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Using Technology to Innovate in University Admission Preparatory Courses

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Using Technology to Innovate in University Admission Preparatory Courses

Final monograph for
MAC0499 – Supervised Capstone Project.

Supervisor: Prof. Dr. Fabio Kon

São Paulo
November of 2018

To the ones who see things differently

Acknowledgments

It is hard to imagine that I went through all of this path alone. Some people helped me to go through both the best and the toughest times.

I thank my parents, Selma Moreira and Sérgio Santos, for all love, support, and patience. The achievement that this monograph represents is a result of all your efforts and dedication to my education and growth.

To my *squad* and friends, Giovanna Guimarães, Guilherme Ishida, Gustavo Ormenese and Raphael Defina, I thank you for the best friendship I could have.

To my dear friends and partners at Ducante, Gustavo Silva and Leonardo Padilha, I thank you for making my days at the University of São Paulo more pleasant and fun.

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Abstract

Ducante, an education startup founded by the author, inspired the present work to discuss the process of building an educational startup and whether it is possible to innovate in high-school level education. This work covers every technical aspect, including business, engineering, and design, of building a startup that aimed to improve education in Brazil, by introducing some key concepts and discussing how the founders applied them during the startup development. Finally, it presents all results of such startup and a subjective statement of the author regarding using technology to innovate in University admission preparatory courses.

Keywords: startup, education, innovation, entrepreneurship, social impact.

Contents

List of Abbreviations

B2B	Business to business
B2C	Business to client
CD	Continuous Delivery
Edtech	Educational technology
ENEM	National exam for high school level (*Exame nacional do Ensino Médio*)
IBGE	Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*)
MVP	Minimum Viable Product
NGO	Non-governmental organization
PO	Product Owner
SAM	Serviceable Addressable Market
SOM	Serviceable Obtainable Market
TAM	Total Addressable Market
UML	Unified Modeling Language

List of Figures

List of Tables

Chapter 1

Introduction

> Wherever there are women and men there is always something to do, there is always something to teach, there is always something to learn.
>
> *Paulo Freire, 1996, Pedagogia da autonomia*

On August 2016, along with Gustavo Silva and Leonardo Padilha, I decided to found Ducante, a startup that aimed to democratize high school level classes and improve Brazil's educational system by enabling poor and less privileged people to have access to core education. We aimed to use continuous learning data to improve the quality of offline classes.

This startup inspired the present work to discuss the process of building an educational startup and whether it is possible to innovate in high-school level education. Utterly, this work will cover every technical aspect, including business, engineering, and design, of building a startup that aimed to improve education in Brazil. Furthermore, this work will present all results of such startup as well with a subjective statement of the author regarding using technology to innovate in University admission preparatory courses.

Motivation

The motivation to found Ducante started way before I joined my colleagues on this endeavor. Silva and Padilha developed the very first version of Ducante, by that time called Shark'n, during Facebook's Hackathon in São Paulo in May 2015. Silva and Padilha continued to develop Shark'n slowly until August 2016 in stealth mode.

On the second semester of 2016, Silva, Padilha, and I decided to take a course entitled "Digital Entrepreneurship" (MAC0467)[1], taught by professor Fabio Kon, supervisor of this monograph, that aimed to join computer science students at Universidade de São Paulo (USP) with business administration students at Fundação Getúlio Vargas (FGV) to develop new startups. I joined Silva and Padilha altogether with two other FGV students[2] that were working on a school focused on University admission exams ran by FGV targeted for low-income people. Together, we kicked-off Ducante.

Beyond our motivation to improve education by applying statistics and computer science knowledge in the education industry, we also had a few personal motivations. We understood

[1] https://bcc.ime.usp.br/catalogo2015/disciplinas/MAC0467.html

[2] Disclaimer: these two FGV students chose not to continue working on Ducante after the class ended. Beyond that, their contribution was not relevant to the topics covered in this work. For these reasons, they were not included in the founding team nor will be mentioned in this work.

that developing these three fundamental skills would be highly beneficial to our computer science careers:

- **Design and implementation of a large system.** We, as students, craved to work on projects that would extrapolate the work scope of typical college work. Beyond that, we craved to a work that required us to research and explore different options.
- **Product development.** Apart from technical challenges, we aimed to learn how to understand user's needs and how to solve their problems.
- **Social value.** We aimed to work on something that would produce genuine value for our society. That is, build something that would solve a real and broad problem.

Finally, this present capstone project is highly motivated to share what we did right and wrong, inspire new students to start new startups and document the days we spent building something somewhat fun and challenging.

Goals

Primary goals of this work include:

- Sharing problems we faced while attempting to improve education in Brazil;
- Sharing how we build and ran Ducante, an educational startup, as a company;
- Sharing how we drove our experimentations and development;
- Explaining and sharing the decisions we made, what worked and what did not;
- Exposing business analysis we did, including anonymized data from our users;

Finally, we desire to inspire people to work on new tech solutions for the educational sector.

Chapters

This work is logically divided to cover business, engineering, and design aspects separately. Throughout the chapters, this work shall introduce some concepts and how they were applied to Ducante. The chapters are divided as:

- **Context**. Introduces a brief history of the internet and startups, how education works in Brazil at a high level and accurately defines the startup Ducante.
- **Problem**. Discusses the problem Ducante was trying to solve and how it evolved as we had insights from people.
- **Strategy**. Covers the business aspect behind Ducante, such as value proposition, business model, SWOT analysis and knowing the competition.
- **Designing for engagement**. Covers the methods we adopted to design our product, including interface, interactions and, more important, how we wanted our platform to work. It also covers a review over ***The Lean Startup***, from Ries (2011), and ***Hooked:*** *How to Build Habit-Forming Products*, from Eyal and Hoover (2014).

- **Agile Development**. Presents some of the available Agile methodologies and how we used them to speed up our development.
- **Technological Aspects**. Illustrates how Ducante was engineered, including the stack of technologies (languages, database, and engines), architecture, data models and infrastructure.
- **Results**. Presents some of the results we had by deploying Ducante to the world and having real people using it on a weekly basis.
- **Conclusion**. Closes this work with a subjective statement from the author, including his opinion on using technology to innovate in University admission preparatory courses.

Chapter 2

Context

2.1 Internet and startups

The value of computer science in the world increased substantially since the Internet rise. The Internet was first introduced in 1969 by the United States Department of Defense Advanced Research Projects Agency[1] but only became popular in the 1990s. In the software engineering industry, the Internet Bubble marked the 1990s, where numerous dot-com companies took place on the Internet, such as Amazon and Google. Since then, entrepreneurship became very popular among computer scientists and software engineers.

As Pressman (2010) states, in the 1990s few people predicted that "software would slowly evolve from a product to a service as 'on-demand' software" and "a software company would become larger and more influential than almost all industrial-era companies." This new format and context, where software plays the role of product and distribution channel reaching much more people at reduced costs, required an evolution of the business literature, to understand these new types of companies. Moreover, as new industries, monetization, and marketing models appeared, the way people run a traditional company suffered a disturbance, requiring them to change the way they operate and innovate to survive.

It was in the 2000s and 2010s that the first important literary references appeared, such as *The Lean Startup* by Ries (2011) and *The Four Steps to the Epiphany* by Blank (2005), adapted to these new types of companies. The term *startup*, which is not specific for software companies, was adopted and gained relevance in digital entrepreneurship. Although there are many definitions, the one used in this work will be the definition proposed by Blank (2010): "a startup is an organization formed to search for a repeatable and scalable business model."

The shift of people reachability and the way companies distributed software allowed several business innovations in different industries. Many companies started to innovate, gain market share, and compete with traditional and well-established companies by applying different business models. As examples, Netflix, that was once a company that leased physical DVDs, shifted to distributing movies over the Internet, and WhatsApp, an app that allowed messaging over the Internet avoiding telecom costs (SMS and MMS messages).

This work documents the construction, evolution, and closure of Ducante, an educational startup (edtech) co-founded by the author. Ducante aimed at rethinking how to distribute educational content and how these content consumption could be harnessed to optimize and improve the learning process.

[1] "A brief history of the Internet". walthowe.com. Retrieved 26 October 2018.

2.2 Education in Brazil

Some key concepts are required to understand the problem Ducante was trying to solve. Brazil has a unique educational system, that was built under its own needs, and is seeking changes and improvements. To what matters to this work, it is interesting to understand how higher education works in Brazil.

The leading and most attempted Brazilian universities are maintained exclusively with federal, state or municipal resources, and therefore they do not require students to pay for studying. Through *Exame Nacional do Ensino Médio* (ENEM, the national exam for high school level), each year more than 9 million students compete for 240.000 positions at 130 higher education institutions maintained with only federal and state resources. Figure 2.2 shows the number of people taking the ENEM over the past 20 years. It also shows a trend line that indicates that the amount of people taking the exam has increased almost linearly over time.

