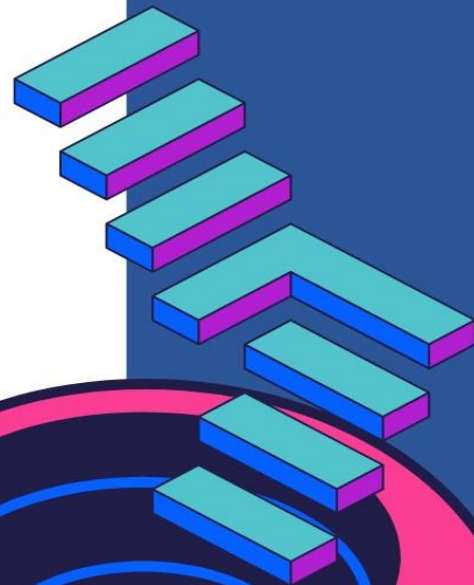


Encouraging **STEM** areas in the force of the labor future

Make it real

June 5, 2023



**Pontificia Universidad
Javeriana, Cali**

Manuel Alejandro Orejuela Garcés
Jorge Andres Figueroa Soto
Juan Fernando Plata
Laura Melo Escobar

Table of Contents

1.Introduction

- 1.1. Executive Summary
- 1.2. Design team
- 1.3. Glossary

2.Context and need-finding

- 2.1. Problem definition (Colombia)
- 2.2. Fieldwork and empathy
- 2.3. Characterization of the stakeholder map
- 2.4. USER’S PERSONA
- 2.5. Identified needs

3.Surveillance

- 3.1. Powerful, breathtaking, and engaging exhibits
- 3.2. Taking STEM to the Home of the User
- 3.3. Redefining and redesigning education

4.Design process

- 4.1. Ideation
- 4.2. Prototyping process
 - 4.2.1. STEM Box
 - 4.2.2. STEM Box Kids
 - 4.2.3. STEM evolution
 - 4.2.4. STEM wars
 - 4.2.5. Ulink
 - 4.2.6. Ciencia Armónica magazine
 - 4.2.7. STEM finity
- 4.3. Prototype Conclusions

5.Convergence process

- 5.1. Required professional support.

6.Final prototype: STEMfinity

- 6.1. STEMfinity concept

6.2. STEMfinity delivery structure

6.3. Contents of STEMfinity deliveries

- 6.3.1. The magazine
- 6.3.2. The mini project

6.4. The value proposition.

- 6.4.1. Subscriber's perspective
- 6.4.2. The client's needs
- 6.4.3. The user's needs

6.4.4. The sponsor's perspective

7.Design development process

- 7.1. Magazines
- 7.2. Mini Gadgets
- 7.3. Boxes
- 7.4. Teaser

8.For further development

9.Business model

10.Final validation

11.The role of each career within the project

- 11.1. Electronic Engineering
- 11.2. System Engineering
- 11.3. Biology/Psychology

12.Process reflection

13.Milestones

14.References

- 14.1. Bibliography

15.Annexes

1. Introduction

1.1. Executive Summary

This project is sponsored by the SUGAR Network, a global initiative that was founded in 2008 and comprises 24 universities from 4 different continents (Fig.1). The network aims to provide a cross-international platform where students from diverse backgrounds can generate a positive impact on their communities by designing and implementing innovative solutions to complex challenges posed by real world corporations. The execution of the present project follows a nine-month schedule based on the design thinking methodology, which is an iterative process that guides the delivery of user and customer-oriented solutions to tackle intricate problems. (SUGAR, 2022)



Figure 1. SUGAR Onboarding of universities (SUGAR, 2022)

15 years ago, Colombia's Pontificia Universidad Javeriana Cali (PUJ-Cali) became a member of the SUGAR Network. In this period, the PUJ-Cali has had the participation of more than 88 students in 33 innovation projects, a process that has highlighted an effective way of Corporate-Academy relationships and the importance of the interdisciplinary and intercultural in the establishment of international networks (Aguilar & García, 2017).

The team come over a problem statement, defined by the corporate partner PUJ-Cali, an institution run by the Society of Jesus with more than 400 years of educational experience in Colombia. As a company, it aims towards the integral formation of people who stand out for their high human, ethical, academic, and professional qualifications and for their social responsibility; and, the creation and development of knowledge and culture in a critical and innovative perspective, for the achievement of a fair, sustainable, inclusive, democratic, supportive and respectful society with human dignity (PUJ, 2013).

As part of the sponsor's mission and led by the conviction that "education is key to transform the world" (PUJ, 2023), the PUJ-Cali aims their attention to Latin America and the low rate of students graduating from Science, Technology, Engineering, and Mathematics careers, also known as STEM (Zilberman, 2021). A pressing problem, taking into account that in the last few decades this line of work has been building a wide and growing demand in the job market (UNESCO, 2020).

With the present concern, the PUJ-Cali and ISDI join up over a real-life problem regarding STEM education in the city of Cali, Colombia. The challenge issued by Luis Tobon, the PUJ- Cali's liaison and Electric Engineering Program Director, consists of:

“Increasing the passion for Science, Technology, Engineering, and Math (STEM) in children between 8 and 16 years of Cali schools, considering the low performance in international tests (PISA) and the reduction of university students in these areas.”

To answer this challenge, the research team implemented a Design Thinking method, a human-centered approach to innovation that focuses on the feasibility, viability, and more importantly, the desirability of new products and services. These characteristics are the basis of five cyclic steps (SUGAR, 2022):

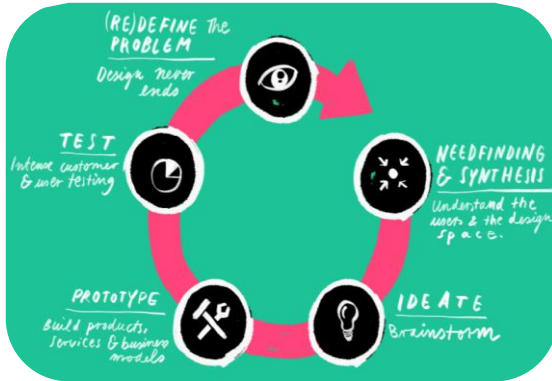


Figure 2. The Design Thinking Micro-cycle (SUGAR, 2022).

Regarding the **need-finding** process, we wanted to know:

1. The perceptions of people involved in this problem.
2. What is being done around the world to promote STEM in schools?

For the first point in our agenda, we made use of the following design thinking techniques. Initially, we established a **Stakeholder map** and conducted over 30 interviews to psychologists, STEM program directors, schools' deans, STEM teachers, parents and our primary user school students. These interactions were guided by a semi-structured interview and also observation of classrooms.

This technique allowed us to understand the problematic from different perspectives

and also identify the following needs regarding the lack of interest in STEM:

- Bad math performance
- Uninspiring environment
- Wrong career expectations
- Digital distractions
- Economical needs

Next, to gain deeper insight into the current strategies to promote STEM, we reviewed over 50 sources and classified them in the following categories:

- Breathtaking exhibits.
- STEM at home and gamification.
- Re-defining and re-designing education.

After a thorough research, product from the empathy and benchmarking process, it was time to think of a solution. In this **ideation** process, we used brainstorming and spider-web techniques and in the span of 3 months we discussed about 236 ideas. These ideas were grouped in the following topics:

- Exhibits/On location activities.
- Video games.
- Products.
- Teaching methodologies.
- Rewarding System.

Out of these ideas, 7 prototypes were developed, and one product idea was selected:

“A subscription-based box that comes with an interactive magazine and experiments.”

With this in mind, a prototype called **STEMfinity** was developed, its goal was to:

“Help kids develop an interest for STEM fields. We want to showcase STEM as a fun and interesting subject that is also part of their daily lives”

In the design, we considered 5 key components:

1. Frequency
2. Theme-based
3. Storytelling + Learning
4. Hands on mini projects
5. Collectible objects

The idea is that each month during a span of 3 months, the kid will receive:

- A magazine.
- A package of stickers for the magazine.
- One mini-gadget.

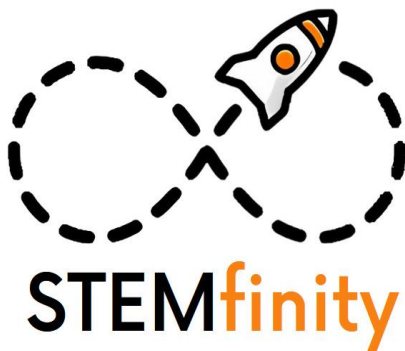


Figure 3. Prototype logo

Each trimester would correspond to one STEM theme such as: Space, Nature, Industry, etc. Where each month the service will tackle one key topic within these STEM fields.

The STEMfinity prototype was validated with two age groups, **20** third graders (7-8

y.o) and **28** sixth graders (10-11 y.o). This testing provided new key information about:

- Student’s engagement and likability with the service.
- Classroom applicability.
- Teacher’s involvement in the process.

As a result, this prototype represented the integration process, a combination of all design components made for a high-value concept that seems to be headed in the correct direction when it comes to solving our challenge.

1.2. Design team

PUJ team



Manuel Orejuela
Electronic Engineering



Laura Melo
Psychologist
Biologist



Jorge Figueroa
Software Engineering



Juan Plata
Software Engineering

Personal descriptions:

Manuel Alejandro Orejuela:

I am Manuel, and I'm from Santander de Quilichao Cauca. I am 21 years old and at this moment I am finishing the ninth semester of Electronic Engineering. I love science, and programming, I am passionate about investments in the forex market, and now I have a huge interest in getting into Artificial Intelligence programming. Beyond academics, I enjoy physical activities such as basketball, jogging, or

going to the gym. In my free time, I enjoy spending time with my family, watching movies, being with friends, and reading a book of personal interest, among other activities. Finally, I define myself as a person who enjoys self-learning.

Laura Melo Escobar:

I'm Laura Melo, I have a bachelor's degree in psychology, and currently I'm a 3rd-year student of biology. I was born in Bogotá D.C. but since 2014 I have lived in Cali, a place that I consider my second home. Since I was in school, I always found

science, the human body, and the mind interesting, hence my passion for neuroscience and research with the purpose of helping people and increasing their quality of life. Recently I've taken on a new hobby, completing a coloring book full of different wild animals.

Jorge Andres Figueroa:

I am Jorge, a student of software engineering and computer science with an emphasis on data engineering. I am interested in test automation and machine learning. I am a person with the ability to adapt to changes, who seeks to develop in interdisciplinary environments and strengthen my professional skills.

Juan Fernando Plata:

I am Juan Fernando, a student of software engineering and computer science at Javeriana Cali. I like driving in general, from cars, motorcycles, and even airplanes, what I love is the feeling of speed and power that you have when you are driving. I also like to go to rivers and lakes to swim and fish. On the other hand, I am a person who communicates very well and loves to spend hours talking with friends about the simplest things.

1.3. Glossary

PUJ-Cali: Acronym for Pontificia Universidad Javeriana Cali, a Jesuit University located in Cali, Colombia.

STEM: STEM stands for "Science, Technology, Engineering, and Mathematics." It refers to a broad academic discipline that encompasses these four fields of study.

Design thinking: Problem-solving method that emphasizes empathy, creativity, and experimentation to generate innovative solutions. It involves understanding user needs, defining the problem, ideating solutions, prototyping, and testing.

Stakeholders: Stakeholders are individuals or groups who have an interest in a company, project, or organization. They may include investors, employees, customers, suppliers, government agencies, and the community. Stakeholders can have a significant impact on the success or failure of a project or organization, and it is essential to consider their needs and concerns when making decisions.

Need finding: Is the process of identifying and understanding the needs, wants, and expectations of users or customers.

Benchmarking: In the context of the design thinking method, benchmarking involves researching and analyzing existing products, services, or experiences to gain insights and inspiration for design. Benchmarking can help designers understand what works and what doesn't work in existing solutions and identify opportunities for improvement.

User persona: Is a fictional representation of the typical user of a product or service. It is created based on research and data collected about the target audience, including their demographics, goals, behaviors, and pain points. User personas help designers empathize with their target audience and design products that meet their needs.

Brainstorming: It refers to a creative problem-solving technique that involves generating a large number of ideas in a short amount of time

Prototype: It consists of a preliminary version or model of a product, service, or system that is created to test and validate ideas before building the final product. It allows designers to experiment with different ideas, features, and functionalities in a low-risk, low-cost environment.

Gamification: the process of incorporating game-like elements, such as points, badges, and leaderboards, into non-game contexts to engage and motivate users. This technique is often used in education, marketing, and other areas to make tasks more enjoyable and increase user engagement. By applying game design principles to real-world situations, gamification can enhance motivation, learning, and behavior change.

Low Code platform: Is a software development platform that allows users to create applications or systems with minimal manual programming. Instead of writing code from scratch, users can use visual and pre-defined tools to drag and drop programming components and logic in a graphical environment. This can significantly reduce the time and effort needed to develop a complete application.

Album Jet: In Colombia it is well known as a strategy that is used for a national chocolate brand called “Jet”. The strategy consists in providing a magazine or album that shows informative content related to nature.

Augmented reality (AR): A technology that superimposes computer-generated content, such as images, videos, or 3D models, onto the real-world environment, enhancing the user's perception and interaction with their surroundings.

2. Context and need-finding

2.1. Problem definition (Colombia)

Science, Technology, Engineering, and Mathematics careers and postgraduate studies, also known as STEM, have a wide and growing demand in the labor market. According to the International Data Corporation (IDC), it is estimated that by 2024 there will be a growth of more than 10 million in demand for professionals in these areas. Despite this, there is a great deficit in the training of these professionals in Latin America, due to the low rate of students graduating in these areas, because of low interest or desertion in university careers. This lack of interest in STEM careers can be observed in the recently published date of Remitly, a company who analyzed global Google searches made between October 2021 and October 2022 with the query "how to be a..." (Figure 4). In Latin America, the most popular searches were related to how to be a social media influencer and business entrepreneur.

In Colombia, this situation is strongly experienced, especially in universities, where it is evident that the percentage of students who are associated with STEM careers is increasingly lower. It is also worth noting the large gender gap, where women are the least involved in this type of careers (Zilberman, 2021).

All the above is supported by reviewing different reliable sources of information. Starting from the databases of the SNIES platforms (National Higher Education System), where there is data related to the number of students enrolled in STEM careers over time. This information can be

seen in figure 5, it is evident that, in recent years, from 2018 to 2021, the number of enrolled in these careers has increased progressively.



