that was set up collectively.***



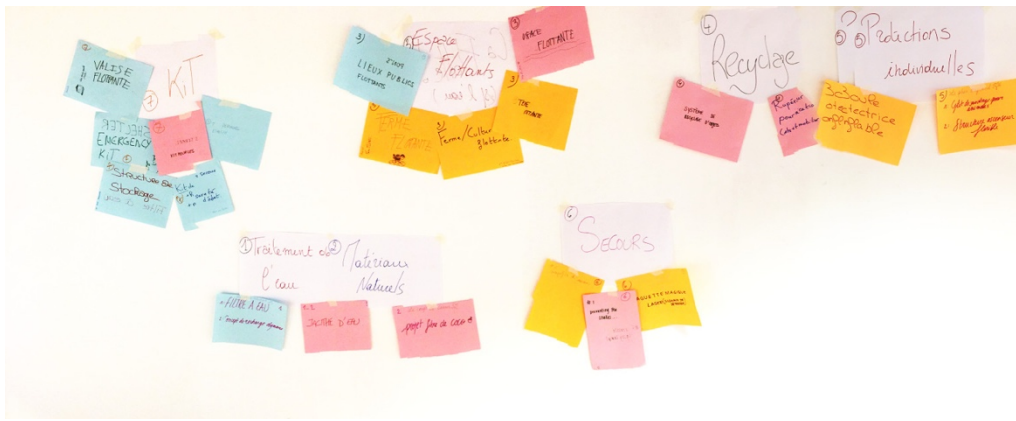


Figure 3: Here was the result of our brainstorming *before* contacting local people in Kerala.

### First video conference with Kerala

Then came the day of the video conference with Kerala. We gathered all the student in one of the author sciences lab (where the internet connection is more stable...). 45 students in the lab that was a lot. We decided to make a **fish bowl** where there is an inner circle with group representatives and the computer holding the video conference and an outer circle with the rest of the students. Stress was really high. We used another tool that Anissa taught us which is by passing a **speaking stick** everybody had the opportunity to express how he felt at that moment and what were his expectations. We felt that the class was really stressed and needed to be calm before the video conference. So, we improvised a **guided meditation** which revealed to be life-saving. Everybody was calmer and attention was high.

Then came the moment of the video conference. We had 7 people from Kerala that were connected by one way or another to a Fablab in Kerala. They were really kind and helpful. They explained the situation they lived in details. Three students were writing all they were hearing. There were lots of information exchanged. Then the different group representatives asked questions related to their projects. This part was more than helpful. First, most of the students understood that **they were doing something real** further than the simple *abstract* assignment. Also, they understood that **their idea they had in mind might have a potential impact and could be useful to other people**. After the talk, students were shaken by all the information they received but at the same time they were empowered with confidence that they are doing something meaningful.

In the afternoon, a group of students started a collaborative document to report the meeting and serve as a common basis on which we can build the rest of the projects. Another group of students decided to reorganize the group thematics in different categories related to the timing of the catastrophe: **prevention** (before a potential flood catastrophe), during the **catastrophe** (chaos), during the **refugee camps** (a few weeks or months after the catastrophe) and the **reconstruction phase** (few years). Energy in the class was at its highest. Students started to see the relevance of their projects and wanted to celebrate. We went for a drink in a bar nearby.

The different projects were still a bit abstract and not really well rooted with reality. We thus pushed them to rapid prototype parts of their project to see the weakness and the strength of each project.

- **Confronting their projects to real people, the students realized themselves the adequacy of their proposal according to the reality and the temporality of the catastrophe.**

### One week away in the countryside

During this class, there is one really important moment, usually a **time for transformation for the students and the class and a milestone for the projects development**. It is the one week stay in the countryside where students are away of all their usual busy life and where they could concentrate only on their project.

This year we chose *Haugimont* (Faulx-Les-Tombes) a remote place in the Belgian countryside. Furthermore, we would be really close to the Fablab of Andenne, a small town in the south of Belgium.