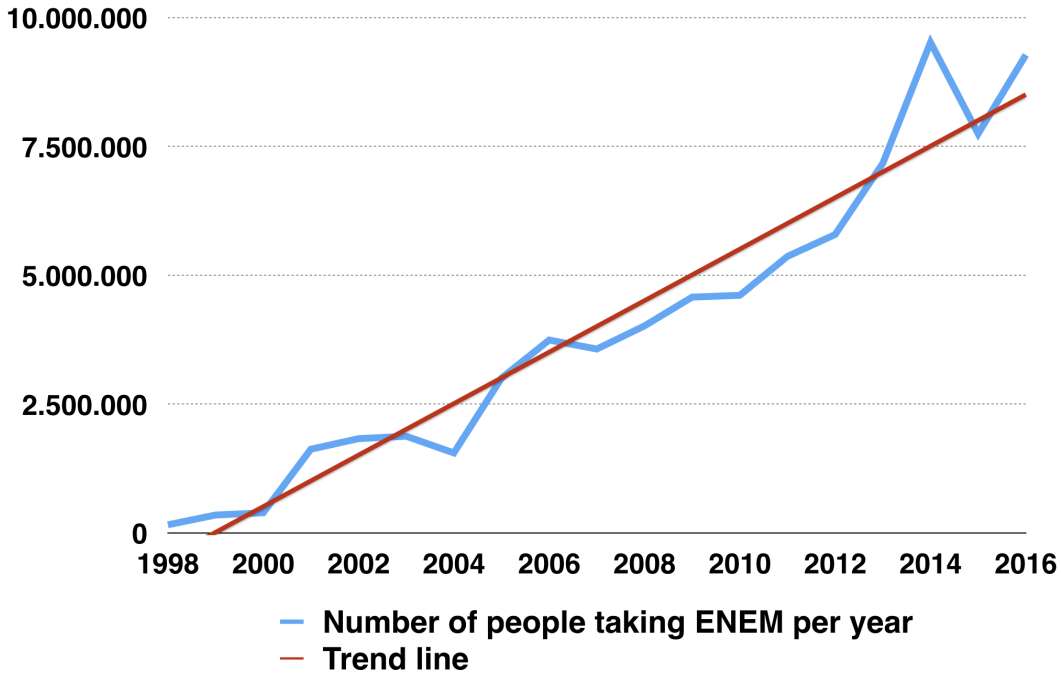

Figure 2.1: *Number of students taking ENEM from 1998 to 2016*

ENEM is not the only admission exam that Brazilians students take as many other higher education institutions, maintained with public or private capital, adopt their admission exams as well. Their scope is very similar, and during high school, teachers prepare their students for these types of exams. This method to validate and classify students has shaped the way high school is conducted in Brazil. Beyond reducing high school classes to mastering those admission exams, it also favored and perpetuated social inequality, as private high schools with much more resources are preparing its students better than public high schools.

Moreover, the reality in Brazil is that many kids do not have access to education at all, as they have to start working as early as 14 years old, according to Globo (2016), and can not afford to study. In addition to poor study access, a lack of guidance and proper resources worsens the education problem in Brazil.

Many opportunities to improvements emanate from this scenario. Ducante attempts to solve a few of these problems.

2.3 Ducante

Three computer science students (as shown in figure 2.2) from the University of São Paulo (USP) founded Ducante, including the author:

- Gustavo Silva is a computer science student at Institute of Mathematics and Statistics, at the University of São Paulo. Silva had internship experience as a software engineer at VTEX and was leading product development and also working as a software engineer on frontend softwares.
- Leonardo Padilha is a computer science student at Institute of Mathematics and Statistics, at the University of São Paulo. Padilha had internship experiences as a software engineer at Google and VTEX and was working as a tech lead and responsible for infrastructure and core softwares.
- Lucas Santos, the author, is a computer science student at Institute of Mathematics and Statistics, at the University of São Paulo. Santos had internship experiences as a software engineer at Google and Facebook and as product owner at Movile, and was leading strategy, execution and also working as a software engineer on backend services.

Figure 2.2: *Founding team (from left to right): Gustavo Silva, Leonardo Padilha and Lucas Santos. This picture was taken at San Francisco, during our visit to Sillicon Valley after winning Campus Mobile.*

Before founding a company together, all of us were good friends and colleagues, having met each other at USP and attended many classes together. We all wanted to build something from scratch, and we had the ambition to build products people would love and use. Changing the way the education system works was something we were excited to do. It combined the idea of having a good and significant impact with solving a problem we recently had, as we were sophomore students. The problem was hard and the path unclear: a perfect combination for three naive students.

Chapter 3

Problem

When we registered to attend "Digital Entrepreneurship" (MAC0467), we already knew we wanted to work on the education industry for problems at the high school level. What we did not have decided yet was what problem to work in the class.

Inspired by the methodology Customer Development[1], described on the book "The Four Steps to the Epiphany" by Blank (2005), we decided to talk and interview students and professors from preparatory schools for University admission exams to understand better their problems and how we could develop a solution for these problems.

Since we started working on Ducante, the problem we identified remained the same, but we found problems with our initial approach that forced us to pivot our solution. In this chapter, we discuss these problems and how we pivoted to adapt to new insights we had.

3.1 First phase

In mid-September 2016, after a few interviews, we identified that many students do not have financial resources to invest in their education. Moreover, many students have hard times to motivate and engage themselves, and many of them do not have time to study at all. The main reason for that was they were splitting their time with study and work. Our solution was to offer high-quality resources for students at low, accessible price combined with study guides. In some sense, it was a Duolingo for University admission exams backed by their school teachers.

We proposed to solve this problem by working together with schools and teachers, in a B2B model, where we monetize from the school. We would help teachers to share resources and working exercises, and give both students and teachers statistics to help them understand their progress. We also designed Ducante to be fun, so students could enjoy their studies on the little time they had in their busy schedules.

Figure 3.1 and 3.2 show our first prototype and minimum viable product. We worked on this prototype for eight months taking from a paper prototype to a usable software, a hybrid mobile app that would work on iOS and Android smartphones. After launching, iterating

[1] According to Wikipedia contributors (2018a), Customer Development is a process that "assumes that early ventures have untested hypotheses about their business model (who are the customers, what features they want, what channel to use, revenue strategy/pricing tactics, how to get/keep/grow customers, strategic activities needed to deliver the product, internal resources needed, partners required and costs.). Customer development starts with the fundamental idea that there are no facts inside your building so get outside to test them. The hypotheses testing emulates the scientific method – pose a business model hypothesis, design an experiment, get out of the building and test it. Take the data and derive some insight to either 1) Validate the hypothesis, 2) Invalidate the Hypothesis or 3) Modify the hypothesis."

and evaluating our solution, we identified some issues in our model, and we decided to pivot to a new solution, using a different approach.

3.2 Second phase

In December 2016, Silva, Padilha, and I signed up for Campus Mobile[2], an university-level entrepreneurship competition (this will be covered in detail in section 8.2.1). Throughout Campus Mobile, we received extensive mentorship and numerous constructive criticisms regarding the solution we have been working on. It was only in April 2017 that we decided to pivot as we found out three critical problems that was preventing us from growing.

First, we found a significant dependency and correlation between teachers and students usage. That is, students usage was depending on having teachers using. Teacher engagement became the upper boundary of the platform usage, and beyond that, we received feedback from teachers saying they saw the platform as additional work and they would not be able to use Ducante regularly. That directly implied in less usage from both teachers and students.

Secondly, we found out that selling to school is seasonal. Most of the schools once they started their academic year, they were not open to negotiate and buy new products or services, as it would impact their budget and strategy for the year.

The last problem — and harder to oversee — was the difficulty in selling the product to schools. The reasons for that include conservatism from teachers against technology usage inside the traditional classroom and the lack of budget for innovation.

Given that, we decided to pivot and develop a B2C solution that would solve the student problem by approaching them directly. The problem we were aiming to address would not change but rather the product we were designing and how we would distribute and monetize our products.