Figure 4. Dream jobs. (Remitly)

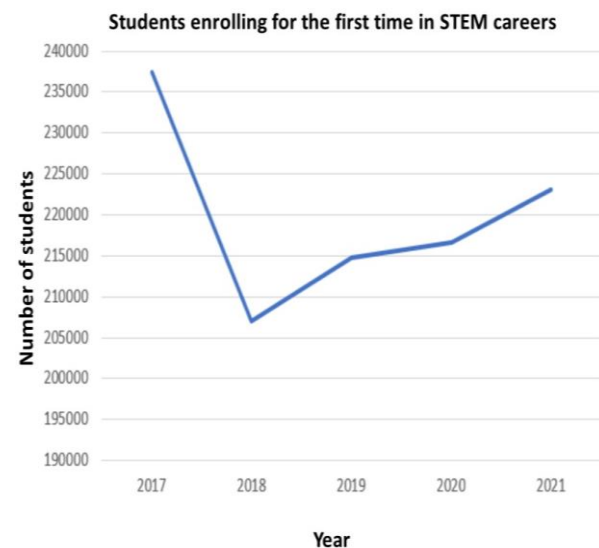
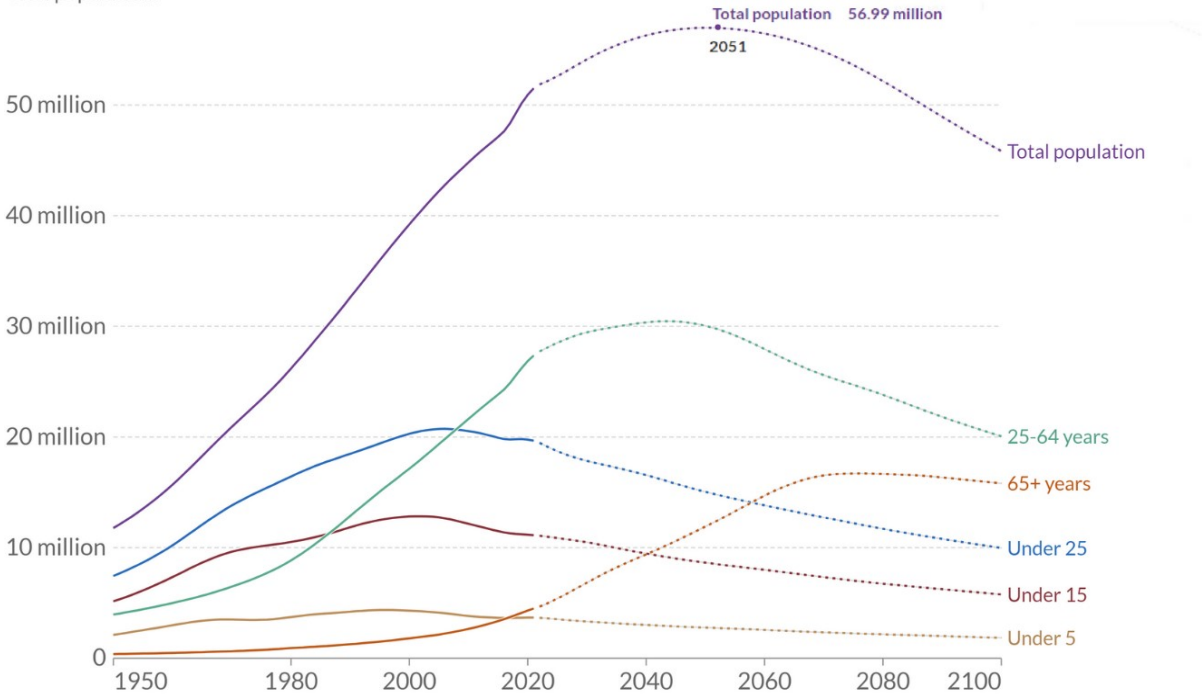


Fig 5. Students enrolling for first time in STEM careers (SNIES, 2021)

Population by age group, including UN projections, Colombia

Future projections are based on the UN's medium-fertility scenario. This is shown for various age brackets and the total population.



Source: United Nations - Population Division (2022)

OurWorldInData.org/world-population-growth • CC BY

Fig 6. Students enrolling for first time in STEM careers (SNIES, 2021)

In addition, the growth of the Colombian population was observed through the Our World in Data platform (figure 6). It is estimated that the population will grow constantly until 2051, however, the growth of the population under the age of 25 (the population that will be the labor force of the future) is expected to continue decreasing.

When comparing the population growth of Colombia with the number of STEM enrolled students, we notice that since 2018 the population and the number of students are not growing proportionally, but rather the population is growing at a higher rate

than the number of students (Graph 7). This disproportionate growth means that Colombia had a deficit of students enrolled.

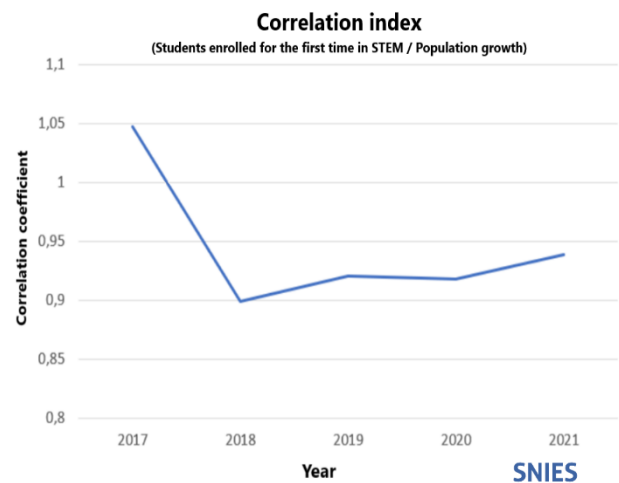


Fig 7. STEM Enrollment/Population Growth Correlation Index (SNIES, 2021)

Another concern in the Colombian context is the poor results in the PISA tests, specifically in the categories related to STEM. For this reason, Colombia ranks low compared to Latin American countries. In figure 8 you can see Colombia's score in science and in figure 9 the performance in mathematics.

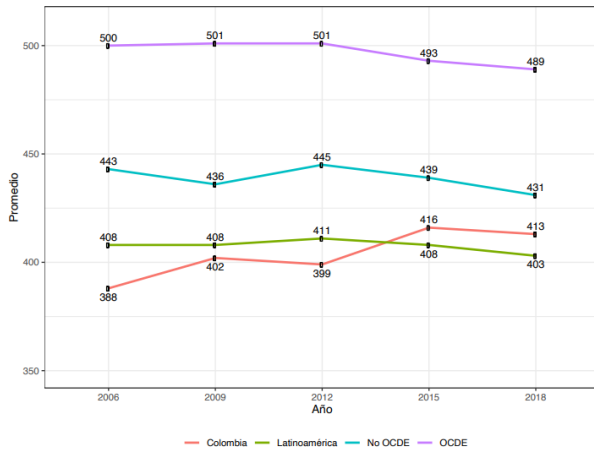


Fig 8. Science score of Colombia in PISA through the years(ICFES, 2020)

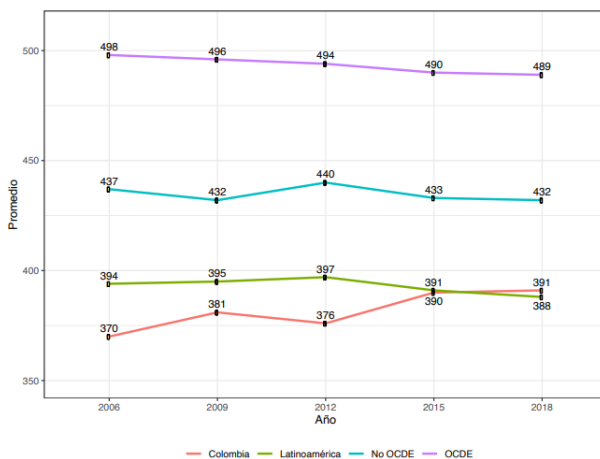


Fig 9. Math score of Colombia in PISA through the years(ICFES, 2020)

Given all of the above, PUJ- Cali, a higher education institution committed to educated well-rounded professionals, aims

to offer a solution to increase the interest of children and young people aged 8 to 16 in the city of Cali, in the STEM fields. The goal consists in reducing the deficit of students in these careers, thereby ensuring that Colombia is prepared to meet the future demand for experts in these areas.

2.2. Fieldwork and empathy

The first stage for understanding the challenge was the need-finding process. The main goal of this stage was to allow the design team to gain insights from the stakeholders of the problem. The team needed to know who they were, what their needs were, what they did, and how they were affected by the problem.

In the need-finding process, the design team started by thinking about the children because they would be the main users of the solution. However, they eventually extended their perspective to include all the people involved in the problem. With this in mind, the next stakeholder map was built:

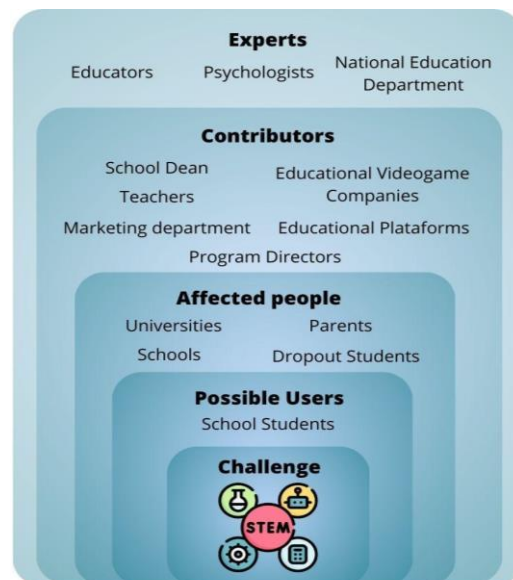


Fig 10. Stakeholders map.

Possible users: Students are the final users; they will be the ones that our solution focuses on.

Affected people: Those who take decisions about the education process in the schools, the universities, and the region.

Contributors: The people and entities that make a part in the education process.

Experts: The experts in the mind, and how the brain works during the learning and education process.

Interviewing

To gain some insights from the different stakeholders, the design team conducted interviews to empathize with the people involved in the problem. As part of this task, the team opted for conducting semi-structured interviews to gather as much information and perspectives as possible. The next stakeholders were interviewed:

- Elementary school students
- High school students
- Academic school directors
- STEM Program directors
- Parents
- STEM school teachers
- Psychologists

Program directors

“There is an aversion to math and science.”

In general, the career directors mentioned in schools and young people there is a rejection of mathematics and science (especially mathematics). In conjunction

with this, the courses that are generally most difficult for people entering STEM programs are courses such as Mathematics, Differential Calculus, Integral Calculus, etc. and they believe that this is due to both a poor conceptual foundation and a rejection of mathematics.

“We must ground expectations and raise inputs to get closer to the ideal.”

Speaking of education in Colombia, attempts by different governments to improve the educational system are recognized, but since these attempts are based on educational models of countries with very different socioeconomic and cultural conditions, they cannot be implemented, in addition to the fact that these are government policies and not state policies, so that when the government changes, the proposals are changed.

“There are very unstimulating conditions, in a private school, in general, there are laboratories, in the official one there are not.”

It was commented that achieving interest in any area of study in public schools is complex since many factors hinder learning. One factor that hinders learning in public schools and at the same time differentiates them from public schools is the presence of laboratories, which is very important since it is thanks to the laboratories that all the theoretical knowledge acquired in the classroom can be put into practice.

STEM school teachers

“The teaching process should always keep a global goal in mind. Each teacher contributes to such a goal from his field of expertise.”

Recognizing that young people like to know the real utility behind what they are learning, some teachers think that learning in general seeks to train the student to be a problem solver.

“If teaching is made with passion, then it is more likely that interest towards the subject will be sowed in the student.”

Within the learning process, the role of the teacher is very important, it is not enough for the teacher to teach the content, he/she must do it with vocation so that he/she can inspire his/her students to continue learning. Teachers are aware that their role is very important for the learning process, and they recognize that even in their STEM fields there are students who have an affinity for other areas, but their responsibility is to teach correctly.

“People tend to have this wrong idea that dealing with numbers is hard. And that's why people tend to avoid careers that involve too much of them.”

Teachers mention that in general students have some difficulty with mathematics, but that sometimes students do not even allow themselves to try to solve problems, but rather shield themselves by saying that they are bad with numbers. Also, since mathematics builds complex theorems from simpler theorems, if there is a failure

in simple theorems, there will be failures in complex theorems.

Observation

To understand the needs of the students, it was discussed what could be a good way to acquire information about their interests in STEM. After benchmarking and conducting interviews with school teachers in STEM, the team came to an agreement that laboratory experiences can boost students' interest in this topic. With this in mind, a visit to the virtual chemistry lab in Lacordaire was arranged.

The virtual chemistry lab in Lacordaire allows students to see atomic structures, perform reactions, and explore theory in a digital environment.

While the team visited the lab, the students had an activity where they had to make groups of 3 and solve a quiz in the virtual lab.

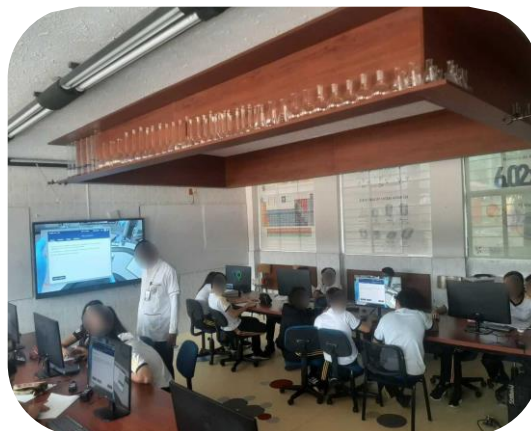


Fig 11. Observation of a virtual chemistry lab.

During this observation, the team realized many things. Most students like this type of lab over conventional labs because they have easier access to information and can move more quickly through the topics (although there were also a few students

Why the lack of interest in STEM?



Fig 12. Why the lack of interest in STEM.

who preferred the normal labs). On the other hand, the professor recognizes that his role has changed more towards being a guide since now he is not the one who presents the information to the students, but they can access the information at all times.

Students shared some opinions about the laboratory:

“I prefer physical laboratories, if something has to explode, let it explode.”

“I like the virtual labs because they are faster, and I feel I learn more.”

“I would like to know how much it changes in a real environment.”

On the other hand, the team asked the students if they were aware of whether they

wanted to pursue university studies and what they wanted to study. It was found that

the majority of the students were uncertain about what they wanted to study.

2.3. Characterization of the stakeholder map

To summarize the answers of the stakeholders regarding the lack of interest in STEM, the team highlighted keywords following three categories:

Relevance: Defined as the perception of whether the STEM course/content satisfies personal needs, goals and/or career goals (Frymier & Houser, 1998).

Resources: It includes the human talent, physical and overall economic resources invested in the education system. In this case, laboratories, teacher’s training, field-trips, etc.

Motivation: A stimulus or influence, incentive, drive, something that causes a student to act; and the expenditure of effort to accomplish results (Vero y Puka, 2017).

A total of **30 interviews** we conducted to experts, contributors and these were their highlighted answers:

The results indicated that all the stakeholders agreed in the **need of relevance** in the content of STEM subjects, where applicability and real-life experiences are required to understand the purpose of STEM lines of work.

Additionally, contributors like college program directors and school teachers point out the **lack of resources**, taking into account that laboratory equipment is expensive and not for easy access.

Lastly, experts such as educational psychologists focus on the importance of **motivation**, with an active role of students in the classroom that are able to overcome the demands. Contributors like educational video game developers suggest gamification as an alternative to approaching difficult subjects and making them less boring.

2.4. User'S persona

To illustrate stakeholders that the team found to be directly involved with the challenge, a series of profiles were created for the better understanding of personal contexts:

- *Patricia, the working parent:*



Fig 13. <https://www.istockphoto.com/es/fotos/madre-soltera>

Description: Patricia is a 35-year-old working mom with a tight schedule. She lets her kids do their homework on their own unless they have questions, if she can't answer it, they look it up on the internet. Even though she doesn't like that her kids spend too much time in front of a screen, Patricia doesn't see another alternative to keep them entertained. In the future, she hopes her kids will do better than her and have high-paid jobs.

1. *Jaime, the school's Chemistry teacher:*



Fig 14. <https://www.f1online.de/de/bild-details/3688497.html>

Description: Jaime is 60 years old and has been teaching chemistry to high-school

kids for 30 years. Most of his classes happen inside a classroom, and sometimes they have laboratories because it is an expensive practice. He usually explains the topic and tries to give some examples. He tries to keep his students engaged with the class, but he doesn't seem to know how.