Figure 5: A very intense one week stay in the countryside

We invested a lot of energy in **making the group to bond** while immersing each student in the context of their project. We would **question each parts of their project**. Now, that the projects were getting more defined. Students started to confront them to external "experts", Michael Gäthögö, a Kenyan maker that works in refugee camps was of an invaluable help. People from the Indian FabLab from Kerala were quite responsive too on the Telegram.

- *During that stay, students had the opportunity to experience : that when a problem comes, it is an opportunity to create a solution that not just fixes the problem but improves the overall situation.*

### Prototypes, prototypes and prototypes.

We spend the next two days at Yourlab, the Fablab of Andenne, where students would prototype and question their project. **Nicolas Arnould** the fabmanager from YourLab was really helpful. This was really intense.



Figure 6: Prototypes, prototypes and prototypes at Yourlab (Andenne, Belgium)



In the evening, we would share food that the students have made. We even ate Indian food that Lucie, a student, prepared for us. That was so good.

The last day, students shared and presented their work they have done during the week.

This whole week was a pretty important time where we learned to work as a group with its ups and downs. Every time there was a problem, we would discuss on how to solve it. **It is a habit to take, not just complain about problems but acting to solve them.** The group was rock solid at the end of the week.

After that intense week, we usually have a small down in the group energy. This is normal. Rapidly, most of the groups were defining their final projects and made a short summary of it. The different projects summary were send to Kerala and a second video conference was organized.

- ***During this very intense week, it was important to make the students to rapid prototype : design, make, test, evaluate, redesign, remake, and so on.***

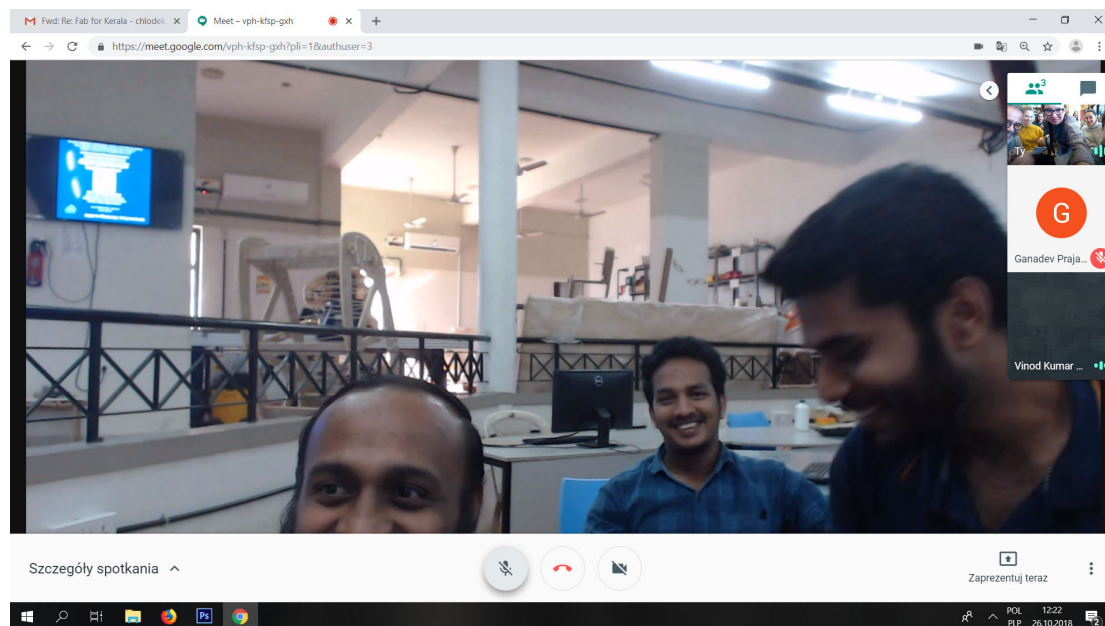


Figure 7: Second video conference with Fablabs of Kerala, India

## Reaching out for help

The projects were more and more relevant, but students needed support, they needed experts that could give them advice to realize their projects. We have plenty of competent people all around us in our university, outside our university, national, international, in the Fablab network, ... We pushed students to reach out for help which worked pretty well. They have contacted about 60+ national and international experts (acknowledged below) that gave tremendous help. ***We really wanted to thank everybody that helped us in this adventure !!*** The quality of the projects improved a lot thanks to outside help.