[2]Campus Mobile: http://www.campusmobile.com.br

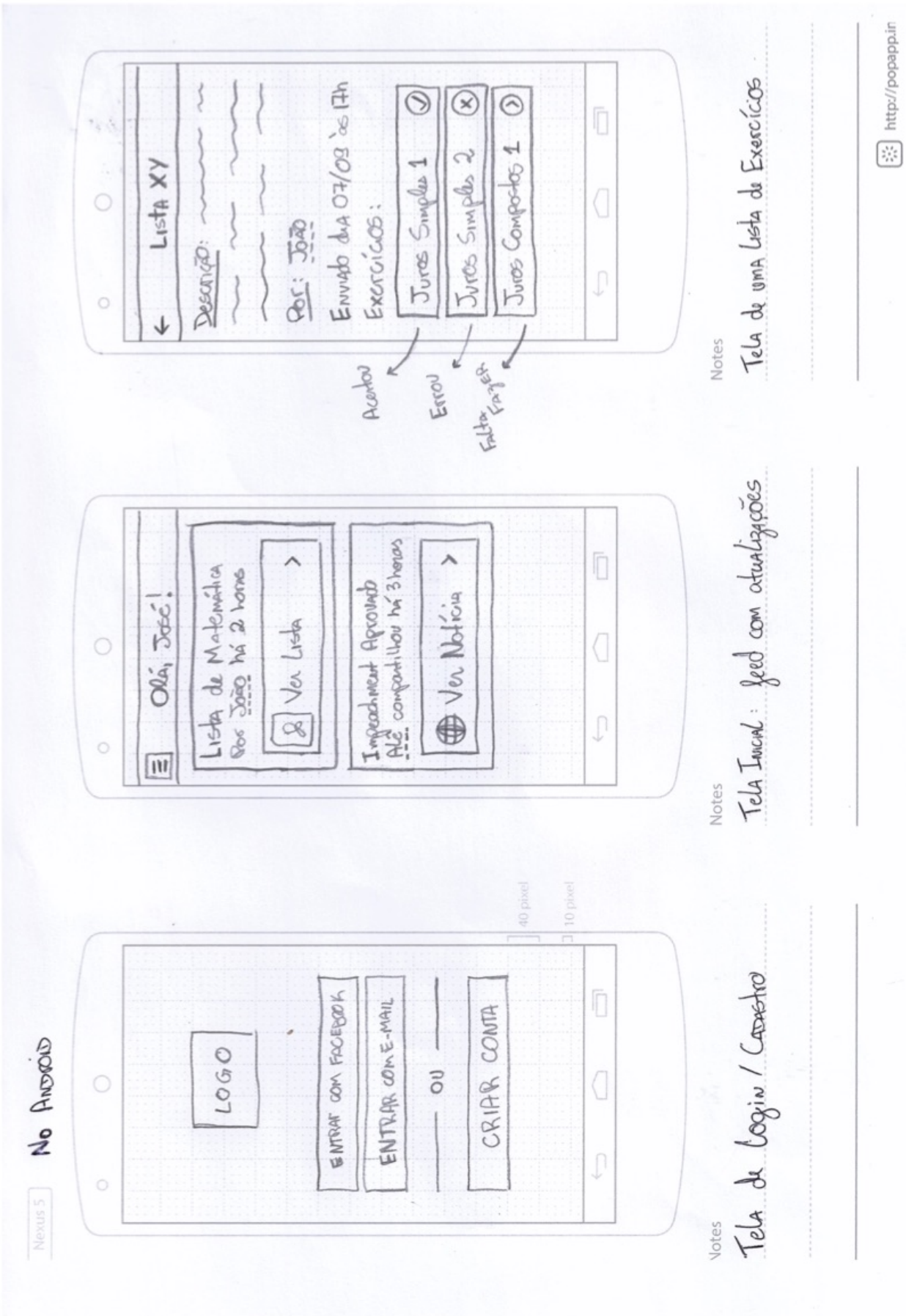

Figure 3.1: *First handmade prototype (1/2)*

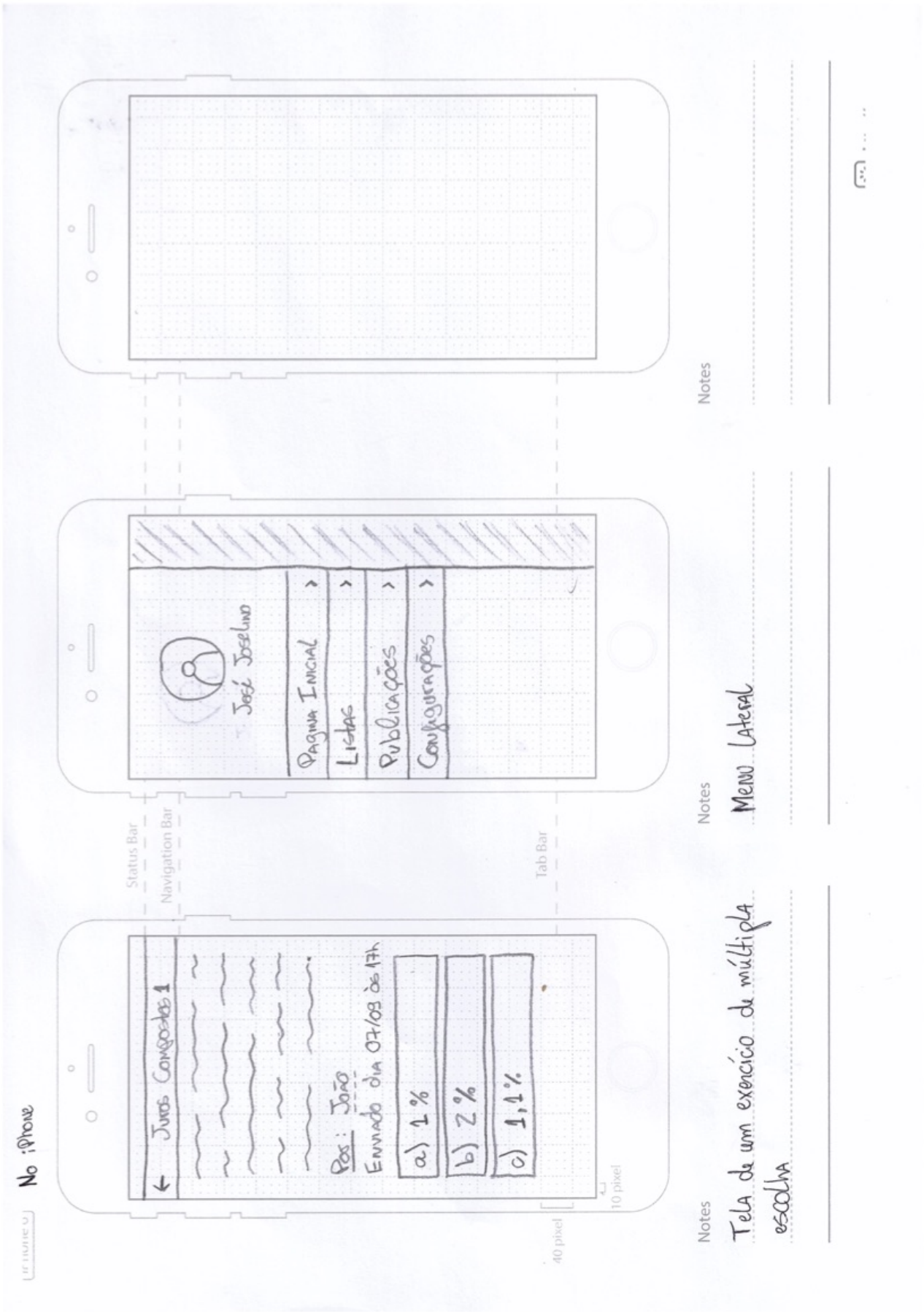

Figure 3.2: *First handmade prototype (2/2)*

Chapter 4

Strategy

> The economic value of one great industrial genius is sufficient to cover the expenses of the education of a whole town; (...) adds as much to England's productive power as the labour of a hundred thousand men.
>
> *Marshall, 1890, Principles of Economics*

We firmly believed that only having a well-designed app and outstanding software, from an engineering perspective, was not sufficient to have a successful startup. Our former experience working on an other successful company showed us the power of a good strategy in accordance with vision and goals. In this chapter, we discuss our vision and strategy to run Ducante.

4.1 Our vision and value proposition

Our vision for Ducante was clear from the very beginning: innovate on the education industry over a combination of business model innovation with technology innovation. The former type of innovation worked for several companies before in different industries, since the technology advances started to allow large-scale distribution at low cost. For example, companies like Netflix and Amazon found on the Internet a highly scalable channel to sell and distribute their products at lower prices than their competitors. Our vision for Ducante was no different. We aimed to, through technology efficiency, offer high-quality educational resources to a large number of students at low cost. The latter type of innovation would imply using technology in a different way that was being used at classrooms. What we had in mind was to gather learning data and statistics to generate knowledge and predict progression.

We always had clarity that our end user was the student. The entire educational structure, from the physical environment to the presence of teachers, is created to support students during their learning process. For that reason, from the very first moment, we designed solutions proposing value to the student at first.

For our primary users, students, we wanted to deliver a low-cost platform to support their studies, providing high-quality materials and an effective mentoring system. We imagined, at first, that the teachers of the schools these students already attend would be responsible for giving those materials across the platform. In figure 4.1, there is an example of a digital class where students can learn more about US president Donald Trump's election, in 2016. Schools would still be responsible for funding the platform costs so students could use it.

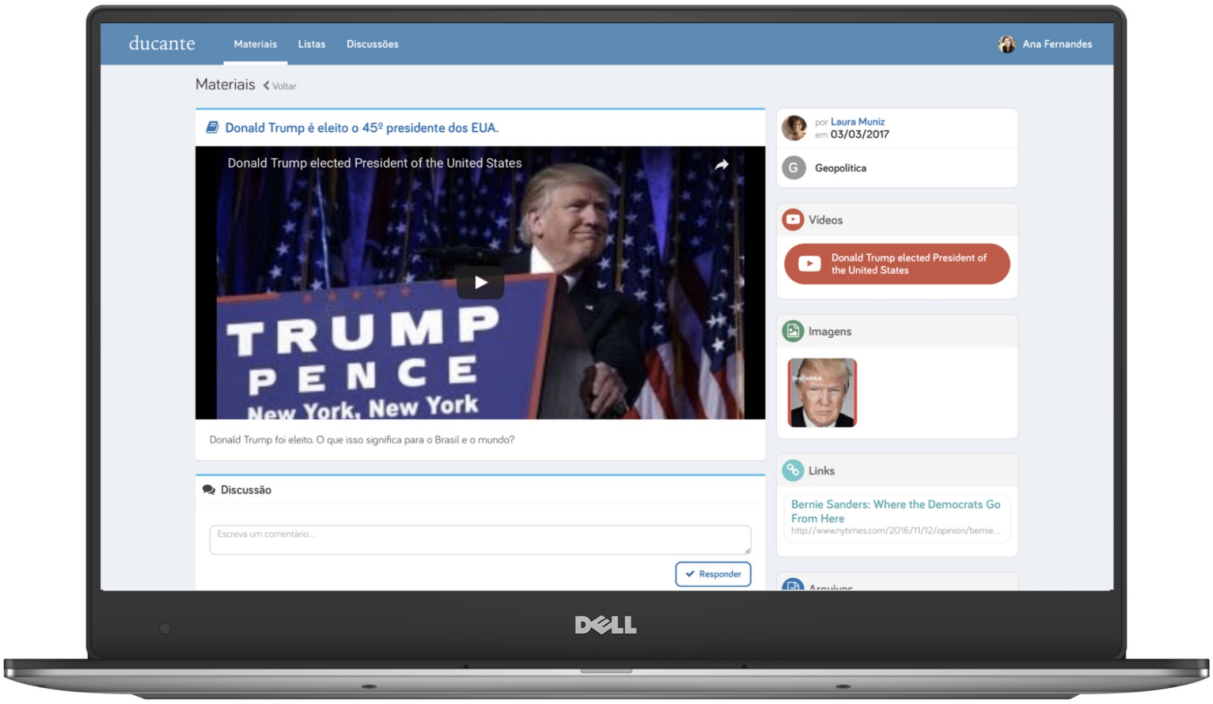

Figure 4.1: *Webapp v1: digital classroom about US president Trump's election in 2016*