- *Daniel, the elementary school student:*



Fig 15. <https://sp.depositphotos.com/stock-photos/estudiante-de-primaria.html>

Description: Daniel is 8-years-old and is in elementary school. He thinks math is a little boring, but likes natural sciences, especially when they go out to pick flowers. When he grows up, he wants to be a Chef, doctor, builder, or astronaut like the ones he's seen on TV.

- *Angelica, the high-school student:*

Description: Angelica is a 16-year-old high school senior, she likes arts and music. She thinks STEM subjects like math or chemistry are quite hard because she's not very good at them. Like the rest of her peers, she likes classes outdoors or when they get to go on field trips outside of school. She is a little stressed out because she doesn't know what to study yet and is

not that familiar with many careers aside from the traditional ones like medicine or law.



Fig 16. <https://www.freepik.es/fotos-veciores-gratis/estudiantes>

2.5. Identified needs

As a part of these hypothetical profiles based on the interviewing process, these are the needs of the individuals regarding the challenge:

- *Patricia, the parent:*

As a parent, Patricia wants the best education for her children, and for her to be able to help them within her capacities. She wishes there would be more interactive experiences, so her kids can learn by doing.

“How can we involve working parents with limited time for interaction, like Patricia, as a motivator in the academic life of their children?”

- *Jaime, the school's Chemistry teacher:*

The biggest concern for a teacher is that all of their students understand a certain topic, so they can move forward into more complex matters. It seems like Jaime struggles to catch the attention of his students and provide practical experiences regarding the class.

“What alternatives can we propose for Jaime to have a more active and dynamic class?”

- *Daniel, the elementary school student:*

As a kid, it seems like Daniel's main concern is to play and explore the surrounding environment. In his school life, he would like to spend more time outside with his classmates.

“How can we improve the learning experiences related to STEM subjects, for kids like Daniel?”

- *Angelica, the high-school student:*

Angelica's main problem is that she doesn't know what to study and perceives STEM as a complicated field. Also, she doesn't know what careers are available and the job possibilities for each.

“How can we introduce the diversity of STEM careers to Angelica and their applications in real life?”

3. Surveillance

The team has already determined that, at the very least, Colombia has a deficit of STEM experts. It is also widely recognized that there is a global demand for STEM experts that is not being met. As a result, several initiatives have emerged with the intent to spark interest in STEM fields. There are numerous interesting proposals and relevant projects worth reviewing. The following section will present initiatives that are considered to be the most significant in the context of the project's goals.

In total, a review of fifty initiatives was conducted. The first notable finding from the research is that all the reviewed initiatives may be placed into three broad categories. Each of these categories attempts to promote STEM through various means, including:

- *Powerful, breathtaking, and engaging exhibits.*
- *Taking STEM to the home of the user, likely using gamification.*
- *Re-defining and re-designing education.*

It will now be reviewed some initiatives that are worth highlighting in each of these categories.

3.1. Powerful, breathtaking, and engaging exhibits

A first way in which it is being tried to encourage engagement in STEM fields is the design and arrangement of exhibits that have the capacity to impact the user. Naturally, museums around the world are very interested in having exhibits with such characteristics. This paradigm in the design and arrangement of exhibits is obviously more appealing for some types of museums than others; whilst art museums, for example, tend to be more traditional in their exhibit design and arrangement, science museums and science centers are usually the ones to bet on bold exhibits that flee from the conventional.

Although the perception of STEM fields is likely culturally dependent, there appears to be a strong stigma regarding STEM education in Colombia. People seem to think that STEM education is hard, has a predominant and overwhelming theoretical component and mathematical skills are the core of STEM education. The negative perception of STEM education may be shared in other cultures around the world, although it is almost certain that there are some cultures where this is simply not the case and more positive conceptions of STEM education hold. For instance, in a survey where Japanese high school students were asked to name concepts that were considered representative of engineering, the three most named concepts were “making”, “technology” and “design”. Interestingly, concepts such as “hard” or “mathematics” were never mentioned.

It is critical that, in cultures where STEM education is regarded as difficult, such

negative perception is debunked. For this reason, exhibits that can capture the true sense of STEM are fundamental in the reshaping of a distorted conception of what STEM is.

In this sense, some institutions whose work is worth mentioning are:

Maloka



Fig 17. <https://maloka.org/wp-content/uploads/2021/12/Logo-Maloka.png>

Maloka is an interactive museum located in Bogotá, Colombia. On Maloka's official website, it is explained that the museum "...encourages the passion towards learning, strengthening the links between science, technology, and innovation." According to the website, over two decades, since Maloka's science center was inaugurated, the organization has been capable of impacting around twenty million Colombian citizens. In addition, Maloka claims to have helped around twenty thousand teachers in improving their teaching methods through innovation, having made more than one hundred scientific publications and conducting thirty research projects.

Maloka's 2021 management report shows that this year the organization.

- Benefited a total of 194.906 persons.
- Welcomed 70.776 visitors in Bogotá's science center.
- Accumulated 113.486 amongst its social media platforms.
- Was mentioned in 49 national journal articles.
- Published 3 scientific papers.

According to Colombia's National Administrative Statistics Department (DANE), Bogotá's population reached around 7.900.000 citizens in 2021. This means that Maloka's total visitor count accounts for around 0.9% of Bogotá's population. The question of whether Maloka is as impactful as one would wish is considered to be posed by this. It is stated in Maloka's 2021 management report that throughout the year, three scientific publications were made by Maloka, but is this significant? These numbers may be found disappointing as an alleged Colombian benchmark in science and technology divulgation.

Considerable frailty is shown by Maloka in its digital content creation, according to the review conducted. Specifically, the YouTube channel of the organization was evaluated, and it was concluded that although some effort has been put in strengthening the digital content creation, particularly since the COVID-19 pandemic started back in 2019, the content lacks engagement and falls behind with respects to the digital content of other science/technology-oriented museums around the world.

The creative minds behind the exhibits

It is likely that exhibit design teams are present in all museums that place great importance on interactive exhibits. In the upcoming months, attempts will be made to contact such departments, if existent, from Maloka and Parque Aventura, a museum of similar nature to Maloka located in Medellín, Colombia. It would also be enriching for the project if the exhibit design teams of other science/technology-oriented museums outside Colombia could be contacted. One such museum is the Exploratorium, located in San Francisco, United States, and is considered the absolute benchmark in terms of the capacity to impact communities positively and greatly at a regional and even national level.

Some companies that specialize in exhibit design have been found, and their services are offered to organizations that consider outsourcing to be more suitable for their needs. Among the specialized companies are;

- GSM Project
- The Work Haus
- Gallagher Design
- C&G Partners
- Thinc Design
- Eve Museografía

It was found that there are companies that specialize in exhibit design and offer their services to organizations seeking to outsource this function. Several specialized companies were identified, including:

Griffith Observatory's Astronomical Exhibition



Fig 18.

https://es.wikipedia.org/wiki/Observatorio_Griffith

In 2006 the Griffith Observatory, one of the most visited places on the west coast of the United States, and the most popular observatory in the world inaugurated its renovated astronomical exhibition. This exhibition was designed by C&G Partners. Edward Rothstein, in a review of the project on the front page of the Arts section of the New York Times explains;

“...the exhibitions by C&G Partners rather courageously turn their back on contemporary pressures in the museum world ... all the exhibits remain deliberately human-centered; they encourage observation and are about observation.”

Although not necessarily focused on children, the exhibit is being highlighted due to its breathtaking nature, which is considered an example of what a contemporary exhibit should look like.

Montreal Science Centre's exhibit "Human"

Although it has already been mentioned, it is noteworthy that the Griffith Observatory Astronomical Exhibition is not necessarily

oriented towards children. However, the exhibit designed by the GSM Project is indeed focused on children. The following overview of the project is presented on the GSM Project's official website.



Fig 19.

<https://www.cntraveler.com/activities/montrealmon-treal-science-centre>

“Geared towards young families and teenagers, the Montréal Science Centre’s newest permanent exhibition, Human, explores the concept of change in the human body, both throughout human evolution and throughout a single lifetime. GSM Project was mandated to design and produce the exhibition, working in close collaboration with the science center’s research team. The result is a highly immersive and interactive exhibition celebrating the exceptional qualities of our human bodies.”

3.2. Taking STEM to the Home of the User

Although people’s interest can be captivated through powerful exhibits, the following must be considered. As previously mentioned, throughout 2021, Maloka's visitor count was equivalent to only about 0.9% of Bogota's total

population. This appears to indicate a considerable limitation of this approach to promoting STEM fields: it seems to have a limited capacity to greatly impact communities at the regional and national levels. There are believed to be two reasons for this.

First, these types of offerings are of course limited by their infrastructure’s capacity. Once the capacity limit is reached no more visitors can be accommodated at the same time.

However, it is likely that the limit capacity of such offerings is only reached during peak season or weekends when some sort of special event is hosted, whilst the rest of the time this limit is far from being reached. When this limit is not reached there is a simple reason for it: not enough people are interested in engaging in such activities at that given time. For this reason, companies and organizations spend a good amount of their budgets on marketing campaigns, so that at any given time there is a good amount of people that are interested in the product or service that is being offered. Of course, as the target market becomes larger it is easier that just a small percentage of such market will be capable of reaching the capacity limit of the available infrastructure, by which point the impact capacity of the project is no longer limited by the target market and instead is limited by the infrastructure. But there is an inevitable barrier that restricts the size of a target market: location. Maloka is visited mainly by people that reside nearby to it, and so happens with all other science/technology-oriented museums around the world.

These are the two reasons that are believed to explain the limited capacity that physical exhibits must greatly impact communities at a regional and national level. For this

reason, it is considered necessary for a project that attempts to promote STEM at a large scale to not be reduced to a locationally limited proposal. In this context, some initiatives have been found that attempt to "bring" STEM to the user, instead of expecting the user to "find" STEM, and so breaking the locational barriers that keep museum exhibits outside of the scope of people that do not reside close to them. Some of these initiatives will now be highlighted.

Vortic



Fig 20. <https://partners.vortic.art/wp-content/uploads/2021/06/cropped-logo-1-1.png>

Vortic is a company that specializes in the virtualization of physical art exhibitions. As explained on their official website.

“ Vortic is a powerful Virtual Reality and digital exhibition ecosystem for galleries, institutions, and collectors to quickly and sustainably curate, share, and revisit exceptional exhibitions with any viewer, anywhere in the world .”

Although Vortic has never worked with science/technology exhibits so far, Vortic is worth highlighting as an initiative that virtualizes art exhibits, showcasing the

power of virtualization tools when used correctly.

Stem Box



Fig 21. <https://www.whatsnew.com/wp-content/uploads/2020/06/captura16-4.jpg>

Stem Box is a service offered by CircuitMess. Stem Box allows children to get familiarized with “coding & electronics through exciting hands-on projects”. Every three months, a kit box is sent to the child’s home with all the necessary components needed to work on a new project. Every three months a new kit box is received so that the child always has a new project to work on.

Minecraft Education



Fig 22.
<https://education.minecraft.net/content/dam/education-edition/logos/education-minecraft-logo.png>

Minecraft, developed by Mojang Studios, is the best-selling video game in history, having sold more than 238 million copies since its launch in 2011. Mojang Studios, understanding the importance of gamification in contemporary teaching methods, developed a special version of the

game that is focused on providing educators with ways to improve interactivity in their classrooms and improve student's learning experiences.

One of the great benchmarks in gamification nowadays is considered to be Minecraft Education, as it has understood the potential of gamification in making STEM naturally attractive and appealing to users. If one wants to effectively "bring" STEM to the user, finding ways to utilize gamification can be a relevant paradigm.

Little Alchemy



Fig 23. <https://littlealchemy.com/img/little-alchemy-open-graph.png>

At first glance, Little Alchemy appears to be a simple game with little relevance to the project, but it is being highlighted for a reason. The basic idea of the game is that more complex objects can be obtained from simpler ones. If someone has some spare time and decides to play the game, they will quickly become intrigued to find out which other objects can be discovered based on the ones they already have. This naturally intriguing and incremental game dynamic has led to the question of whether it would be possible to design a learning experience that produces the same dynamic while conveying a clear and powerful message: more complex knowledge is always built upon more basic knowledge, but all knowledge is waiting to be discovered, and the process of discovering it can be

engaging and intriguing, although challenging.

3.3. Redefining and redesigning education

A last approach to promoting STEM fields is related to the transformation of the way students are currently being taught. There is ample literature about the inadequacy of traditional education systems, and while the purpose here is not to conduct a comprehensive review of these systems and suggest an extensive list of criticisms and necessary reforms, it is clear from the research that a disturbing realization has emerged. It is likely that younger generations are increasingly questioning the value of traditional higher education. As a result, new initiatives have emerged with the intention of resolving this uncertainty for younger generations by providing more flexible and personalized education. One such initiative that is worth highlighting has been found.

Juni



Fig 24.

https://junilearning.com/images/juni_logo_preview.png

Juni is a web platform that offers online STEM-related courses for children. Juni's value proposition is made clear in their official website.

“Juni sets your child up for real world success by offering flexible online education in STEM subjects like Coding, Game Development, Investing, and more.”

As mentioned in the quote above, the importance of flexibility is highlighted as an important component of their offering, and it is made clear how it is incorporated into their model. On Juni's official website, three course formats are offered: private one-to-one classes, unlimited access to Juni's self-paced courses, and an a-la-carte catalog of short courses that can be paid in advance.

Platzi



Fig 25.

<https://upload.wikimedia.org/wikipedia/commons/thumb/3/32/Platzi.jpg/1200px-Platzi.jpg>

Every day, new online learning platforms appear with interesting value propositions. Juni is a platform that focuses on STEM-related education for children, but there are plenty more platforms that appeal to greater audiences. In recent years, Colombia has seen the birth and growth of Platzi, which has become one of the biggest South American online learning platforms. Platzi has a course offering that is suitable for people of all ages, so it is likely that eventually, we will hear of ready-for-work, totally capable, young adults whose complete skills arsenal was developed

using only resources available in online learning platforms such as Platzi.

If traditional tertiary education is perceived as less attractive than newer and more flexible alternatives, it is reasonable to question how it could be affected. Thus, it is important to ask what measures are currently being taken to present traditional tertiary education as a desirable and viable option for those seeking further education beyond secondary school.

Tecnológico de Monterrey, TEC21 Model

The Instituto Tecnológico de Monterrey (ITM) in Monterrey, Mexico, has developed a new learning model that they call TEC21. As they explain on their official website, the model “...allows the development of solid and integral skills that help [graduates] solve present and future [real world] challenges creatively and strategically.” The ITM states that their model is unique because of the four components it is built upon;

Challenge-based learning

Throughout their studies, students will “...develop disciplinary and transversal competencies by solving real world challenges...”. These challenges prove to be the core of the learning model because, as the ITM states: “In this model, the central learning unit are the challenges.”

Personalization and flexibility

To make their model suitable for everybody, the TEC21 proposes a three-step learning process:

1. Choosing a knowledge field of interest. Learning starts from here and all the necessary generalities of the selected field are learned.

2. Choosing a career. Learning is specialized from here and all the core competencies of the career are developed.

3. Choosing specialties. The career is personalized from here and the student has the possibility to develop a career profile that adjusts to his expectations and passions.

Inspiring teachers

According to the model, teachers must “create active learning environments and find in the [real world] challenges the trigger to develop the competencies that students need, while guiding them on how to transfer the acquired knowledge to real [world] contexts.”. In short, teachers must have very positive impacts on the student’s learning and development.