After the second skype with Kerala, some groups were already very advanced, and others were completely lost. So here came the work of surgical operations for us where we would help students to transform their problems into opportunity to improve their projects. Every group was different with efficient and less efficient processes. But at the end, it worked fine for nearly all of them.

- ***We were surprised, even impressed, by the number of national and international experts (more than 60) that the students contacted to get help.***

## First pre-jury

Just before Christmas, we organized a day of presentations for the projects. Students prepared a **Pecha-Kucha**, 20 slides and 20 seconds per slide. This presentation format was invented by designers to share rapidly and dynamically their work. Students have to prepare. They don't always like the strong



constraints but after training several times, it worked pretty well. They would also present all the prototypes they have made. The general conclusion was that for most of the groups, their project was really well defined thanks to the experts they have met and their research on the situation in Kerala. However, prototypes could have been more developed. Rapid prototyping is a skill you have to learn and practice. **The technological skills is sometime a barrier to allow the students to express their thoughts through the realization of prototypes in the fablab.** These are important skills that Fablabs can help to train.

### Final jury

One week before the final project presentation in front of an external jury, students pushed their projects very hard. It is a strange habit in the architecture culture, they would wait until being really close to the deadline, for a last hard push that sometimes give ways to very creative solution. When under stress, you are forced to make decision and if stuck, you have to find a solution that can sometimes be surprisingly creative.

For the final push, we opened the Fablab and students would come and work night and day.

On the day of the final presentation. We have invited a wide variety of experts to evaluate the projects of the students. We had a Belgian architects from ULB that have Indian origin, a leader of the worldwide Fablab network, a *Doctors Without Borders* field agent that work in refugee camps and build hospitals all over the world, a meteorologist that spend all his spare time in our Fablab, a fabmanager, designer and photographer, a skilled electronician, a skilled autodidact/DIY and a researcher and ULB professor of Intellectual Property.

Each group had the opportunity to report their work. We would appreciate (i) how relevant is the problem they have identified and how they propose to act to solve it and (ii) the prototypes they have made that demonstrate the feasibility of their project in Fablabs.

Adrien Centonze, the new fabmanager of Fablab ULB, that was hired at the end of the class, helped us to build a website with the students to share their projects. The website was built in less than a week. But it was important that the projects of the students could be documented and spread in the Fablab network and all over the world.

- ***At the end, we felt our help was not anymore required. We felt obsolete... That is the best (and weirdest) feeling a teacher can feel announcing that students have taken the lead on their project, they know where they were going, energy was on their side, they were autonomous.***

### 3. A selection of developed open-source projects

Here are a few remarkable projects among others (all can be found here [7]) where we can appreciate the proposed solution and the process the students have followed:

#### A waterproof backpack :

How to protect in a flood people's precious personal belongings such as diplomas, certificates, administrative papers... ? The project is about fabricating waterproof backpacks in tarpaulin using a pattern and soldering machines that would be made in the Fablab network in Kerala. Every village would receive one machine and a pattern to reproduce the project in the desired quantity.

#### A foldable boat :

During the Kerala floods, 4500 fishermen with their boat saved about 65 000 people. Would it be possible to produce boats in a Fablab that could be used in case of emergency ? Making enough and affordable boats for a population as large as the one of Kerala is not an easy game. The project is about turning one standard sheet of plywood (122cm x 244cm) in a foldable boat that would suit one family and could be easily reproduced using a pattern.