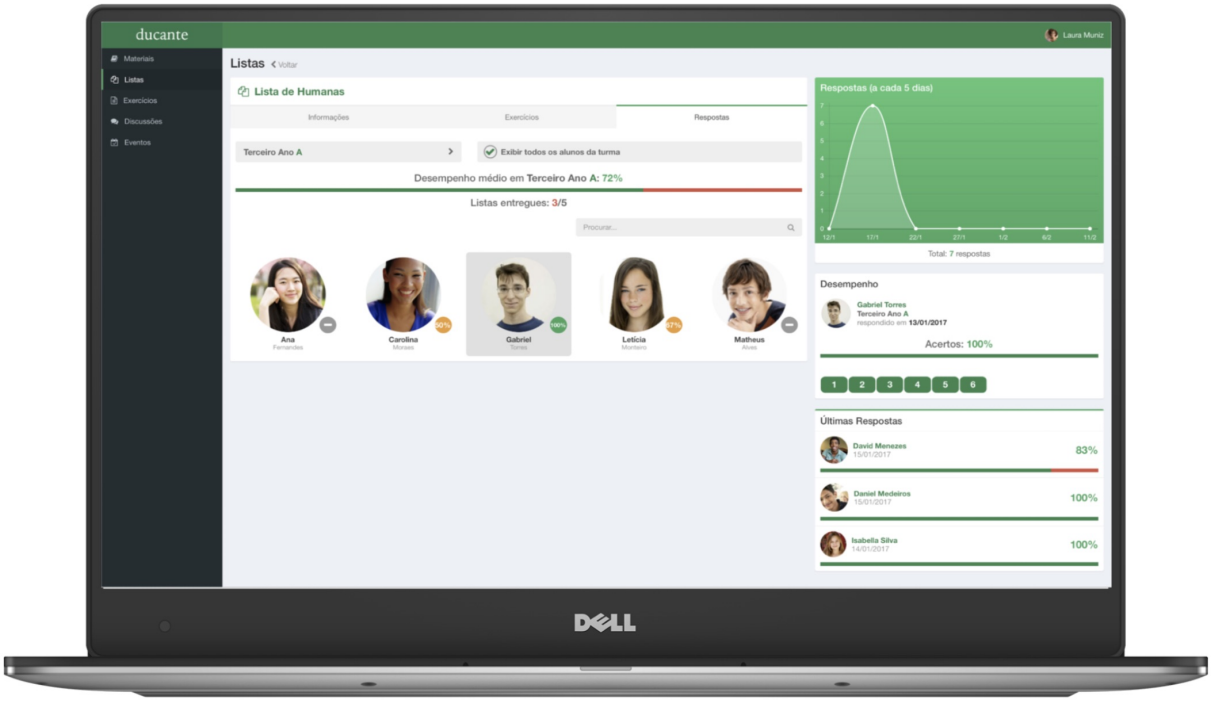

Figure 4.2: *Webapp v1: teachers interface to understand students performance*

As in the first phase, teachers were part of our solution, and we also considered proposing a value for them. We aimed to provide tools to allow them to improve their classes quality: from content distribution and communication/social tools to data analysis of students learning progress. Figure 4.2 shows how teachers could easily create and distribute a list of exercises for students, like homework.

The way we designed Ducante was to be a fun and engaging platform on top of three functionalities:

- Digital classroom: teachers could share resources, including videos, audios, files (such as PDFs) and plain text. Teachers and students could interact and discuss all uploaded content.
- Homeworks: teachers could create and deliver homework with automated evaluation. Once students gave their answers, teachers would receive a detailed data analysis over the results.
- Online discussions: allow students to raise questions and issues before getting to the real, offline classes.

Later, we understood that this model does not work, as described before, and that we would need to change our strategy. Once schools and teachers went out of our business, we started to look for providing high-quality resources through partnerships with companies specialized in producing educational content. In this model, we would charge the student directly on a subscription model and share profits with these partner companies. On a more extended vision, we would allow any teacher in Brazil to produce and publish their content; this would empower teachers by giving them a much broader audience for their classes and potentially create new job opportunities.

Although we changed our strategy and product, we aimed to continue supporting students through the learning process as before, by applying artificial intelligence techniques under an automated and data-oriented approach.

4.2 Business model

Business Model Canvas (Osterwalder, 2004) is a tool used to sketch and develop a new or existing business model. It is useful to oversee a company's value proposition, infrastrucutre, customers, and finances. As Osterwalder *et al.* (2009) states, a business model is "a shared language that allows you to easily describe and manipulate business models to create new strategic alternatives." During "Digital Entrepreneurship" (MAC0467), we designed a business model canvas for Ducante's first solution (figure 4.3).

As soon as we pivoted, we came back to the business model canvas, evaluated what was right and what was not and then we redesigned it to match Ducante's second solution (figure 4.4). We found out that most of the structure would not change but only key partners, revenue streams, and value proposition. All of these changes reflected precisely the changes we made in our second solution.

Customer Segments

Definition from Osterwalder et al. (2009): "Customer Segments (...) defines the different groups of people or organizations an enterprise aims to reach and serve".

We took some time to understand the total addressable market (TAM), serviceable addressable market (SAM) and serviceable obtainable market (SOM) in the scope of Brazil's market. A more generic solution would include middle school, high school, 4-year undergraduate programs, language schools, and music schools. That leads to a TAM of 75 million students in Brazil.

As a first product and attempt from Ducante, we only aimed students preparing to take a University admission exam, leading the SAM to an amount of 10 million students. We also considered having 1% of this market's share as possible.