A memorable experience

This summarizes ITM’s proposal to remain relevant and appealing in the context of, not only STEM education but also education as a whole. Likely, a challenge-based learning model that promises to develop integral competencies and effectively prepare students for the real world will prove to be attractive to a vast group of people. It is also worth noting that the ITM first proposed this model in 2014 and has been working on and implementing it since. This means that the ITM has been refining and improving its proposal for eight years now. Meanwhile, how has the Pontificia Universidad Javeriana Cali attempted to remain relevant in a market where every day new and innovative education alternatives arise?

4. Design process

This next phase of the project consisted of agile prototyping of ideas that our team considered to have potential as possible solutions to our challenge. The key objective here was being able to validate whether the concept being explored through the development and testing of a prototype could be deemed, not only viable or not functionally speaking, but also valuable to our final users, id est, the school students.

This phase of the project took us through an enriching journey that allowed us to explore different concepts which, although shared the same goal of raising interest around STEM subjects amongst school students, had drastically different approaches on doing so. In this section we will provide a brief summary of the experience the team had in this stage of the process.

4.1. Ideation

Naturally, each of the developed prototypes that will be discussed shortly came from an initial idea that was, usually, conceptually refined by the team upon its selection. Each one of our prototypes constitutes the result of specific ideation and selection processes that yielded the idea with the most perceived potential to generate impact.

Normally, before developing a new set of prototypes, the team got together to have an ideation session. These yielded at least several alternatives from which one would be finally selected to be developed further. For most cases, the ideation tool used was simply brainstorming, which to our

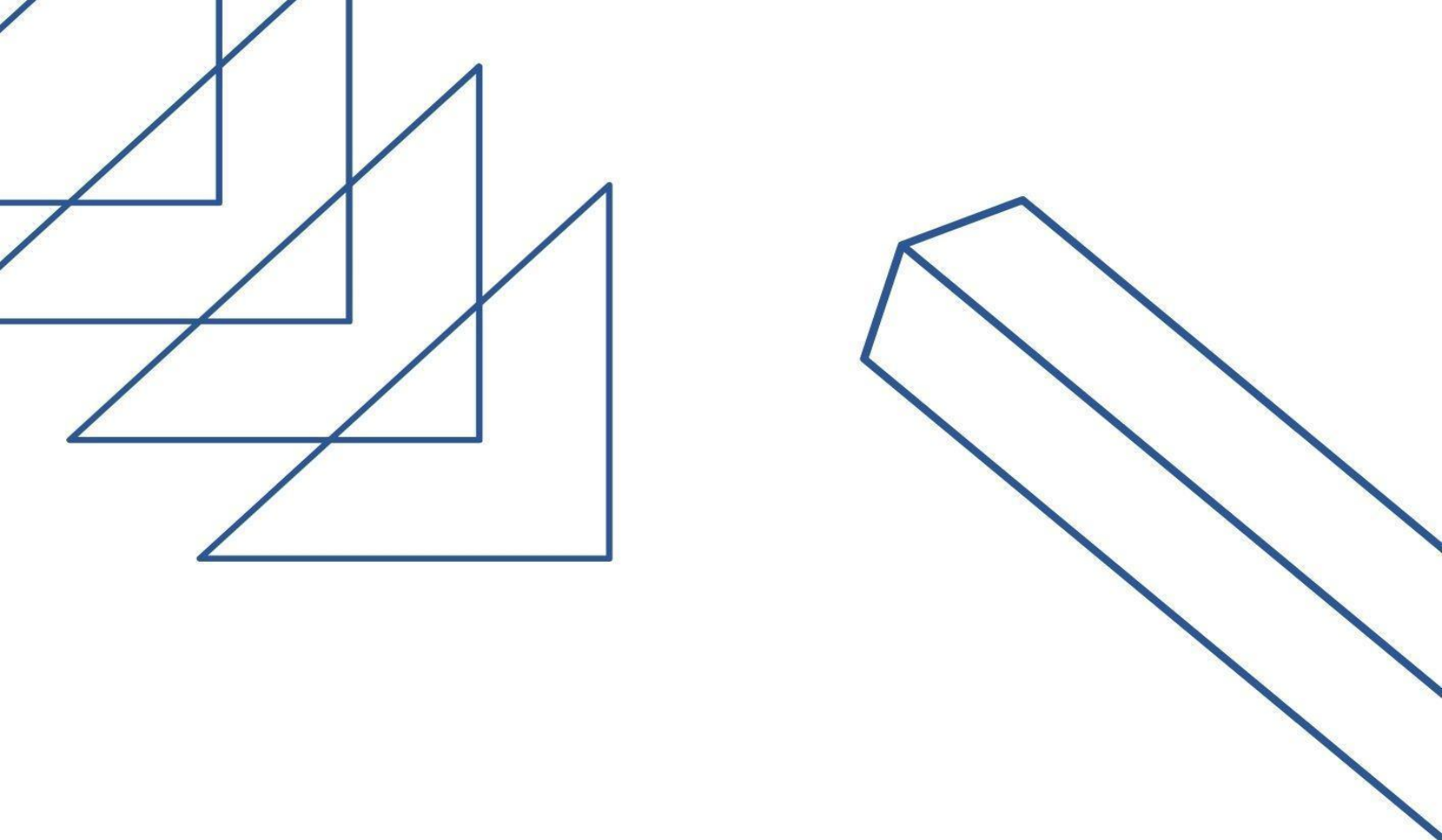
consideration, proved to be an effective and efficient ideation tool.

However, different ideation tools were used. For example, small prompts were used to guide the ideation process. Basically, equal periods of time were dedicated to generating ideas that were related to each prompt. Afterwards, these ideas were categorized according to their immediate viability and disruptiveness, producing three groups:

- 1. The ideas that could be immediately executed**
- 2. The ideas whose execution was debatable**
- 3. The ideas that were considerably innovative or disruptive**

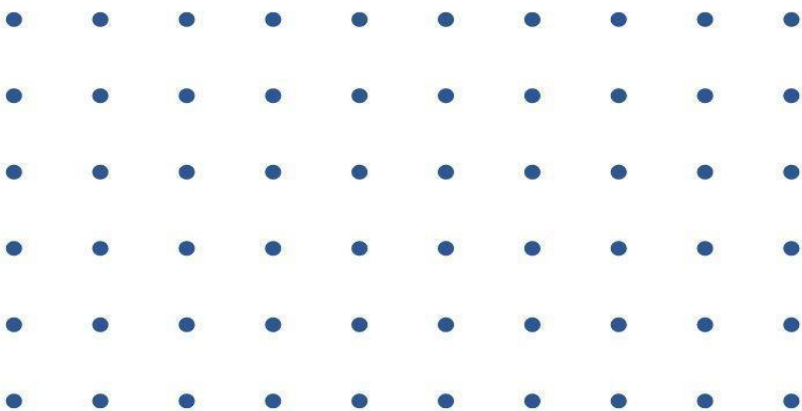
Finally, after having categorized these ideas, a reduced group of them was selected to be conceptually developed further after a set of elimination rounds were performed.

Interestingly, it is worth to highlight that none of the prototypes we developed on this phase of the project came from ideas that were produced during the ideation session whose methodology was just described. Thus, we consider brainstorming to have been a worthy ideation tool for our purposes.



CEP: Critical Experience Prototype

The "critical" aspect of a prototype refers to either a critical part of the context or a critical part of the form that was identified during the exploration. It involves both critical functions of the tentative solution system and critical experiences for the user.



4.2.1. STEM Box



Fig 27. STEMBOX logo. Self creation.

The what

The STEM Box prototype was designed as a way to showcase the practical application of different areas of STEM to students aged 16 and 17. It consisted of a box that contained a set of instructions for completing a challenge: lighting up a lighthouse. The challenge was broken down into three missions, each corresponding to a different area of STEM.

Biochemistry Mission

In the first mission, students tested the pH of seawater using purple cabbage juice as a natural indicator.

Programming Mission

In the second mission, students had to organize the logical steps of a computer program that allowed them to make an analysis of a photo of the red substance created in the first experiment.

Electronics Component

Finally, in the third experiment, a code was revealed from the analysis, which opened

up a little box containing a circuit to light up a LED that symbolized the lighthouse.

The STEM Box aimed to be a physical experience that showcased the application of STEM in a way that would motivate and engage students. The narrative aspect of the box was intended to make the challenge more compelling and place students in the role of engineers.

The why

The objective behind the prototyping of the STEM Box prototype was showcasing the practical application of STEM to college students in a way that would engage and motivate them. We saw a need to make STEM more compelling and relevant to students, particularly those who might not already have a strong interest in the subject. The team also recognized the potential of a physical experience to demonstrate the practical application of STEM and engage students in a hands-on way.



Fig 28. Validation process.

The learning

The STEM Box prototype provided valuable insights into how to engage and motivate students with a physical experience that demonstrates the practical application of STEM. The narrative aspect

of the box was seen as useful in making the challenge more compelling, but it was noted that the instructions needed to be clearer. A challenge or competition was also seen as crucial for engaging students in the physical experience. It was also observed that motivating students who were not previously interested in STEM could be challenging, particularly at this age. Overall, the Stem Box prototype demonstrated the potential of physical experiences to showcase the practical application of STEM and motivate students to explore the subject further.

4.2.2. STEM Box Kids

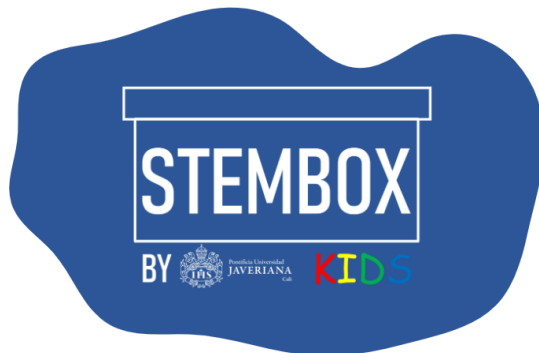


Fig 29. STEMBOX KIDS logo. Self creation.

The what

The second version of STEM Box, called STEM Box Kids, aimed to engage children between the ages of 8 and 12 in unconventional experiences that could potentially stimulate their interest in STEM. The prototype consisted of four boxes, each corresponding to an area of STEM.

Physics Box

The physics box exhibited the Bernoulli principle through a hairdryer and a ping pong ball.

Chemistry Box

In the chemistry box, the concept of pH was demonstrated using purple cabbage juice and substances with different pH levels such as vinegar and baking soda.

Programming Box

The programming box included a racetrack with a remote control car that the children had to program using flashcards.

Electronics Box

Finally, the electronics box required the children to create a simple circuit with a battery to turn on a small turbine.



Fig 30. Validation process.

The why

The purpose of STEM Box Kids was to engage younger children in STEM through experiences that could capture their attention and stimulate their interest. It was learned that creating an interest in older children might be more difficult, hence the focus on children aged 8 to 12. Three main characteristics of younger children were explored: curiosity, observation, and amazement. It was concluded that making different boxes corresponding to each area

of STEM would be less confusing than mixing all the experiments in one box, as done in the previous version.



Fig 31. Validation process.

The learning

During the validation process of STEM Box Kids, interaction was carried out with 6 children aged between 5 to 14 years old, who exhibited varying responses to the presented boxes. The children aged 5 were motivated by the experiments but were easily distracted. Those aged between 7 to 8 displayed a high level of interest and motivation to explore and solve the different boxes. However, the children aged between 10 to 14 appeared to be less enthusiastic about conducting the experiments. It was learned that showcasing physical applications of STEM motivates children and the age group that seems more receptive to this type of experience seems to be in the range of 7 to 9 years old. Additionally, this type of experience seems to work best in a classroom where a mentor's guidance is key.

4.2.3. STEM evolution



Fig 32. Game logotype. Self creation.

The what

Stem Evolution is a prototype designed to teach STEM skills to children between the ages of 7 and 12 using gamification techniques. Inspired by successful language learning platforms like Duolingo, the game challenges players to solve STEM-related problems and progress through levels to unlock more advanced content.

The game's design encourages players to think critically and creatively, as they solve problems and discover new scientists and their contributions to the STEM field. It offers different paths and levels of difficulty to cater to different learning styles and preferences, making it a more personalized learning experience.



Fig 33. Game Interface.

The why

The development of Stem Evolution was driven by the desire to make STEM education more engaging and accessible to children. By using gamification techniques, the prototype aims to encourage students to practice their STEM skills in a fun and interactive way. The use of a digital platform makes the game easily accessible to students who are already comfortable with technology.

Stem Evolution was created to answer the question of whether gamification techniques can be effective in promoting STEM skills in young students. It also aims to investigate whether a digital platform can be a useful channel to encourage STEM learning.

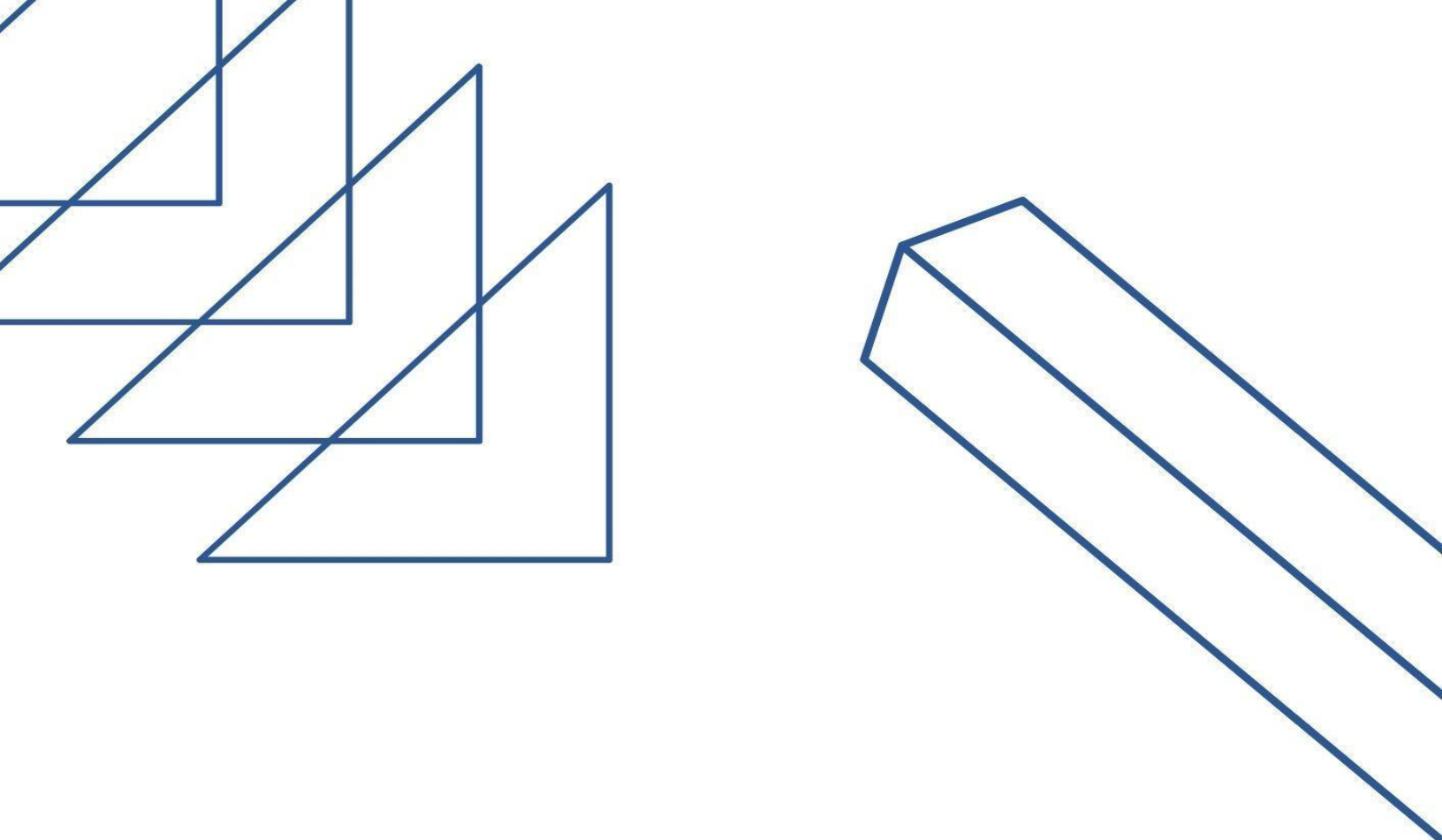
The learning

Stem Evolution was tested with five children within the desired age range, and the results were promising. The children found the game easy to use and were excited to play it, especially when discovering new characters and exploring the STEM world. They also demonstrated an eagerness to solve the STEM problems presented in the game, indicating that gamification techniques can indeed be effective in promoting STEM learning.