### **Spirulina pump :**

The 3 months after the catastrophe, there were one million refugees in camps. The question was about reducing the amount of food that is transported during this transition period.

Students have calculated that to feed 300 people (average quantity of people per camp) with enough nutrients except sugar you need 50 m<sup>2</sup> of space to cultivate spirulina. The project was to develop a pump that brings oxygen 4 to 5 hours per day, which is the amount that is necessary for the spirulina to grow.

### **Road markers**

When 80% of the land is flooded, how can you navigate by boat without damage avoiding trees, roofs, antennas... ?

The idea would be to place beacons, like those signaling wreck to navigators, at every crossroads. These would be made of recycled plastic using colors to signal where to pass and would deploy as soon as the road is flooded.

### **Water Filters**

Purifying water requires some high-tech systems such as ultra-purification membrane in polymer. What if we could use available materials to make a water filter ? Students have worked on a water filter made of pine wood. This is a really promising endeavor that would definitely need to be pursued

## **4. Conclusions**

Based on the students' multiple introspections all along the semester, we have found that the social experience is a real highlight. Students valued the unique moments of real collaboration with their peers, the unusual and genuine relations with their professors (thanks to the sociocratic tools). The one week stay in the countryside is definitely one of their best experiences. Some said that they really learned to try, fail and rebound while being supported by their peers.

They would have liked to learn more about the digital fabrication tools but one semester to learn all that is really ambitious. In future years, our hope is to get the students earlier in the Fablab so they would know the tools at the beginning of the class. Another option that would be ideal is to expand this class to a two-semester long class, but this is difficult due to the schedules imposed by our university.

At the end, it is 17 very diverse projects that were prototyped and documented, all feasible in a Fablab environment [7]. All the groups, in collaboration with local people in India, identified a relevant question to work on. Some are advanced, they could be reproduced right away in an Indian Fablab, others are still under development. All these projects are open-source and shared on the Fablab ULB website [7]. Particularly, students learned the power of Fablabs and its network, the power of collaboration, the power of interdisciplinarity and experienced the highs and lows of a real-world project development. To illustrate the latter, here is a figure made by a physics student in its final introspection that speaks for itself (inner feeling vs time).

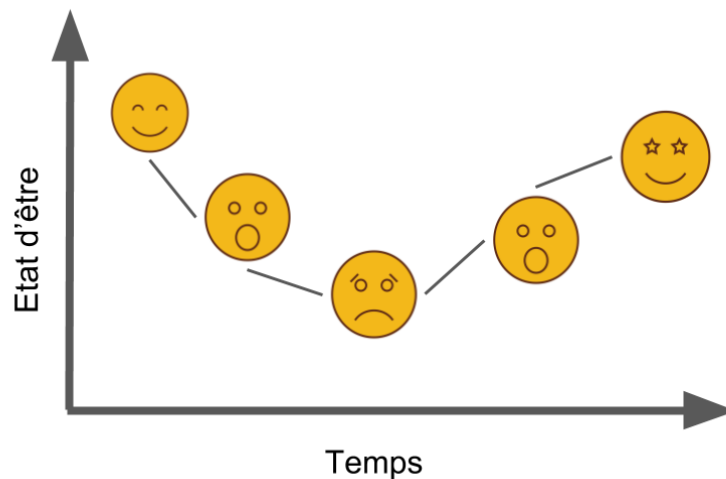


Figure 9: Inner feeling vs time of Ibrahim Khaled, a physics student, all along the semester  
[image taken from the student final introspection]

Taking a step back and analyzing the solutions that are proposed by the teams of students, we notice that they are usually outside their field of study [8]. During the semester we saw architecture students talking about physics, we saw physics or engineering students talking about architecture and interested in more social issues. Following the process described above, what became the center of their preoccupation was the question to be solved and the new skills, competences and help they needed to acquire as problems arise.

We believe that teaching that way could lead to a new and innovative course entitled :

### ***How to solve (almost) any problem in complex situations ?***

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