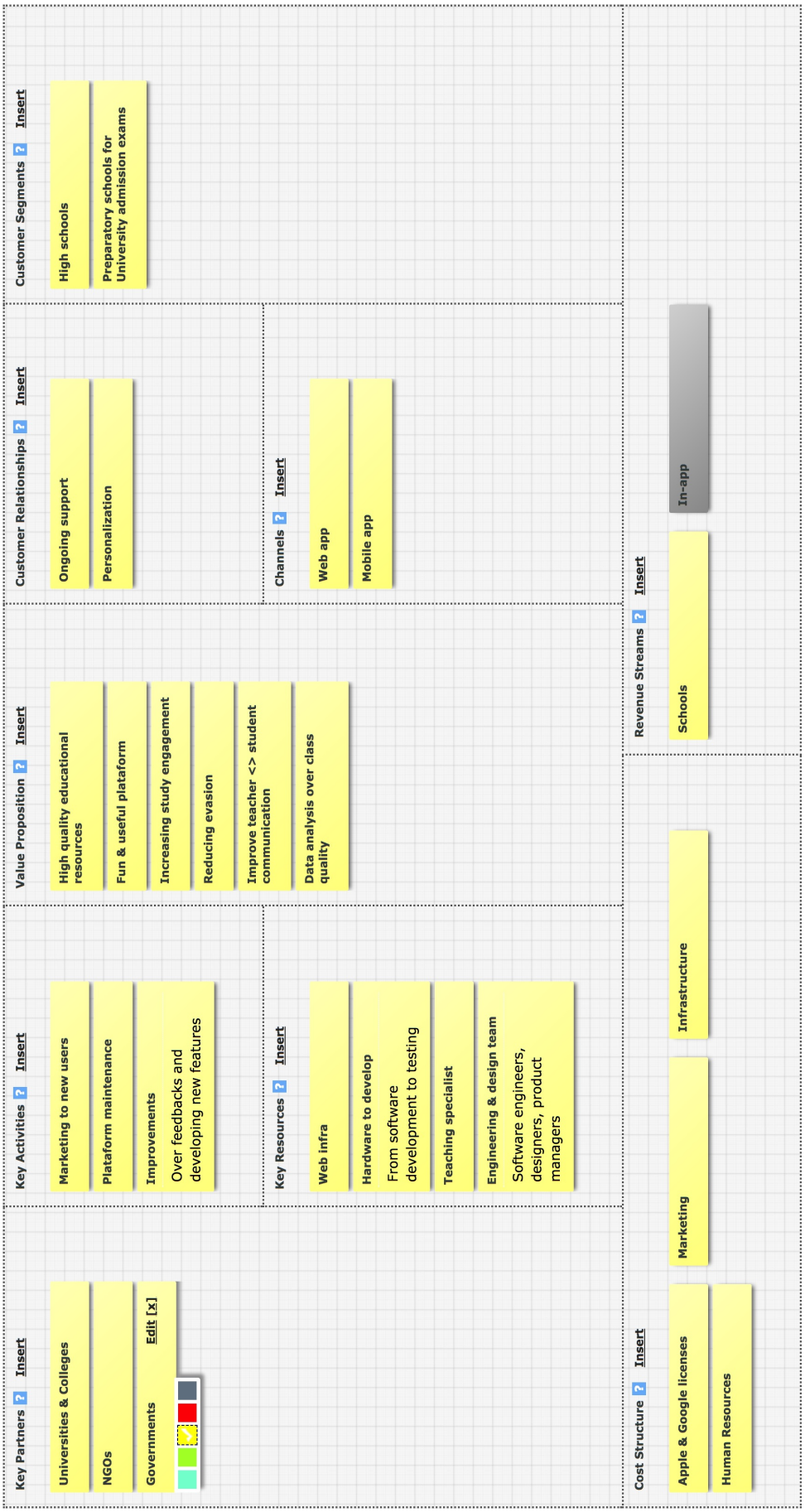

Figure 4.3: *First Business Model Canvas*

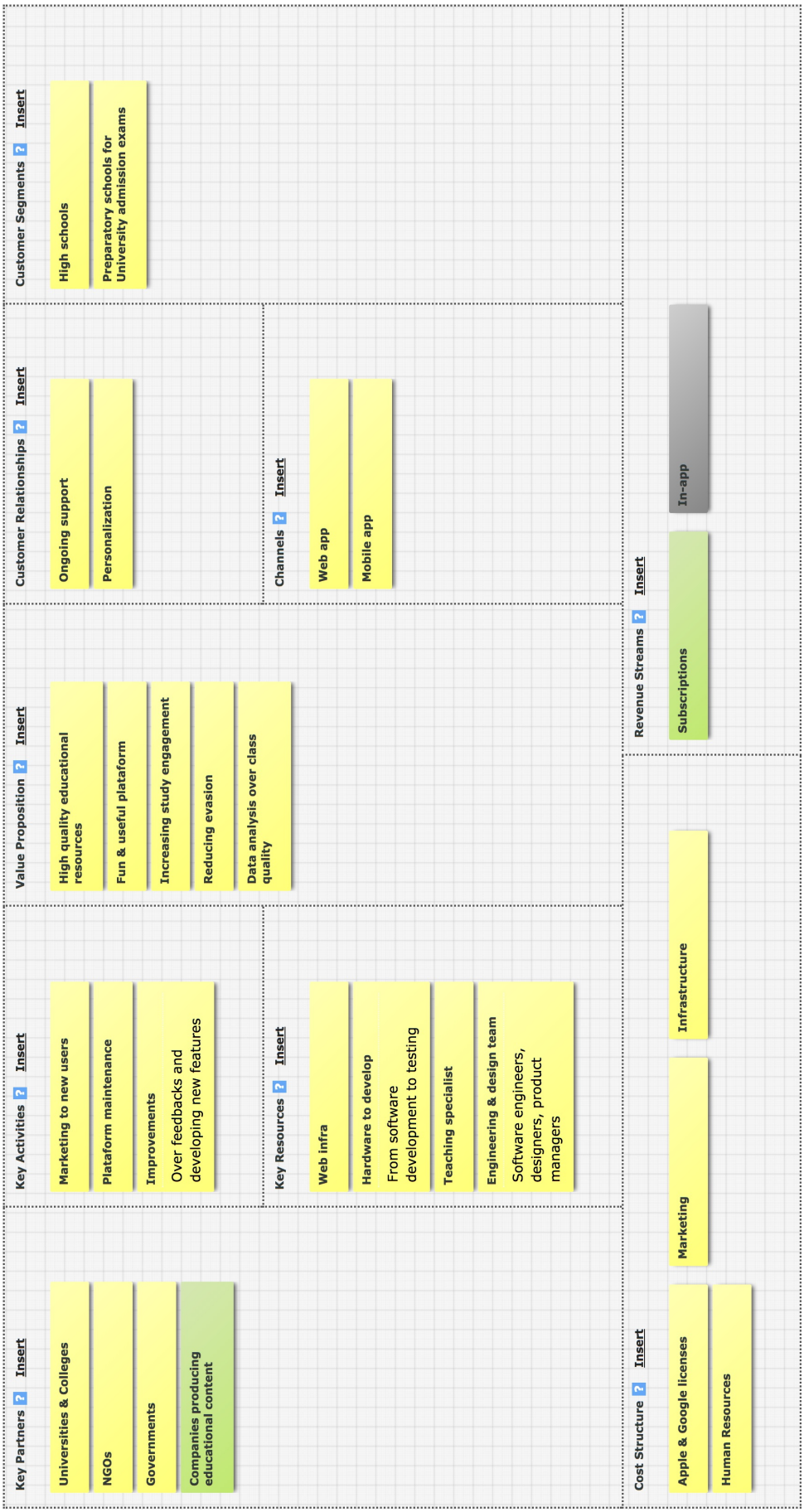

Figure 4.4: *Second Business Model Canvas, after pivoting*

Value Proposition

Definition from Osterwalder et al. (2009): "Value Propositions (...) describes the bundle of products and services that create value for a specific Customer Segment".

For students, we proposed value by helping them achieve better results in their studies. We would help them by allowing efficient home studies with guidance and concrete understanding of what was working for them and what was not. Moreover, we aimed to offer a low-cost solution in a convenient and easy to use software.

For teachers in the first solution, we aimed to help them create better, more personalized classes and make the process of creating, distributing and evaluating homework easier.

From the very first day, accessibility was something we also had in mind while designing Ducante. We could help more people study and teach by developing a platform for everyone.

Channels

Definition from Osterwalder et al. (2009): "Channels (...) describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition".

Our web page, distributed through web browsers, and our mobile applications, distributed through Apple's App Store and Google's Play Store, were our primary distribution channels. We considered these channels to be the most important for our business. While we were working directly with schools, the schools themselves operated as a communication channel with our users (both students and teachers).

Later on, speaking with some telecom companies executives, we find out that Brazilian carriers were also a valuable distribution channel in Brazil, as they have a payment infrastructure set up and millions of users to offer our product.

Each of these channels differs in acquisition cost and reachability.

Customer Relationships

Definition from Osterwalder et al. (2009): "Customer Relationships (...) describes the types of relationships a company establishes with specific Customer Segments".

We considered ongoing support to be a primary relationship channel between students and us, as they could show their issues, concerns, and feedback.

Revenue Streams

Definition from Osterwalder et al. (2009): "Revenue Streams (...) represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings)".

Before pivoting, we aimed to generate cash by offering Ducante as software as a service to schools under a fixed contract. After pivoting, we were intended to monetize through a subscription model, where students would pay directly to us. Prices and frequency would vary throughout the year, as demand changes seasonally across the academic year.

Key Resources

Definition from Osterwalder et al. (2009): "Key Resources (...) describes the most important assets required to make a business model work".

For Ducante, it meant web (hardware) infrastructure, Ducante's software, and human resources.

Key Activities

Definition from Osterwalder et al. (2009): "Key Activities (...) describes the most important things a company must do to make its business model work".

Improve our platform, make sure users are engaged and using it on a daily basis, and getting new students to use it was our key activities.

Key Partners

Definition from Osterwalder et al. (2009): "Key Partnerships (...) describes the network of suppliers and partners that make the business model work".

Universities (and colleges), NGOs and governments were considered key partners due to their reach of potential users. In 2016, 72% of all students at graduate level studied all their high school in public high schools, according to Agência Brasil (2017), based on a study from *Instituto Brasileiro de Geografia e Estatística (IBGE)*. This number presented an excellent potential for marketing Ducante along our core targeted users.

After pivoting, another critical partner showed up: companies producing educational content. Without teachers, we would have a blank platform, with no meaning, until we filled with educational content. These partners were vital for our product to work. Padilha, Silva and I discussed the threats this represented to our business: a sudden partnership breakage could potentially kill our business. We started to consider alternatives, including allowing any teacher in Brazil to submit content and have a team to evaluate if it was good enough to be distributed on Ducante.

Cost Structure

Definition from Osterwalder et al. (2009): "Cost Structure describes all costs incurred to operate a business model".

Distribution licenses, marketing, infrastructure, and human resources were Ducante's main costs.

4.3 Blue Ocean strategy

In *"Blue Ocean Strategy"*, Kim *et al.* (2005) describes two types of oceans: the red ones and the blue ones. As the author states, "in the red oceans, industry boundaries are defined and accepted, and the competitive rules of the game are known. Here, companies try to outperform their rivals to gain a greater share of existing demand. As the market space gets crowded, prospects for profit and growth are reduced. Products become commodities, and cutthroat competition turns the red ocean bloody".

In Brazil, the education industry boundaries are well defined. Even though there is room for improvements, schools compete among themselves over quality and price. As education is standardized by the Brazilian Ministry of Education, most of the schools do not change the scope of learning or educational content. Nevertheless, as competition for a position at a University increases and the required knowledge and know-how changes (such as programming skills), it opens an opportunity for what Kim *et al.* (2005) name as *blue ocean*.

Kim *et al.* (2005) states that "blue oceans, in contrast, are defined by untapped market space, demand creation, and the opportunity for highly profitable growth. Although some blue oceans are created well beyond existing industry boundaries, most are generated from

within red oceans by expanding existing industry boundaries (...). In blue oceans, competition is irrelevant because the rules of the game are waiting to be set". Table 4.1 shows the difference between the red and blue oceans.

Red Ocean Versus Blue Ocean Strategy	
Red Ocean Strategy	**Blue Ocean Strategy**
Compete in existing market space	Create uncontested market space
Beat the competition	Make the competition irrelevant
Exploit existing demand	Create and capture new demand
Make the value-cost trade-off	Break the value-cost trade-off
Align the whole system of a firm's activities with its strategic choice of differentiation or low cost	Align the whole system of a firm's activities in pursuit of differentiation and low cost.

Table 4.1: *Red Ocean Versus Blue Ocean Strategy. Source: Kim et al. (2005)*

Kim *et al.* (2005) also proposes a framework, entitled as "The Four Actions Framework", that helps breaking the trade-off between differentiation and low cost, and help to create a value. It can be seen on figure 4.5 and broke down into four essential questions (Kim *et al.*, 2005):

1. Which of the factors that the industry takes for granted should be eliminated?
2. Which factors should be reduced well below the industry's standard?
3. Which factors should be raised well above the industry's standard?
4. Which factors should be created that the industry has never offered?