The use of a digital platform was also found to be advantageous, as children are increasingly comfortable with technology and find it a natural way to engage with educational content. However, it is important to note that the prototype remains limited to the virtual world, which may present a challenge in encouraging hands-on experimentation and exploration of real-world STEM concepts. Nonetheless, the success of Stem Evolution suggests that gamification and digital platforms can be effective tools in promoting STEM education, making it more accessible and engaging to a wider range of students.

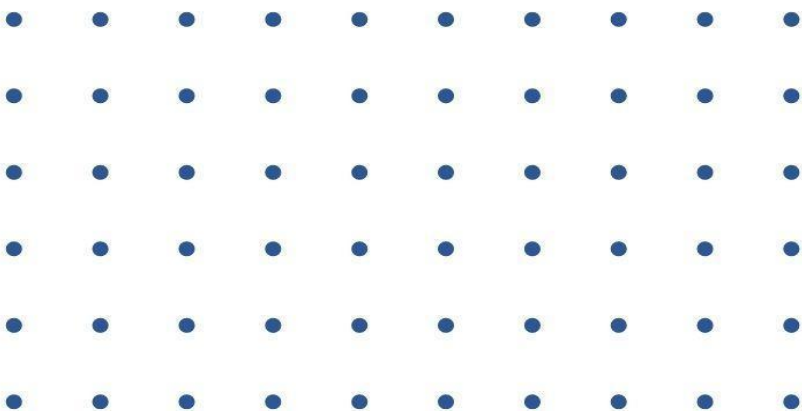


Fig 34. Validation process.



Dark Horse prototype

The Dark Horse signifies the unknown contender in a horserace, who unexpectedly wins. This prototypes stretch our imagination by heading into the most unknown parts of the Problem Space to produce interesting thought material that can help to develop more captivating solutions.



To obtain new ideas that aligned more with what a **darkhorse** conceptually is and what it implies, the design team opted to carry out a new brainstorming process, methodology for idea generation different from the one previously taken.

For this process, a series of images were taken as inspiration and ideas were generated based on them in relation to the challenge being addressed. Below is an example image.



Fig 35. Inspiration image for brainstorming.

A total of **239** new ideas were obtained by following this methodology. A total of **262** ideas were obtained, including the **22** ideas previously developed.

4.2.4. STEM wars



Fig 36. STEM WARS logo. Self creation.

The what

STEM WARS is a prototype that proposes a new approach to introducing STEM concepts in the classroom. It draws inspiration from a military theme to make learning more engaging for children. The design team took ideas from different branches of the military, such as aviation, navy, and intelligence, to introduce STEM-related concepts through experiments that illustrate their applications in the military field. They also incorporated aspects of military training, including respect for authority, hierarchy, submission, merit, and physical activity, to enrich the learning experience.

STEM WARS comprises a series of experiments that introduce different STEM topics to children. The experiments cover topics such as aerodynamics, robotics, chemistry, and physics, and are designed to provide hands-on learning experiences that help children understand the practical applications of STEM concepts.

The why

STEM WARS was developed to explore whether using a controversial theme like war, although in the context of STEM-related knowledge applications, could effectively improve engagement in the learning process of children. The design team also wanted to understand whether mixing physical activity with mental activity would improve children's interest in learning and whether presenting applications first would make them more interested in science.

The team believed that introducing STEM topics through a military theme would make learning more engaging for children. They hypothesized that by using a theme

that children are already familiar with, and by incorporating aspects of military training, they could create a learning environment that would be both fun and effective. They also believed that by combining physical and mental challenges, they could improve children's interest in learning and their overall engagement with the material.



Fig 37. Validation process.

The learning

The validation process for STEM WARS was carried out with 13 seventh-grade children, aged between 10 and 12 years old. The children were given a series of STEM-related challenges, both physical and mental, and their responses were observed and recorded.

Through this process, it was found that the military theme is useful and interesting for introducing STEM-related topics to children. The children enjoyed the hands-on experiments and responded positively to the physical challenges. The design team also found that mixing physical activity with mental activity improved children's alertness during learning and helped them engage with the material more effectively.

Physical penalties were found to be an effective means of correcting behavior,

with children responding well to the consequences of their actions. Additionally, having clear objectives in the activities was found to be vital to keeping students focused and engaged.

4.2.5. Ulink



Fig 38. Ulink logo. Self-creation.

The what

Ulink is a career counseling service that seeks to identify and explore students' interests during the last four years of their secondary education. In the span of these four years, student's interests are identified and explored further by providing them with all sorts of academic resources that may be meaningful to their academic journey. The identification of these interests relies on sophisticated data analytics and continuous monitoring of the students' learning experience, in an attempt to collect all available information. These data sets allow for better counseling, which in turn let students make more informed decisions about their future career paths.

Although the Ulink concept is likely viable, the team recognized that developing a comprehensive career counseling service within a two-week period was not feasible. As a result, the team proposed a landing page prototype to communicate the value proposition and make a "call to action" by

encouraging the visitor to explore the service further. The landing page was designed to differentiate Ulink from other career counseling offerings by highlighting its unique approach and the benefits of a longer, more personalized counseling experience.

The why

The team recognized a critical need among secondary school students for more effective career counseling services. Despite the availability of traditional career counseling services, many students struggle to make informed decisions about their future careers. Ulink aims to fill this gap by addressing the two main flaws of traditional career counseling services: the limited time frame and reliance on traditional vocational tests. By providing a longer, more personalized counseling experience that utilizes sophisticated data analytics, Ulink aims to provide students with more valuable and relevant information to guide their career decisions.

The team's goal with the Ulink prototype was to validate whether their approach to career counseling could offer real value to students. Overall, Ulink aims to provide students with a more comprehensive and personalized approach to career counseling. Through the use of sophisticated data analytics and a longer counseling experience, Ulink aims to help students identify and explore their interests in a way that traditional career counseling services cannot.

4.2.6. Ciencia Armónica magazine

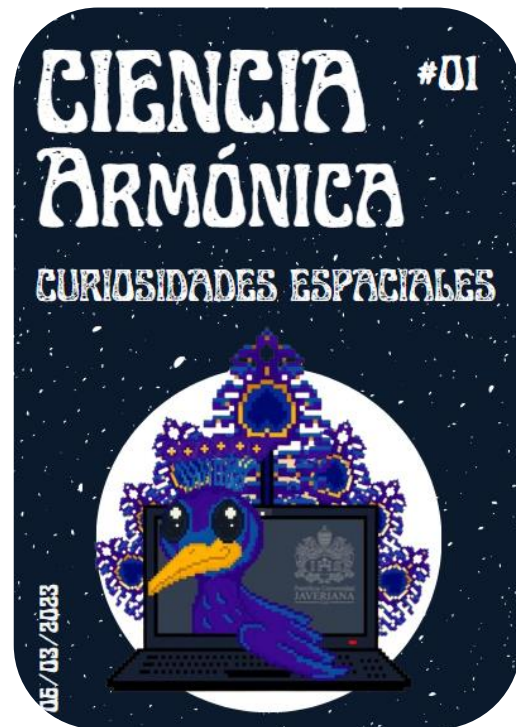


Fig 39. Cover of the magazine.

The what

Ciencia Armónica is a prototype concept of an informative magazine designed to promote STEM education amongst children aged 7 to 12 years old. The magazine design resembles that of popular collectible sticker albums, such as the Panini's World Cup or Jet Chocolate albums, and includes stickers that feature STEM-related topics.

In addition to the stickers, the magazine also features QR codes that can be scanned to access virtual reality experiences related to the topics covered in the magazine. The magazine aims to make learning STEM concepts more interactive and engaging for children, using a format that is already familiar and appealing to them.

The why

The Ciencia Armónica prototype was developed to test the effectiveness of a novel approach to promoting STEM education amongst children. By combining a popular format, such as collectible sticker albums, with informative content and interactive experiences, Harmonic Science aimed to make STEM education more accessible and engaging for children.

The team's goal was to understand whether a magazine with collectible stickers and virtual reality experiences could be an effective strategy for promoting STEM education. Through the prototype, the team aimed to validate whether this approach could promote interest and curiosity in STEM fields among children, and to learn how to improve the design and content of the magazine to better engage and educate children.

The learning

During the prototype validation, it was discovered that astronomy is a particularly engaging topic for students and that many of them already possessed some prior knowledge about it. The magazine was successful in actively and passively engaging the children through its reading materials and activities, which was a positive outcome.

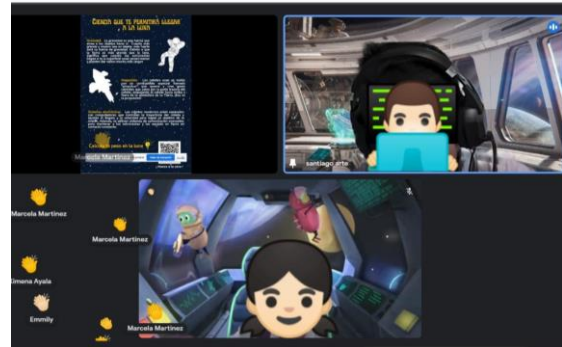
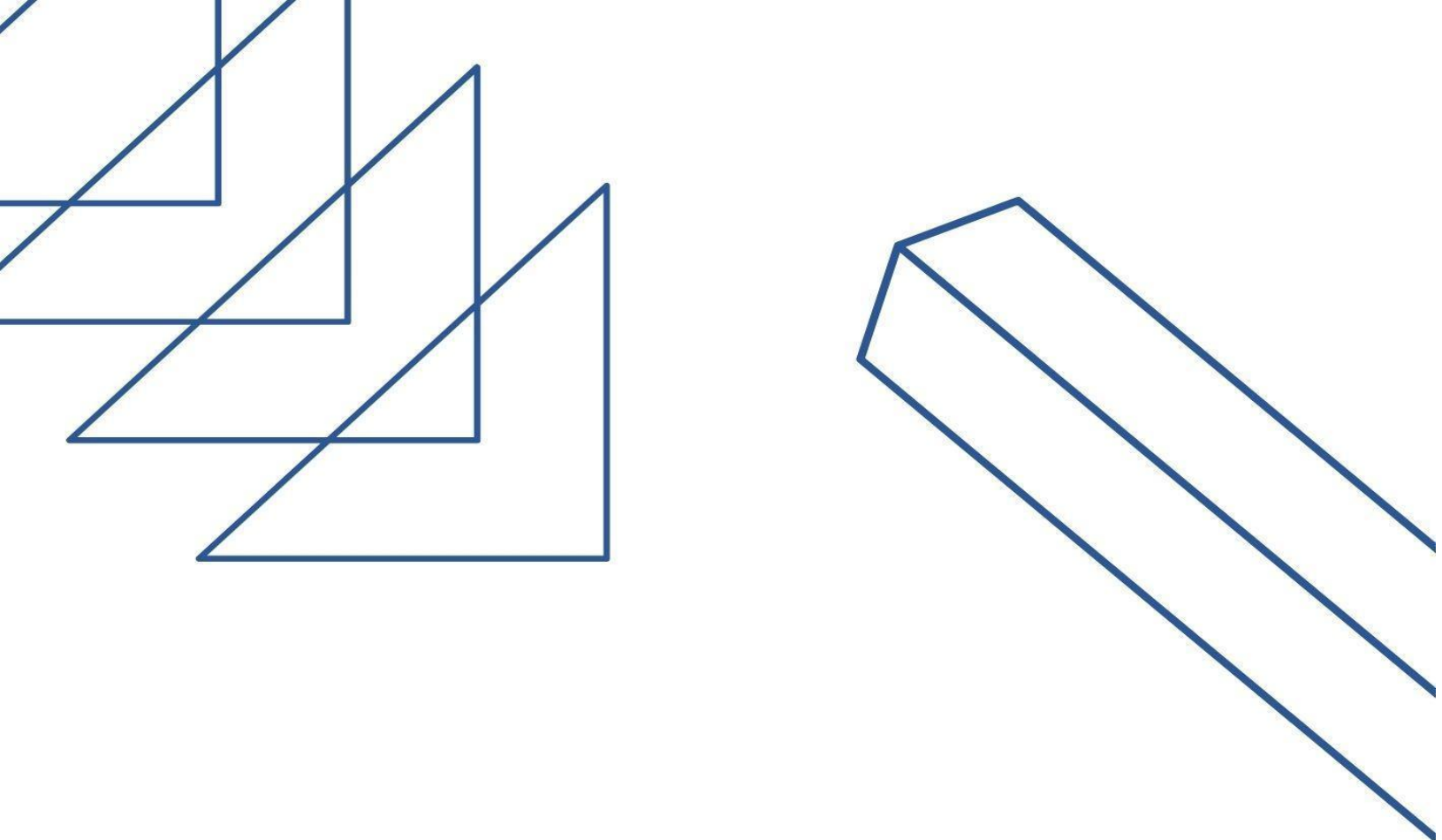


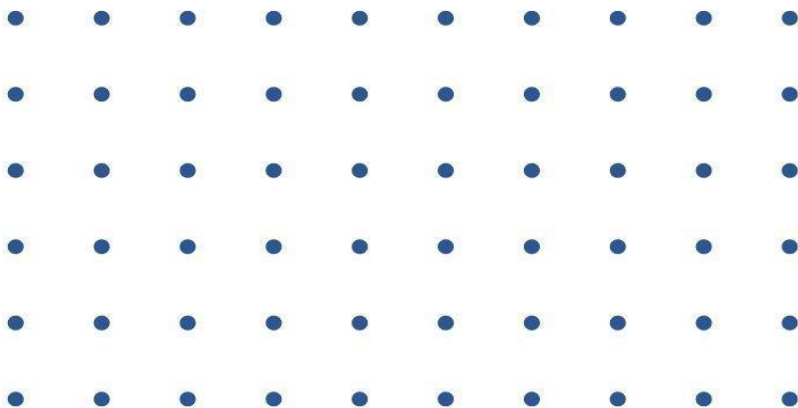
Fig 40. Validation of the magazine.

In addition, the use of augmented reality was found to be a particularly effective component for students, as it provided an innovative and engaging tool for introducing new topics. Overall, these findings suggest that the STEM Magazine prototype was successful in promoting interest and engagement in STEM fields among children and provide valuable insights for future improvements and iterations of the magazine concept.