We strongly believed in the idea of bringing something somewhat new was a must. More than creating a need for learning, we aimed to be the default choice for complementary studies and break the trade-off between quality and cost that the industry was fighting for. As a result of applying the framework, we comprehended that:

1. Learning should be a moderated addictive, engaging and fun activity, as opposed to the common understanding that the study is not fun;
2. Each student have its learning speed and needs, and their learning process should be adapted to that;
3. In order to be more fun and engaging, studying should have fewer formalities;
4. Students should be more frequently evaluated, to measure their progress with a higher precision;
5. The industry never (or hardly ever) offered a way to fill knowledge gaps or adapt learning speed according to students needs;
6. Most of the schools in Brazil did not follow the new generation habits and did not have any digital presence on the learning process;

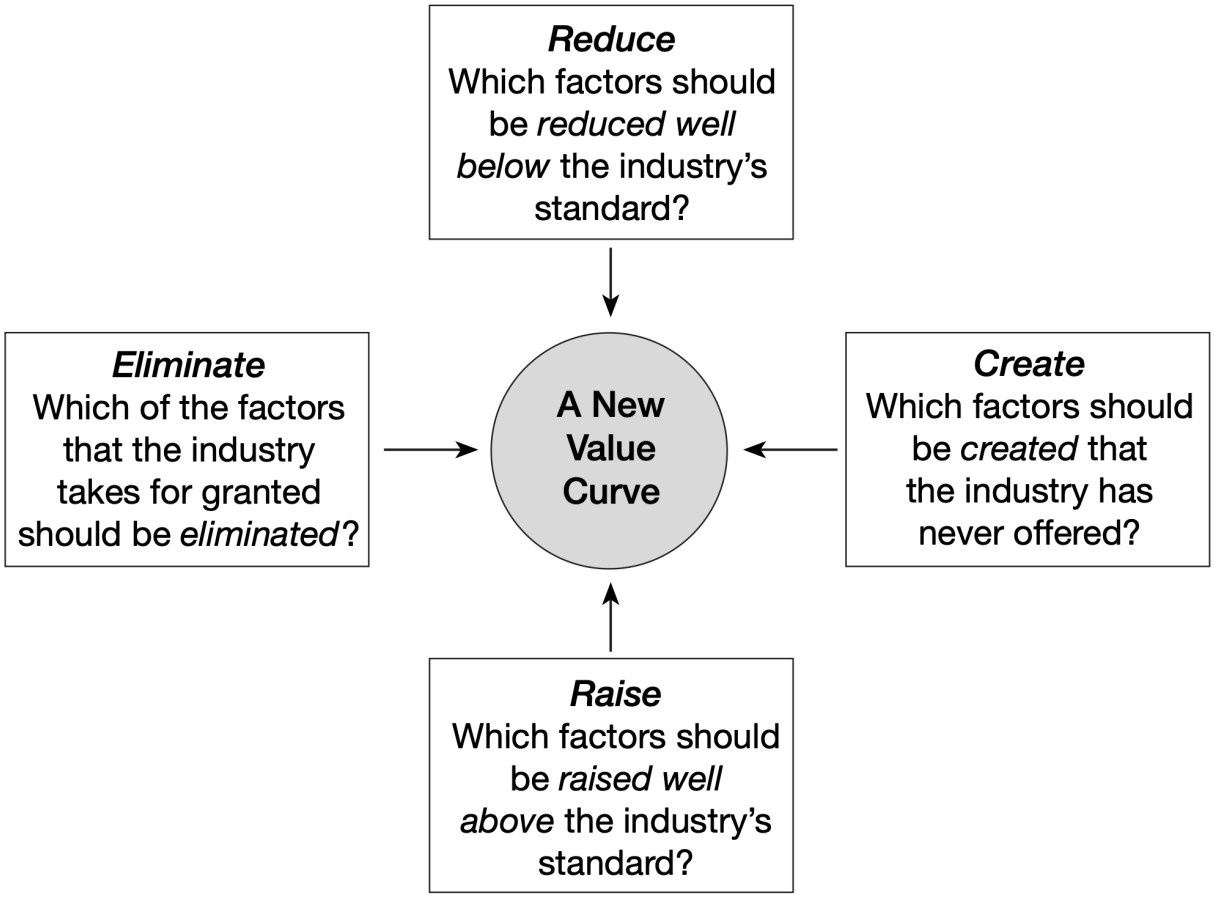

Figure 4.5: *The Four Actions Framework. Source: Kim et al. (2005)*

4.4 SWOT analysis

SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is a framework designed to help business to understand their competition and strategic planning. Its goal is to identify internal and external factors that are positive or negative to a companies long-term running. Such analysis can be constructed as a two by two matrix and is intended to evaluate four different forces: strengths, weaknesses, opportunities, and threats. The first two forces are said to be internally-related as the last two are said to be externally-related (related to the environment and industry competition). These four forces can be described as:

- **Strengths**: an advantage of a business over the competitors;
- **Weaknesses**: characteristics of a business that can represent a disadvantage against the competition;
- **Opportunities**: external factors that a business can exploit to take advantage;
- **Threats**: external factors that can harm a business;

We did a SWOT analysis and built a two by two matrix to oversee any problems or find good opportunities that could be exploited. It can be found on table 4.2.

	Helpful	**Harmful**
Internal origin	Human capital with engineering experience; Small, fast-moving organization (startup);	Lack of capital and entrepreneurial knowledge; Founders with other ongoing activities (all students);
External origin	Very few competition; Startups have not found a good, scalable solution; Tradicional companies are moving slowly to build tech solutions	Lack of educational content; It is hard to gain user's trust; Lack of uniqueness that prevent competitors for cloning our solution;

Table 4.2: *SWOT analysis for Ducante*

4.5 Competitors

By the time we were working on Ducante, we have mapped a few direct (companies doing a similar product) and indirect (companies competing for similar users under a similar budget) competitors. It was essential to understand what was the current state of applied technology on education in Brazil, what was other people trying and what was working.

- **AppProva**. Test and diagnostic platform for students, schools and higher education institutions. A few months after we failed building Ducante, AppProva had an exit, selling the startup to *Somos Educação*, a major educational company in Brazil. They had outstanding marketing by offering national-wide exams for practicing and training, where they were able to get many leads and get in touch with different schools.

- **Descomplica**. The website offers thousands of online classes dedicated to ENEM. They were leading the industry by selling online lectures with practicing exercises at a low cost.

- **Gabaritar**. A mobile app that offers the latest University admission exams (including the ENEM) to be studied and a study time management tool based on user's amount of time available for study.

- **Geekie**. An interactive platform for personalized teaching, containing classes and including teachers in an alternative process to the traditional classroom. They reached a large number of students through partnerships with the government.

We also considered companies building traditional educational resources, including books and online videos, as additionals competitors, as people might split their investment into multiple sources.

Chapter 5

Designing For Engagement

> Design is not just what it looks like and feels like. Design is how it works.
>
> *Steve Jobs, 2003, Interview for The New York Times*

While we were designing Ducante, we always had an excessive concern about building a user-friendly and addictive software. We believed that this would be essential, as we were looking to making a tool with great engagement over a long time.

We understand that studying can be a tedious and tiresome task for many students. Moreover, studying can be a struggle to fight on a daily basis, either for lack of time and energy, or lack of will and encouragement.

As the product grew, became more mature, and critical features were implemented, we began investing efforts to implement features that would make the platform more attractive and addictive. As an example, we started the development of a gamification system, where users were rewarded for satisfying their natural desires of socializing, learning, mastery, competition, achievement, status, self-expression (Lieberoth, 2015). Allowing the student to score when they answers a question from a friend or when completing a list of exercises are examples of activities that have been gamified.

The problem of finding good opportunities to reward the student is interesting and complex, from a behavioral, pedagogical and technological point of view. Although we did not have any technical support regarding pedagogy, we sought to encourage study habits that we considered to be good, such as completing all activities within the deadlines stipulated by the teachers (or even before the deadline, to be better rewarded).

To achieve good results in the implementation of gamification and other functionalities that would improve the levels of engagement, we studied and applied two software and product development methodologies to guide our product and design decisions. In this chapter, we review these methodologies and discuss how we applied them on Ducante.

5.1 Lean Startup

In "The Lean Startup", Ries (2011), the author introduces a methodology for product and business development. This methodology is composed of a set of tools and processes, such as the notions of a minimum viable product and continuous delivery.

We decided to adopt much of the Lean Startup methodology, especially the *Build-Measure-Learn* loop, one of the processes that are introduced by the method. This process

resembles the scientific method, using an experimentation-oriented approach to develop and validate product and business hypotheses.

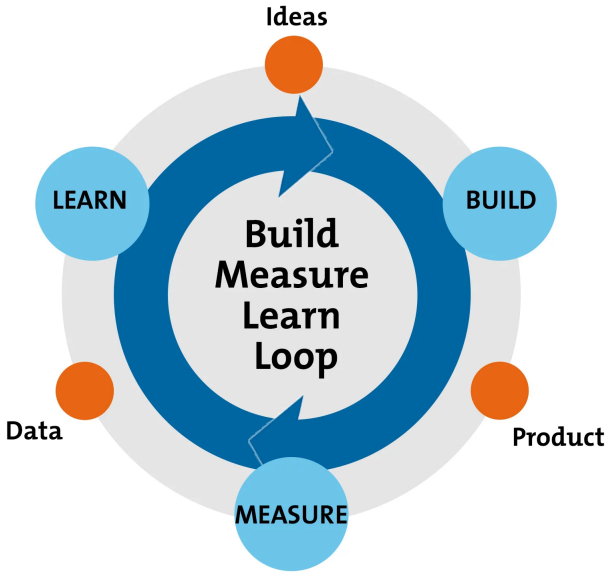

Figure 5.1: *Learn Startup: Build-Measure-Learn loop. Source: MindTools (2018)*

As shown in Figure 5.1 (MindTools, 2018), *Build-Measure-Learn* loop consists of having ideas and hypotheses, building the minimum software needed to test this hypothesis and validate it with the user. In this way, we have managed to avoid high costs of time and human resources, while confirming our assumptions and ideas.

In our experience, for this process to work well, we should always understand how we would validate our hypotheses, with actionable (show clear cause and effect), accessible (easy to understand) and auditable (easy to verify and audit) metrics. We developed a framework that allowed us to validate all the hypotheses we needed to validate. Such a framework is a combination of different methods:

- A/B testing with users and data analysis (over *post-mortem* logs);
- Use of laboratories and artificial test environments, such as Qualcomm's testing laboratory;
- 1-on-1 sessions with our users and partners, such as setting up meetings with users and asking questions;
- Apply surveys/questionnaires digitally to a fraction of our users;
- Analyze usage sessions. Along with a proper privacy policy, we stored usage sessions (only screen, in video format; no audio or camera) that allowed us to analyze and understand how users used the platform, what difficulties they had to perform a task and how long it took them.

To apply surveys and analyze usage sessions, we used *Hotjar*[1] that allowed us to receive user feedback, apply questionnaires, record, and watch usage sessions. Data analysis, either

[1]Hotjar: https://www.hotjar.com/

by conversion funnel or actions taken, was performed by a combination of two software: *Facebook Analytics*[2] and *Periscope Data*[3]. These tools allowed us to do data analysis in a simple, very efficient, and real-time way. Figure 5.2 is an example of a data analysis made with Periscope Data and figure 5.3 is an example of a conversion funnel made with *Facebook Analytics*.

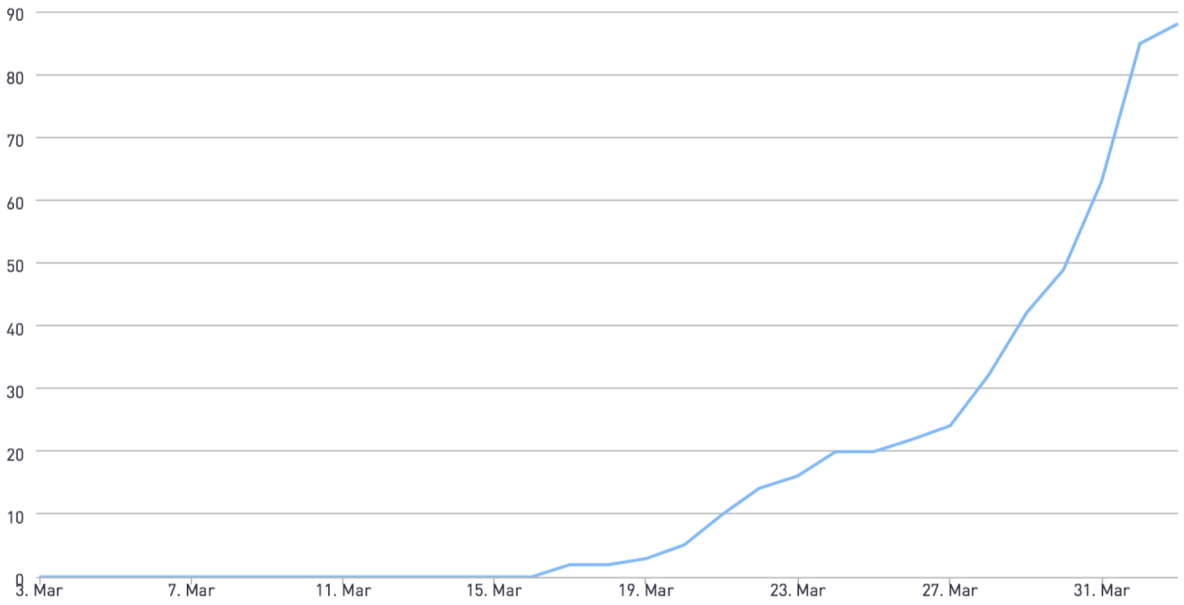

Figure 5.2: *Periscope Data: list of exercises solved over time.*

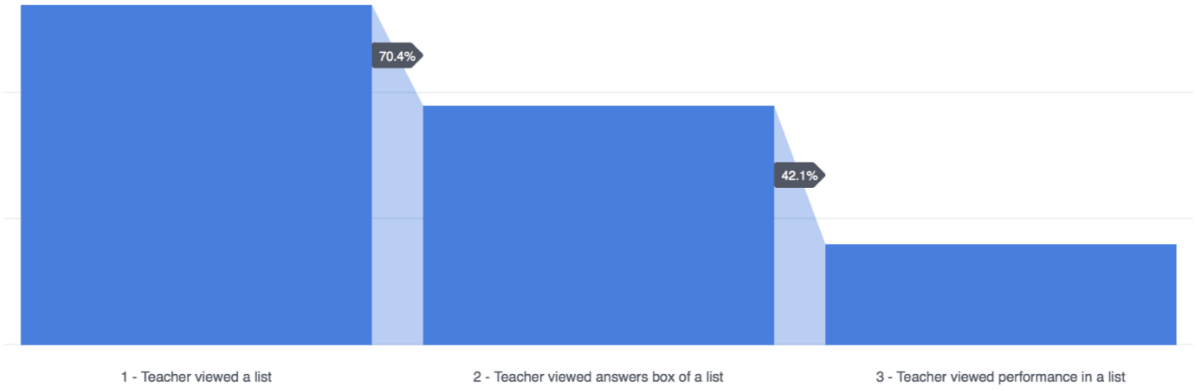

Figure 5.3: *Facebook Analytics: funnel over teachers who viewed performance in a list of exercises.*

5.1.1 Hypothesis

In the early days of Ducante, we defined seven core hypotheses for the development of Ducante's first platform. These hypotheses were pivotal and guided much of the work we had developing Ducante as a product and business. The four below were related to the business we were looking to develop:

[2]Facebook Analytics: https://analytics.facebook.com/
[3]Periscope Data: https://www.periscopedata.com/

1. "Students want to know their progress". We would apply questionnaires and have 1-on-1 sessions with users. We would also measure the number of views and session time the user spent evaluating their progress.

2. "Teachers want to know how their students are doing, individually or collectively". Same as hypothesis 1, but for teachers (rather than students).

3. "Students want to develop new knowledge or reinforce previous knowledge in their time". We would need to understand how custom exercises lists (a feature that allows students to practice without teachers guidance) were used. We would also need to analyze event data and talk to students.

4. "Students find it fun and challenging to win badges". 1-on-1 sessions and a combination of A/B testing with data analysis over engagement metrics.

The other three were related to the product we were designing:

5. "It's easy to understand and solve exercises lists within the app". We would analyze the events funnel between starting to solve exercises lists and submitting them for evaluation. We would also look at error events to understand what are the most common issues among users.

6. "Finding and consuming content delivered by teachers is easy". Similar to the previous hypothesis, we would analyze the events funnels. We also wanted to have a session with students where we will ask them to find content inside the app, where we would observe how difficult it was to perform such a task.

7. "Building, distributing, and evaluating exercise lists is easier on Ducante". Here we would need to analyze how many exercises lists are built and distributed by teachers, understand how often and how they used this functionality. Besides, we need to talk to teachers (1-on-1 sessions) to understand why they have or have not used Ducante for this end.

5.1.2 Building, measuring, and learning

For Ries (2011), entrepreneurs should continuously seek business hypotheses that provide real value to the user rather than the founders' daydreams. Ries coined the idea of validated learning where data and feedback from actual customers substantiate assumptions. We believe that we found correct hypotheses and also prove that some ideas we had were wrong.

Using the Build-Measure-Learn cycle, we developed Ducante in an organized, fast way and showed that hypotheses 1, 2, 4, and 5 were correct. We also discovered that hypotheses 6 and 7 were false, that indicated a severe flaw in Ducante's apps design. It required us to redesign a large part of the interface and improve user interaction within the system, ensuring more productivity and efficiency. We could not validate hypothesis 3, although our initial results showed that users rarely returned to study old content, due to the overload of content and activities.

Hypothesis 5 was proved through a combination of conversion funnel analysis, user conversation, session usage, and data analysis. Figure 5.4 shows the number of response submissions per day, where rapid growth in the number of submissions indicates that there is no difficulty in answering exercise lists from the apps.

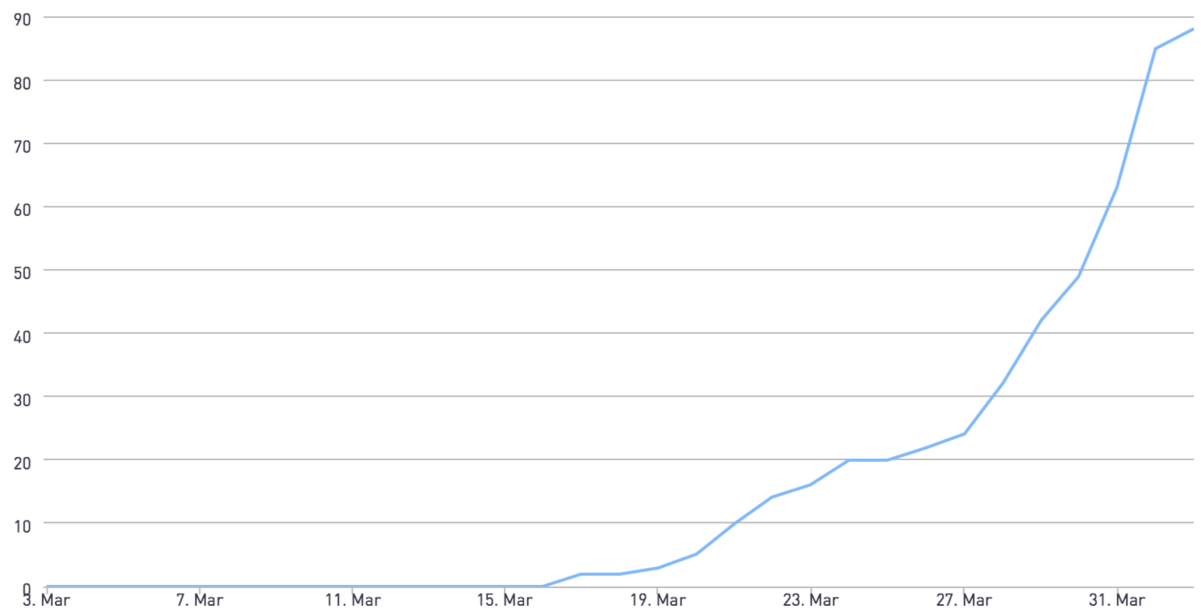

Figure 5.4: *Number of answers submissions over time.*

Once we found that hypothesis 6 and 7 were false, we redesigned some screens and flows and rethought some user interactions in the platform. The change was deployed on March 20, and the observed improvement was almost immediate, as can be seen in figure 5.5.