Funky prototype

A funky prototype is a sample or model of a product build to test a function or process specific. It's a concept prototype that allows objective evaluation and testing with the users.



Our prototyping phase culminated with the development of what is called a Funky Prototype. This last prototype provided us with the opportunity of committing to a concept that should vaguely resemble what an actual solution to our challenge could look like.

As with the previous prototypes, we were free to propose a concept that had not been explored before. However, upon discussion, we concluded that we had gathered valuable insights that suggested some prototypes had been successful enough to be considered towards the development of our final design proposal.

The following are the prototypes that we consider having been notably successful, accompanied by an explanation of the design component that provides added value to the prototype.

STEM Box:

The use of hands-on activities to encourage and enhance knowledge acquisition.

STEM Wars:

The use of storytelling and context setting to create an immersive themed environment where knowledge has a clear purpose and significance.

Harmonic Science:

The use of a subscription service model that allows for greater impact by providing a periodic product or service to the user.

Since the development of the Funky Prototype expected us to commit to a first, more coherent and robust idea oriented towards a final solution to the challenge, we integrated these three design components

into our prototype's proposal as they clearly suggest what a successful solution to our challenge should look like.

The result of integrating these three design components is the following prototype...

4.2.7. STEM finity



Fig 41. STEMfinity logo. Self creation.

The what

STEMfinity is a subscription-based service that provides children with an innovative and engaging approach to learning STEM concepts. STEMfinity's mission is to inspire and cultivate an interest in STEM fields by making learning both fun and accessible for children.

The service offers a monthly subscription box that includes a collectible sticker magazine, a sticker pack, and a hands-on mini project. These items are carefully curated to provide a unique and interactive learning experience for children. Each delivery showcases a different STEM concept that is related to everyday life, encouraging children to explore and learn about the world around them in a fun and creative way.

The why

STEMfinity aims to showcase the fun and interesting side of STEM subjects, making it a part of children's daily lives. By encouraging children to engage in hands-on activities and providing them with relatable and interesting content, STEMfinity helps children develop a lifelong interest in STEM fields.

As we have previously implied, STEMfinity arises from the integration of three valuable design components that we identified from our previously worked-on prototypes. We attempted to complete this integration in the most well-rounded way possible, so that the proposed concept felt organic. The following is the value proposition of STEMfinity divided into its four core components...

Periodic and Theme-Based:

- We capture and retain kids' attention by delivering a new issue of the magazine every quarter.
- Each issue of the magazine delves deeply into a specific theme.



Fig 42. Validation process.

Storytelling + Learning:

- The magazine's design features compelling and intriguing information about the explored theme.
- Kids learn as they complete each magazine issue.
- Our pet friend is always there to accompany the kids in the process.

Hands-On Mini Projects:

- The final delivery box contains three previously worked concepts presented as interactive mini projects.
- The goal is to allow children to explore and experiment manually.

Collectible:

- By the end of each quarter, the kids have three new magazines and interactive experiences.
- All these items are now part of their collection from the STEMfinity Universe.
-



Fig 43. Validation process.

Concluding Remarks on The Funky Prototype

STEMfinity represents the culmination of the prototyping phase of our project. While we consider all prototypes to have been significant in our divergence process, we are particularly satisfied with the achieved result of STEMfinity. We believe the integration process was conducted appropriately, and the combination of all design components made for a high-value concept that seems to be headed in the correct direction when it comes to solving our challenge.

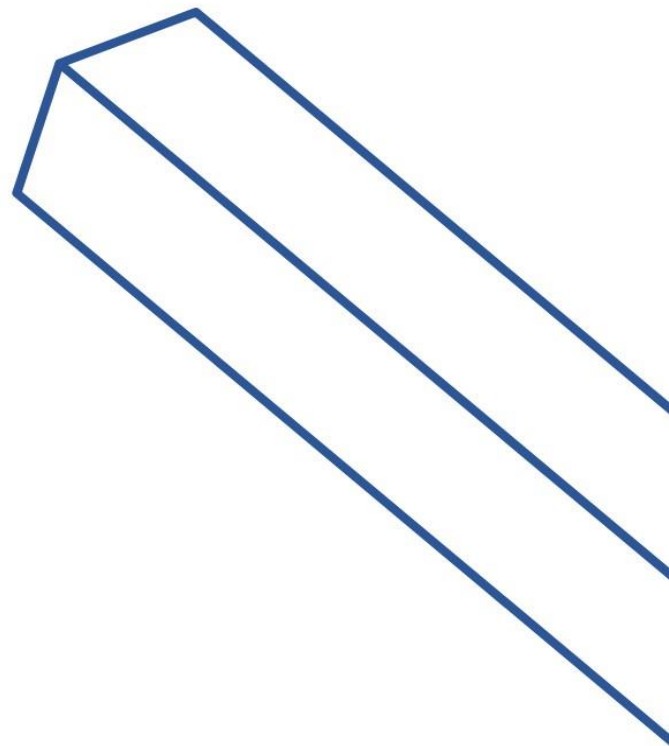
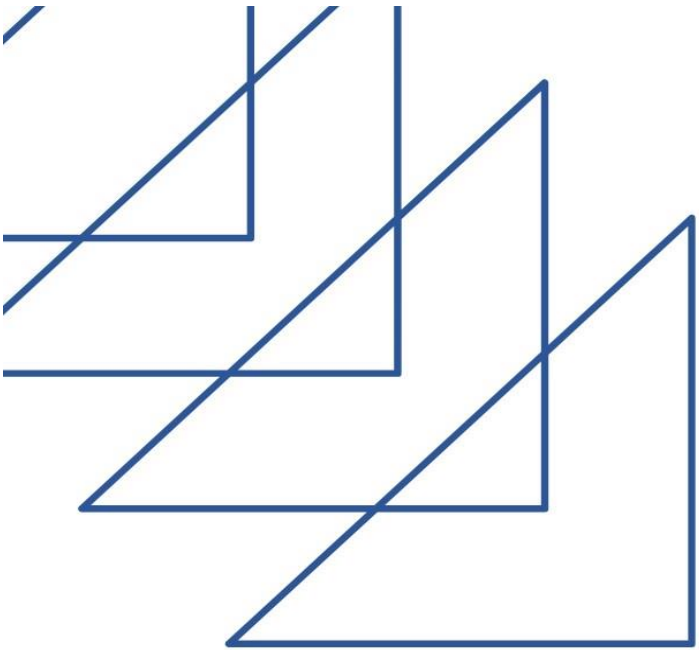
4.3. Prototype Conclusions

In this seven prototypes, the team explored different strategies with different age groups. The following are some insights recollected in this stage:

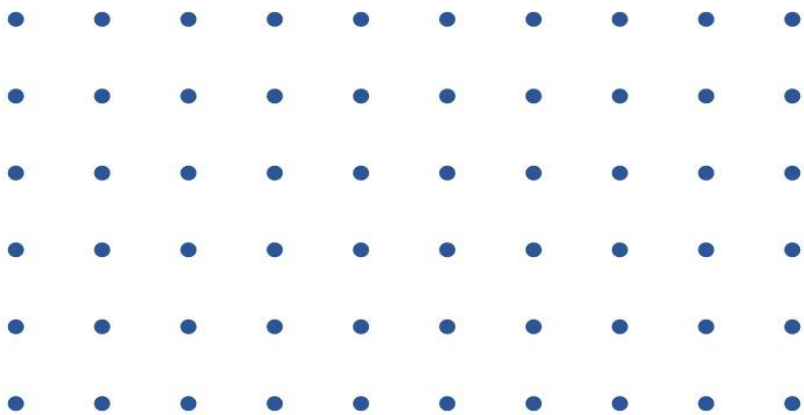
- The younger the kid, the easier it is to engage and spark interest in a specific topic.
- High-school kids already present negative stereotypes regarding STEM fields, that are difficult to change.
- As elementary and high school students have different learning and motivation processes, it is difficult that one strategy could fit them both.
- Younger kids (8-12 y.o) had a greater motivation and learning impact regarding the prototypes.

In this manner, the design team decided to redefine the original challenge by narrowing down the age group following the prototyping results:

“Increasing the **interest** for **Science, Technology, Engineering, and Math (STEM)** in children between **8 and 12** years of Cali schools, considering the low performance in international tests (PISA) and the reduction of university students in these areas”



Convergence Stage



5. Convergence process

After having developed 7 different prototypes, the design team found the need to gather the learnings obtained during the stages of benchmarking, empathy, ideation, and validation stages in order to create a final proposal that would provide a solution to the challenge initially presented.

In this process, the team identified 5 main causes for the lack of interest in STEM among children and young people. The 5 causes are mentioned below in the following figure:

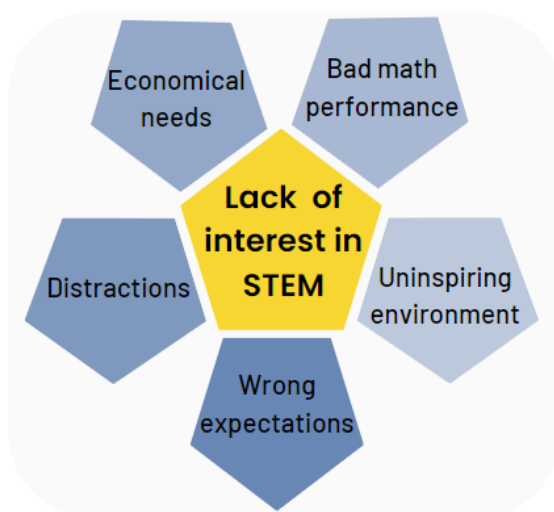


Fig 44. Pentagon of causes.

The explanation behind each identified cause is as follows:

- **Bad Math performance:** Children generally have an aversion to mathematics. The reasons behind this aversion can range from negative experiences in class to learning difficulties related to numbers.
- **Uninspiring environment:** This factor was evident in the lack of practice spaces and laboratories where the

applications behind the concepts observed in the classrooms could be seen.

- **Wrong Expectations:** After interacting with multiple school students, it was evident that there is a lack of knowledge about the tasks and roles of professionals working in STEM careers, leading to incorrect expectations among children.

- **Distractions:** As a result of the democratization of technology, it is increasingly common to find electronic devices in classrooms and learning spaces. Moreover, it is also increasingly common for young children to have access to such devices in the classroom, becoming significant distractions, which in turn lead to disinterest in the topics covered in class.

- **Economical needs:** The last reason identified as a cause of disinterest in STEM is economic needs. Specifically, this is evident when observing how STEM fields in higher education institutions in Colombia have high tuition costs compared to other programs within the same institutions.

On the other hand, concerning the ideation, validation, and prototyping stages, the design team chose to take the most successful prototype and integrate it with the key learnings from the previous prototypes.

Within the aspects that were considered key for the final prototyping, 5 were taken into account. These are the 5 principles that were considered:

- **Periodic:** It was considered important to be able to provide new content to children and young people periodically. This is important because exposure to new

content on a regular basis helps develop the habit while avoiding long periods without new content.

- **Theme-based:** Recognizing that STEM is a diverse family of careers and acknowledging that professionals must constantly interact with experts from other fields, the decision was made to present themes instead of specific careers. This also serves another purpose: introducing STEM through topics in which children may have an interest or prior knowledge.



Fig 45. STEMfinity themes.

- **Storytelling + Learning:** The design team was able to observe how having a clear goal or purpose when engaging in activities with children and young people makes them take the activities more seriously. By incorporating strategies such as storytelling, role-playing, and clear objectives, it is expected to increase children's interest in STEM.
- **Hands-on Mini Projects:** It was found that for all age groups with whom we interacted, engaging in activities where they can see the applications of acquired concepts was highly entertaining (especially for younger age groups).
- **Collectible Objects:** Lastly, recognizing the positive results obtained with Ciencia Armónica and its sticker

component, the team acknowledged the importance of involving collectible elements such as stickers, albums, or gadgets for children to keep and remember.



Fig 46. Some STEMfinity stickers.

5.1. Required professional support.

For the proper development of the prototype and to achieve satisfactory results in terms of quality and professionalism, the design team chose to identify the types of professionals who would benefit the project. Here is a list of professional roles and their expected contributions:

Graphic Designer: Responsible for organizing the magazine content in a visually appealing manner for children within the specified age range, while also giving the magazines a distinctive visual identity.



Fig 47. Final imatotype.

Packaging Designer: Responsible for designing the packaging for the various gadgets included in STEMfinity deliveries.



Fig 48. Packaging prototype.

Industrial Designer: Responsible for designing the gadgets related to the magazine topics in a way that allows for their production in the facilities of Universidad Javeriana Cali. Additionally, the designs should ensure that the experiences can be carried out by children within the specified age range, with or without adult assistance.

STEM Experts: They will review the quality of the content that will be included in the magazines to ensure accurate information is being transmitted.

Writer/Literary Expert: Responsible for writing the magazine texts in a way that is easily understandable by children within the specified age range.

It was possible to collaborate with some people who have some of the profiles that represented value for the project. The collaboration consisted mostly of giving the design team constant feedback.

6. Final prototype: STEMfinity

6.1.STEMfinity concept

STEMfinity is a thematic box delivery service that allows children aged between eight and twelve to learn about STEM related topics through engaging magazines and challenging mini projects. STEMfinity allows children to learn as they have fun, while also nurturing their curiosity and encouraging them to keep learning further.

6.2.STEMfinity delivery structure

STEMfinity delivers four collections each year, and each of these collections is comprised of three deliveries. STEMfinity collections cover broader themes, whilst deliveries center around more specific topics within the collection's theme.

To understand this better, we could think of a collection named "A journey through space". This collection could be composed of the three following deliveries, which cover three more specific topics, while sharing the common collection theme:

- *A journey through our solar system*
- *A journey through our galaxy*
- *A journey beyond our galaxy*

STEMfinity deliveries are made monthly, so collections are completed every three months. Since one of the purposes of the service is that the children can acquire a full understanding of each collection theme, the STEMfinity subscription is based on collections, and not their monthly deliveries.

6.3.Contents of STEMfinity deliveries

We will now discuss the contents of STEMfinity deliveries. We encourage that the items contained in each delivery are not limited to the ones described next. If the product design team considers a different item to be suitable for a particular delivery, then the box's content should be extended, provided such extension adds value to the subscriber's experience. However, each STEMfinity delivery should contain, at least, the following items.

6.3.1. The magazine

The magazine is the core item of the box, and the main element that allows children to learn and discover. The magazine's design will be key in making sure that it is engaging to children. For this reason, the magazine should have the following attributes.

Engaging speech

The way the magazine's contents are introduced must be appealing to the children. In this sense, vocabulary must be chosen appropriately and a story like narrative can be used to maintain the children's attention.

Active learning

STEMfinity's purpose is not only to illustrate knowledge, but also allowing children to learn and develop an integral set of skills. For this reason, the magazine's design should contain small activities and puzzles that are related to the covered content and the children can work on. Stickers could also be used as a way to enhance the learning process, by encouraging children to find the correct

placing for each sticker depending on the surrounding content.

Interactive experience

Children's attention span is very short, and reading can easily turn into a monotonic activity. For this reason, the magazine should somehow incorporate digital content that can make it more dynamic and interactive. This could be achieved by the usage of augmented reality, which is a particularly interesting alternative, as it allows for some types of content to be illustrated more appropriately and attractively. We could think, for example, of a cell, which could be better portrayed with a 3D model that can be visualized using augmented reality.

Call to action

We wish to encourage children to continue their learning process even after they have finished reading the magazine. For this reason, the magazine should make a "call to action", in the sense that it should suggest to children outside resources that are related to covered content, allowing them to continue exploring the topic proactively.

6.3.2. The mini project

The mini project provides children with a hands-on activity that exemplifies how things work. It should build upon one of the concepts introduced in the magazine by allowing children to construct an artifact which demonstrates the application of such concept in a tangible manner. However, in terms of user experience, it is important that the children are not restricted to just the building of the artifact. To provide a meaningful learning experience, the mini project should achieve the following.

Knowledge application

We place great importance on knowledge application as it is crucial in producing a profound learning experience in children. We wish the mini project to illustrate with great clarity how theoretical knowledge can be applied in the real world. It should also be clear how knowledge application is purposeful, in the sense that it is motivated by specific needs, so that children understand the value of applying knowledge in clever ways to solve real world problems, i.e., engineering.

Extension of the magazine

The mini project must also contribute to the learning process of the children. As mentioned before, the mini project will allow children to apply part of the knowledge they acquired whilst reading the magazine. Working and completing the mini project should provide the children with a deeper understanding of the theory behind the application.

Appropriate challenge

It is critical that the mini project represents a challenge. Otherwise, children could quickly lose interest in the activity since they would not see any major achievement in completing it. However, if the mini project is too difficult, then children might also lose interest, although in this case it would probably be because of the frustration caused by their incapacity to make progress in the activity. For this reason, the mini project's difficulty level must be very well pondered, so that the children's experience has an appropriate balance between satisfaction and frustration. If this balance is achieved, then the mini project will be engaging for the children.

6.4. The value proposition.

We will now discuss why there exists a need for a service like STEMfinity, and how it can generate value for its subscribers. Afterwards, we will also review the ways in which the service accounts for the interests of the project's sponsor, i.e., the PUJ.

6.4.1. subscriber's perspective

In the context of STEMfinity there exist two types of subscribers. The client, which is the person who finances the service, and who is usually the parent of the child to whom the service is directed. And the user, which is the child to whom the service is directed, and who is usually the client's child.

Having made this distinction, we will now explain how the STEMfinity service provides a solution for the different needs each subscriber of the service has.

6.4.2. The client's needs

There appears to be an increasing inconformity with traditional education, particularly scholar education. There seems to be a growing distrust in the capacity of traditional scholar education of developing the integral skills needed for the future success of children, while also accommodating to their specific interest and needs. STEMfinity provides three offerings that traditional scholar education does not.

Curiosity and creativity stimulation

Interests exploration

Integral development

6.4.3. The user's needs

Children do also present some needs that STEMfinity can solve. These needs arise from the incapacity of traditional scholar education to provide a more personalized learning experience for these children. The following are the four offerings that STEMfinity can make to children.

Relatable, engaging and fun

Surprising and diverse content

Learning by doing

Emotional connection and collector experience

6.4.4. The sponsor's perspective

We have already discussed how STEMfinity addresses some particular needs of its subscribers. Let us now, however, discuss how STEMfinity also addresses the project sponsor's needs. Across the many meetings that we have had with the PUJ to discuss the project's progress, the PUJ has consistently stated its commitment to "...promoting STEM education amongst school children", particularly across the Valle del Cauca region. This is the main intent of this project, and our final solution should be oriented towards this objective. Additionally, the PUJ wishes the project's final solution to provide ways to connect school students of the region to the institution's infrastructure, and thus increasing the likelihood of these school students eventually becoming PUJ students as they grow older. As of now, it may appear unclear how STEMfinity is aligned with the PUJ's interest. For this reason, we will now discuss the ways in which STEMfinity provides the means to the PUJ to achieve these two desired outcomes.

Connecting school students to the institution's infrastructure

STEMfinity, as currently conceived, does not directly connect school students to the PUJ's academic infrastructure. However, we must point out that the STEMfinity concept can be easily extended to achieve this result. There exist multiple channels that can be explored with this purpose, and we encourage the PUJ to extensively explore such possibilities once the service is launched. For now, we will discuss two ways in which the service could be extended to allow the PUJ to achieve this.

Exclusive retail point

The PUJ has a shop called "Tienda Javeriana" inside its campus. The PUJ could use this shop as an exclusive retail point for the service deliveries. This would clearly connect STEMfinity's users to the institution's infrastructure, as they would have to visit the campus to get the given delivery.

However, one could argue that there is no point in visiting the campus when subscribers can easily have the service be delivered right to their homes. Although this is true, this problem can be easily fixed by creating an incentive for getting the delivery directly in the college's campus. For this purpose, we could simply have the deliveries retailed in the PUJ's shop contain a special kind of mini project, which can only be found in these deliveries, and not in the ones shipped to subscribers.

Thematic college visits

Additionally, the STEMfinity service could also be extended to include thematic college visits centered on knowledge applications. These visits could offer an experience similar to that of the mini

projects but taken to a higher level of complexity and excitement. For example, the PUJ could create high impact exhibits that are based on the mini projects and "magnify" the illustrated phenomena. This way, the PUJ would host these exhibits and could then open them to the STEMfinity subscribers.

There are plenty of possibilities to create inside campus experiences for the STEMfinity subscribers, and we encourage the PUJ to explore them in order to connect the users of the service with the institution's infrastructure.

Concluding remarks on the sponsor's perspective

These are just two ways in which the PUJ's desire to connect school students to the institution's academic infrastructure can be achieved. There are probably plenty of other vehicles by which such results can also be obtained. We encourage the PUJ to explore all such alternatives, as they will add considerable value to the service.

7. Design development process

Now, after the planning phase, the design team took into consideration the key components of STEMfinity and the requirements to make it real!

7.1. Magazines

Three magazines were designed, each corresponding to a STEM topic. The brand's chosen fonts were the following:

- Righteous: Titles
- Century Gothic: Body

Throughout the magazine, three colors were kept as it were the brand colors:

- Black: **#000000**
- Orange: **#F58120**
- White: **#FFFFFF**

Another constant component in the magazine was the companion “Lupe” an original illustration of a magnifying glass that guided the children through the magazine. We had a total of nine illustrations of Lupe in different states of emotion from surprised, to happy, to concerned, in an attempt to give more human connection and dynamism to the magazine.



Fig 49. Lupe winking illustration.

A journey to space: Space Phenomenon.

In this issue, topics such as: Black holes, eclipses and rockets were discussed. The colors chosen for this magazine ranged in a cold color spectrum like black, dark blue, purple and gray.

A journey to the garden: A Green World.

As this magazine focused on plants, the topics centered on: Vegetal cell, plant parts and photosynthesis. The chosen colors were mostly green and light blue.



Fig 50. Magazine front page: Journey to the garden.

A journey to the factory: Using Energy.



Fig 51. Magazine front page: Journey to the factory.

Finally, a journey to the factory focused on energy evolution throughout the years, starting from vapor energy to the now digital era. The colors of this magazine evolved as the topics advanced from a gray coal like theme to a blue and white aesthetic.



Fig 52. Magazine: Journey to space

All magazines had real-life photographs to illustrate the topic. Some of these pictures were stickers, so the children could interact with the magazine while they read it. Additionally, throughout the magazine, there were activities that invited the children to research into the topic by themselves and also fun facts that the kids found interesting.

Finally, the magazine had an Augmented Reality component, where kids scanned an image with the app Overly and could see a video relating to the magazine topic.

7.2. Mini Gadgets

For each magazine, the team developed a mini gadget relating to each topic:

A journey to space/ Eclipse simulator.

The idea is for the children to build a model that allows them to visualize a representation of lunar eclipses in a low-light environment. This was achieved using a structure with a light bulb at its center, acting as the sun, while an arm extends concentrically from this light bulb and holds the representation of planet Earth and the moon.

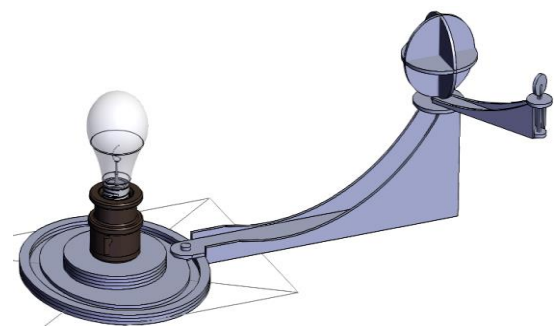


Fig 53. Eclipse simulator blueprint.

A journey to the garden/ Stereoscope.

In this case, the pieces sent to the child form a stereoscope. It allows them to visualize objects, especially in the garden, with a 10x magnification. The added value is that allows them to adjust the desired magnification by adjusting the height at which the lens (a magnifying glass) is positioned. This also provides the possibility of manipulating the object to be observed, as the lens is constantly fixed in position.

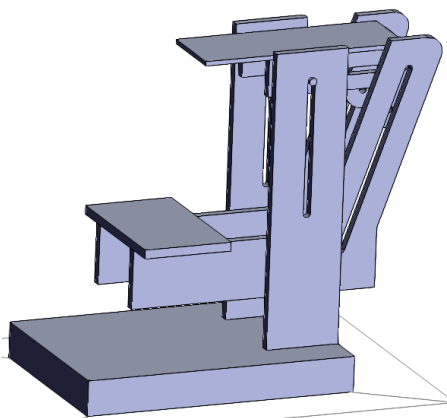


Fig 54. Stereoscope blueprint.

A journey to the factory/Hydraulic robot arm.

For the factory theme, a hydraulic arm was designed to allow users to perform practical and theoretical contrasts, especially regarding the topics related to robots in factories. This gadget is the most robust one that was created, due to the number of components it comprises, including 8 syringes of 10 ml each and a pair of hoses. The result was successful, as the hydraulic arm is fully functional.

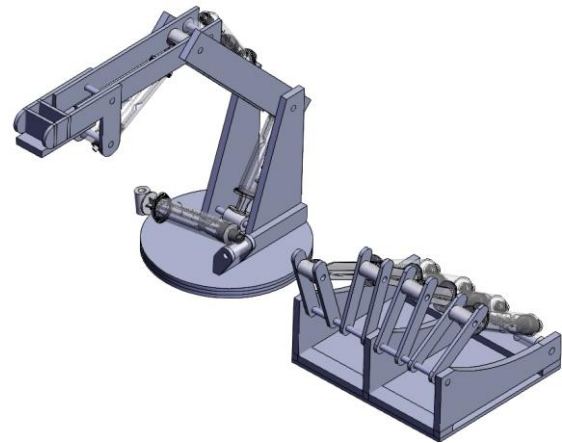


Fig 55. Hydraulic robot arm blueprint.

The mini gadgets blueprints were developed in Solid works. Then, the pieces were cut on a laser cutter and assembled with nuts and bolts. All the cuts were made in MDF wood, as it was an accessible resource at the university and also represents a material with sufficient rigidity, which provides user convenience in handling without damaging the pieces.

Additionally, an instruction guide was also made, so the kids could build the mini gadgets on their own.



Ahora si, manos a la obra...

En esta experiencia vamos a poder observar cómo ocurren los eclipses. Pide ayuda a un adulto para construir la magia.

¿Cómo lo armo?



Fig 56. Instruction guide example.

7.3. Boxes

Across the product development process, it became evident that the packaging of the product was an important factor in achieving one of the STEMfinity's core objectives: the collectible experience.

Things acquire a collectible value when they are not only desired, but also worth keeping. From a product point of view, packaging is particularly crucial in achieving the latter. A product with poor packaging is more likely to be thrown away. However, when effort is put into the design of a meaningful and impactful packaging for a product, then that product will not only provide value itself, but also through its packaging. A great example of this phenomena can be seen in the way Apple places great importance in the packaging of its products. It appears to be that Apple is able to induce a particular behavior in its users by doing this: Apple users tend to keep their product's packaging even after unpacking the product.

That, right there, was the goal the design team pursued when creating the STEMfinity's packaging: creating a packaging that is worth keeping, not only because of it being aesthetically pleasing, but also because it provides an organized and efficient way to accommodate the STEMfinity delivery contents if they, for some reason, should be placed back in their packaging.

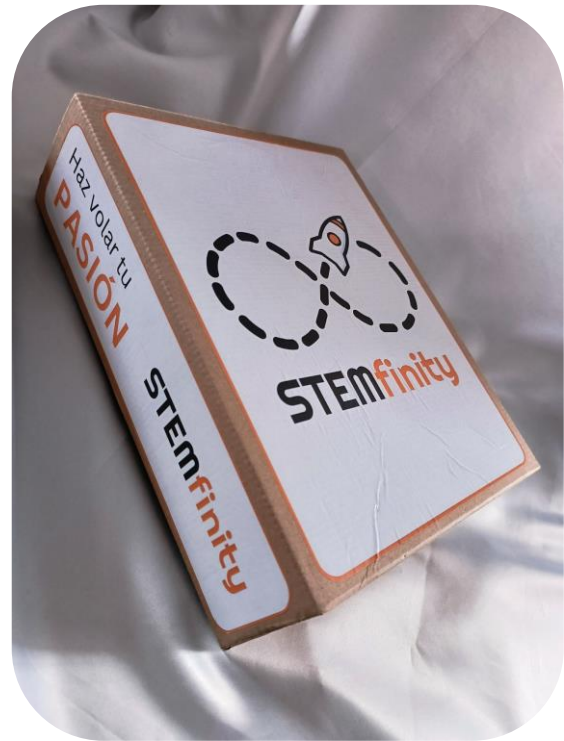


Fig 57. Final Box.

Doing this, we can be sure that the STEMfinity users will use the packaging as a way to store their deliveries and not just get rid of them. This allows for the creation of a personal collection and its organized storing.

7.4. Teaser

A short promotional video was produced with few tools the design team had on hand. A challenging aspect was not to take more than one minute and thirty seconds, but it was successfully carried out.



Fig 58. Real Beauty. Dove.

The production of this video drew significant inspiration from some promotional videos by the brand Dove. For instance, the video "Real Beauty Sketches" served as a guiding model. In general terms, the style of these promotional videos aims to convey the brand's philosophy in an emotive and indirect manner, without necessarily showcasing specific products.

After all the production process, scriptwriting, recording, editing and so on, the expectations of the promotional video will be met. The result deals with some scenes where 3 characters narrate that their dreams of studying STEM careers were not fulfilled, for various reasons related to insecurities and fears. The end of the video is the most emotional, since the character of a girl is shown, who expresses having her dreams intact for studying a STEM career, concluding with the Stem Finity brand logo.

The video can be seen in the next youtube link:

https://www.youtube.com/watch?v=RU5FNYGrW0w&t=13s&ab_channel=SUGARNetwork

compressed wood, acrylic, or others. The appendix contains the link to access these files.

Due to time constraints, more premium versions and quarterly collections could not be developed by the team. However, for the continuation of this project, it is necessary to continue with the ongoing design of collections for quarterly subscriptions and further delve into the development of the premium component.

9. Business model

The Canvas Business Model (CBM) allows us to easily visualize and identify the key components of a business proposal. The following image presents the CBM of STEMfinity.

This is a convenient visual tool to understand the way the STEMfinity subscription service could be structured as a self-sustainable business activity.

A more detailed discussion on the STEMfinity's business model is provided in the fig 61. We encourage the reader to review it. Below is the entire scheme to understand the business model.

The Business Model Canvas

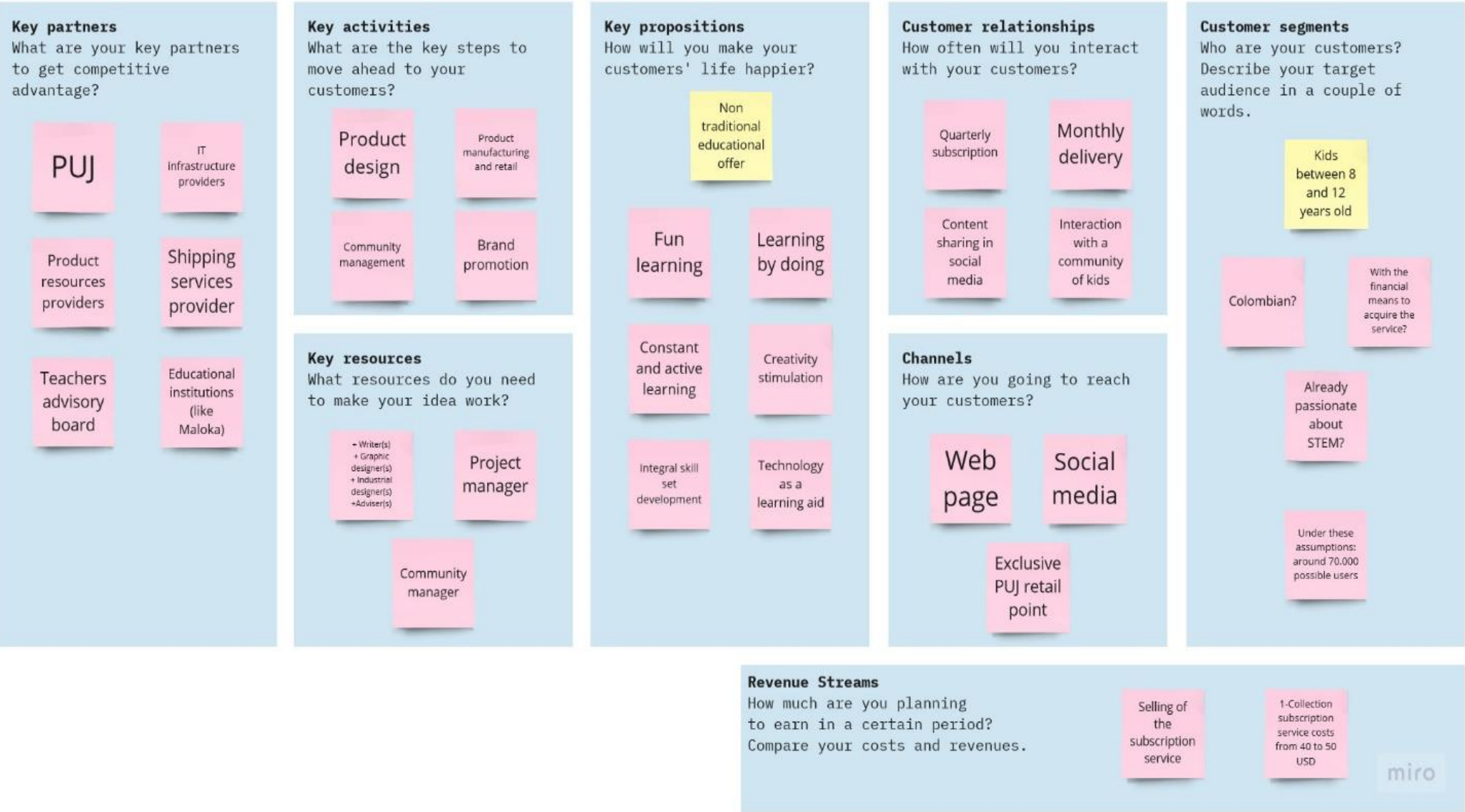


Fig 61. Canvas Business Model.

10. Final Validation

STEMfinity as a final product was validated with 15 6th graders that had 11-12 y.o. In this experience, the following points were observed:

- Augmented reality experiences catch the attention of children and cause amazement and engagement with the magazine.
- The use of stickers invites the kids to explore the contents of the magazine.



Figure 62. Validation of STEMfinity

- The construction of the mini gadgets caused curiosity and an eagerness to build the final experience and get to interact with it.



Figure x. Validation of STEMfinity

11. The role of each career within the project

11.1. Electronic Engineering

Electronic engineering played an important role in different stages of the project, with diverse contributions from various perspectives thanks to the versatility of knowledge acquired in this field of study.

During the initial stages, technical knowledge in electronics proved invaluable in evaluating the global and national context. This was particularly useful in assessing physical and technological alternatives proposed by other companies or entities to address the problem at hand. Examples included toys, educational devices, science fair projects, software proposals, among others. Below are some images taken at Melquiades' booth, an exhibition event showcasing various STEM demonstrations, with a strong emphasis on electronic engineering. This initiative originated from the University of Valle.

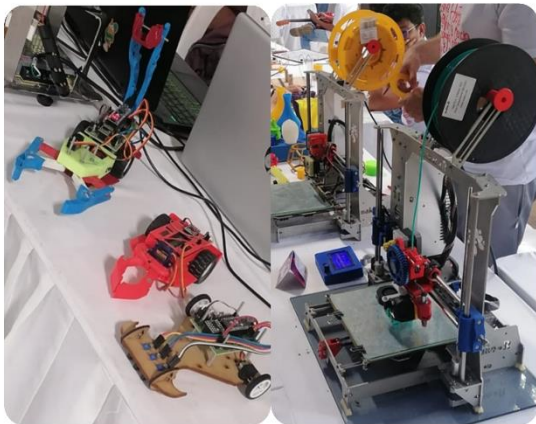


Fig x. Melquiades' booth experiences.

In the prototyping stage, electronics played a vital role as low-level prototypes were developed week after week. Some of these

prototypes included a remote-controlled boat, an online game for practicing STEM topics, educational circuits for children, and didactic strategies to comprehend the logic behind software, among others. Knowledge in design, especially electronic design for educational purposes and a younger audience, was crucial during this stage.

In the convergence stage, electronics played a fundamental role in the design and 3D modeling process for the experiences included in each box. Specifically, both premium proposals focused entirely on the use of electronics. One of them involved designing an educational experience where children can build a moisture detector, while the other featured a conveyor belt.

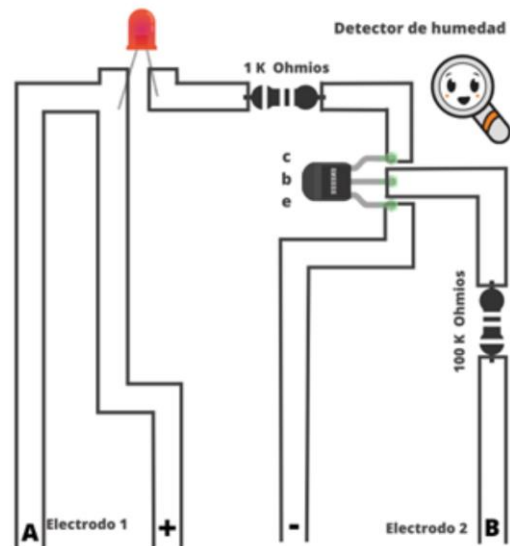


Fig x. Moisture detector.

Beyond the aforementioned aspects, numerous skills acquired throughout the electronic engineering program were applied. These include project management, budget evaluation, discernment in selecting electronic components, and much more.

11.2. Sistem Engineering

During the early stages of the project, the skills acquired during the Systems Engineering degree were primarily those related to the academic and scientific emphasis of the program. This is because during the initial phases of the project, an extensive literature review was conducted, accompanied by analysis of graphs and data regarding the global, Colombian, and Cali contexts.

During the prototyping stages, knowledge and practical experience in project development were also contributed on a weekly basis. This is because in the software development industry, it is common to find agile development methodologies, and the students put their experience in such agile developments into practice to successfully prototype each week.

Regarding specific aspects of the prototypes where contributions were made from Systems Engineering, they were mainly related to software development or algorithmic thinking. An example of this is the development of the Ulink website.

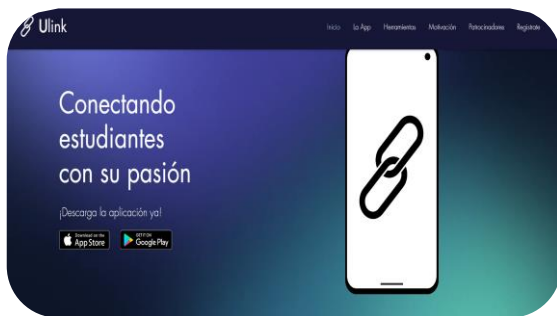


Fig x. Ulink web page.

In the final stages of the project, contributions were made in the creation of the STEMfinity website, as well as the

search and testing of various applications for the development of augmented reality experiences.

Excluding the previously mentioned theoretical knowledge, the project development involved both the use and improvement of general skills applicable to all engineering disciplines, highlighting some skills such as project management, effective communication, creativity, and problem-solving.

11.3. Biology / Psychology

As a project that needs to identify people's needs, in this case our main users were children, understanding their point of view and being able to connect and extract relevant information in the empathy stage, was key to the process of designing a solution. Therefore, psychology skills came on useful to handle and observe the behavior of children regarding the prototypes that developed throughout these months.

Additionally, while designing the final prototype, one of the magazines was focused on a biology topic, plants, so diving in and reviewing concepts to be more understandable and fun for children was going back to the basics of the career.

12. Process reflection

The last few months of work on this project have been filled with numerous learning opportunities. The design team has faced various challenges on a daily basis, such as interdisciplinary work, collaboration with colleagues from another country, and prototyping ideas within short time frames. The implemented methodology (design thinking) has yielded fruitful results, particularly during the prototyping phase, where many prototypes were developed from different perspectives.

One of the strongest takeaways from this experience is the need to implement a different strategy to incentivize the world of STEM fields, depending on the age range of the target audience. The team also learned the importance of combining different alternatives, such as the interaction with virtual, physical, passive, and active components, among others.

Finally, the team is satisfied with the result obtained after the convergence stage. The challenges were overcome, and a great representation of the project is expected at the global exhibition in San Francisco.

Jorge Figueroa

During the past few months participating in the project, I have been able to see education from a completely different perspective than I have had for so many years as a student. I am particularly motivated by the idea that with the effort and work I put into the project and the prototypes, we can inspire a greater number of children and young people to get closer to science and engineering, or at least recognize the importance of these fields

and the role that professionals in these areas play in our society. On the other hand, I like the Design Thinking methodology because it is flexible while having a clear goal: the user. This means that all changes and improvements are made with the aim of delivering a better product or experience to the user, which is something I find very satisfying.

Manuel Orejuela

I feel proud of our team's dedication to using design thinking and our ability to overcome various challenges. I am impressed with our focus on tailoring our approach to different age groups in the STEM field, and our emphasis on combining different components for a holistic learning experience. I am excited to continue our success in our final product development and interdisciplinary collaboration. In relation with the methodology of design thinking I have personally enjoyed using throughout our project, especially during the prototyping phase. This approach has allowed us to generate a variety of different prototypes, each with their own unique perspectives and contributions. Through this process, we have gained numerous insights and learnings that have been invaluable in guiding our project's development.

Juan Fernando Plata

Although this project as a whole has been demanding, the last month brought with it an even higher level of pressure on the team. However, I can proudly say that the team embraced this pressure remarkably, and was capable of tolerating uncertainty appropriately. The result of this hard work and versatility can be seen in the product we did not only

envision, but also created. STEMfinity is a well conceived product that I believe has a place in the market and can produce a great impact amongst children.

I am immensely proud of the result the team has achieved, but also very grateful for the way in which this project has allowed me to develop professionally and personally.

Laura Melo

Over the past few months, I've been introduced to a new methodology of innovation, that allows creativity flow and autonomous work. In this path, I was accompanied by a brilliant interdisciplinary team of students. It's not been an easy process, but it has had results. These outcomes are a product of the effort of this team with the mission to motivate more students to enter STEM fields that we are a part of. Therefore, it's also a personal experience that requires understanding our interests and being able to share them to the younger generation.

STEMfinity comes up as a feasible solution to promote STEM careers from an everyday point of view, a philosophical perception of how things around us have evolved with a simple explanation. Overall, in this process something that was highlighted was the passion for our careers, and a wish to transmit that feeling through a fun experience.

13. Milestones

- November 8: First meeting ME310.
- November 10: Delivery of missions 1 & 2.
- November 15: Weekly meeting.
- November 16: First Global meeting.
- November 22: Weekly meeting.
- November 23: Second global meeting.
- November 26: First meeting with David Baldeon(Expert in gamification)
- December 6: Weekly meeting.
- December 12: Third global meeting.
- December 14: Practice for Fall Presentation.
- December 15: Fall Presentation.
- December 22: Fourth global meeting.
- January 17: Delivery mission 3(Critical Experience prototype).
- January 24: Weekly meeting.
- January 30: STEMBOX validation.
- January 31: Weekly meeting + delivery of mission 4(Critical Function Prototype).
- February 2: Triz Workshop.
- February 5: Stembox KIDS validation.
- February 7: Weekly meeting + delivery of mission 5(Dark Horse Prototype)
- February 8: Meeting with Frank Nichols(Illusionist).
- February 14: Fifth global meeting + weekly meeting.
- February 16: Second meeting with Frank Nichols.
- February 17: Sixth global meeting.
- February 19: Seventh global meeting.
- February 20: Meeting with Catalina Lagarcha(Expert in education).
- February 21: Weekly meeting.
- February 27: STEM Wars validation + second meeting with David Baldeon.
- February 28: Weekly meeting.
- March 6: Ulink validation + meeting with William Aguirre(past ME310 member)
- March 7: Weekly meeting + delivery of mission 6(Funktional Prototype)
- March 13: Harmonic Sciences Validation.
- March 14: Weekly meeting.
- March 21: Weekly meeting.
- March 27: Stemfinity validation + Alejandra María González meeting(Ucollege director)
- March 28: Weekly meeting + Winter presentation practice
- March 30: Winter Presentation

14. References

14.1. Bibliography

- ICFES. (2020). Gov.co. Retrieved December 14, 2022, from https://www2.icfes.gov.co/documents/39286/1125661/Informe_nacional_resultados_PISA_2018.pdf/4c66530f-027e-696a-81da-be6e5108e5e9?version=1.0&t=1646970884580
- SPADIES - Sistemas información. (n.d.). Gov.co. Retrieved December 14, 2022, from https://www.mineduacion.gov.co/sistema_sinfo/spadies/
- Zilberman, A., & Ice, L. (2021, January 19). *Why computer occupations are behind strong STEM employment growth in the 2019–29 decade*. Bls.gov. <https://www.bls.gov/opub/btn/volume-10/why-computer-occupations-are-behind-strong-stem-employment-growth.htm>
- Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). STEM: Country Comparisons: International Comparisons of Science, Technology, Engineering and Mathematics (STEM) Education. *Australian Council of Learned Academies*, 1-178.
- Frymier, A., & Houser, M. (1998). Does making content relevant make a difference in learning?. *Communication Research Reports*, 15 (1), 121-129. DOI:10.1080/08824099809362106.
- Vero, E., & Puka, E.(2017). The Importance of Motivation in an Educational Environment. *Formazione & Insegnamento*, 15(1), 2279-7505, doi: 107346/-fei-XV-01-17_05

15. Annexes

A Google Drive folder has been set up, where you will find all the valuable material from the various stages of the Project. This includes photographs, flyers for each prototype, 3D plans for all the mini projects, magazines, and other information.

Here is the link to access the Google Drive folder:

<https://drive.google.com/drive/folders/11-aw8bg89ZpW-rRqBBd9XlkPHfEzhUAY?usp=sharing>