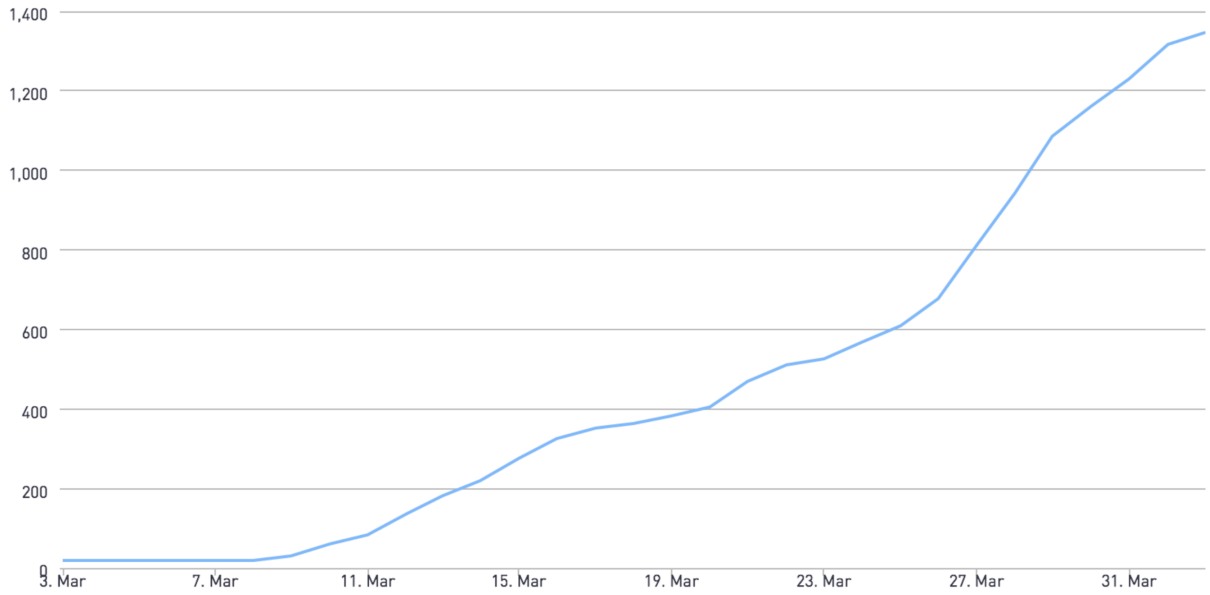

Figure 5.5: *Number of viewed content over time.*

Apart from the central hypotheses, we have developed additional hypotheses along Ducante's development journey. One assumption we sought to validate further was that the first user session on the platform was easy. Our concern was that students would not use Ducante for the first time because some friction could stop them from logging in. Additionally, as we partnered with schools, we would create student accounts for them, since student data was given from school to us directly. This could make it harder for users to first login to the platform, as it is not clear their e-mail and passwords. Through data analysis, we verified that more than 90% of the students who had an account were able to log in without problems.

Figure 5.6 shows the email we sent to users to make the first access easier.

Figure 5.6: *E-mail sent to help users in their first login.*

5.1.3 Minimum Viable Product

Ries (2011) proposes the idea of a minimum viable product (MVP), which in his own words, "helps entrepreneurs start the process of learning as quickly as possible". The idea is to build the software with a minimum amount of effort that can allow Build-Measure-Learn loop to happen. Although an MVP is meant to be minimal, it is not necessarily the minimal software that one can imagine; figure 5.7 illustrates the idea behind MVP. Ries suggests that the first products are not meant to be perfect, but rather validate value proposition.

There are other interpretations of MVP, as suggested by Brikman (2016) and Wylinka (2017), who understand MVP as a process and not a proper product. The premise is that MVP is not a product with limited features, but a method for validating the assumptions that present the most significant risk of sustaining your business or idea. MVP here is then presented as a discovery process (as shown in figure 5.8): a hypothesis is raised, an experiment is constructed to validate the assumption, which is then validated or discarded.

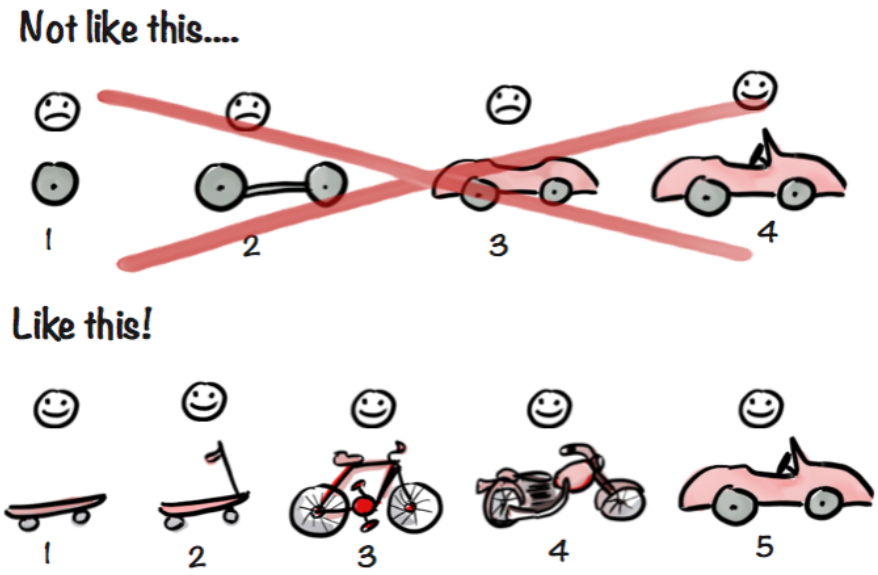

Figure 5.7: *MVP as a incremental product. Source: Kniberg (2016)*

Understanding MVP as a process motivated many entrepreneurs and companies to adopt failure and agility as values to be incorporated into their culture, such as Facebook that took the motto "Move Fast and Break Things" for years in its culture.

In Ducante we first adopted the former definition of MVP by a restriction imposed in "Digital Entrepreneurship" (MAC0467) class. Once we delivered our first product and crossed the line where we had something, every increment in the Ducante was seen as a continuous process of experimentation oriented to a hypothesis.

5.1.4 Pivot

Ries (2011) discusses the existence of a challenge that occurs to entrepreneurs at the beginning of building a successful product: when to pivot and when to persevere. For Ries, a pivot is a structured fix in the course of developing a product, strategy, or growth engine. More than that, to pivot or persevere is to accept or not the initial hypotheses of the value proposition.

For Ries, pivoting takes courage: many entrepreneurs, when questioned, say they would preferably have made the decision sooner. Entrepreneurs often hide behind fanciful or vain metrics that deny the real state of a business. Other times, even the inconclusiveness in hypothesis validation, or even neglect and incapacity, make the decision more difficult.

During Ducante's construction, deciding to abandon all our strategy and product was no different. As discussed in chapter 3, we once pivoted to approach the problem from a different perspective with a different sales strategy, because we assumed that it would be mandatory to grow as efficiently and organically as possible. In chapter 8.3, *Failing*, we will discuss how our incompetence and vanity took us precious time to realize that we were going the wrong way.

5.2 Build Forming Habit Products

> "Through consecutive Hook cycles, successful products reach their ultimate goal of unprompted user engagement, bringing users back repeatedly, without de-

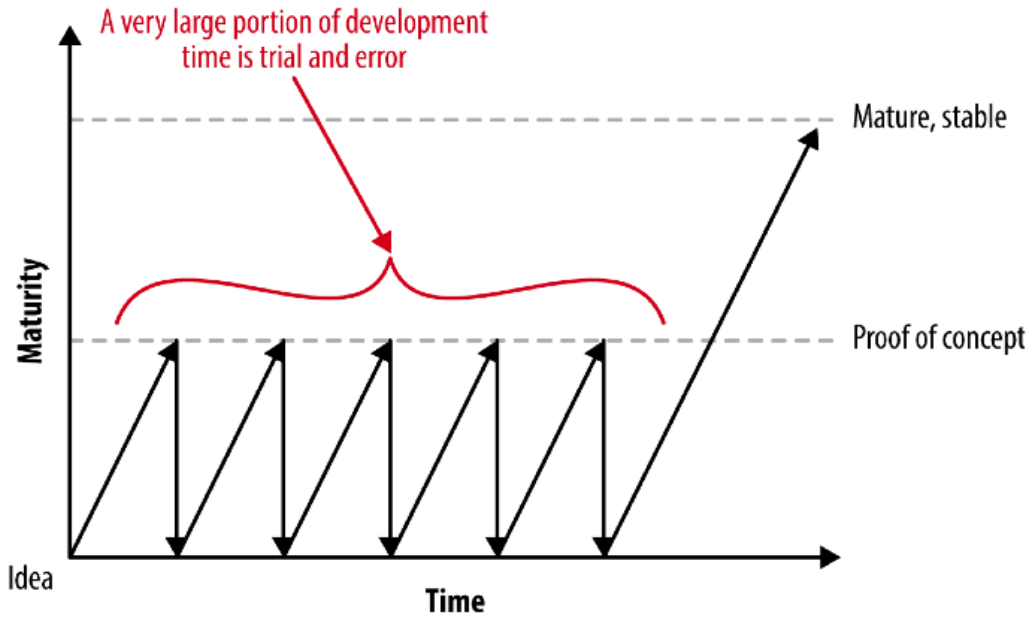

Figure 5.8: *MVP as a process, not as a product. Source: Brikman (2016)*

pending on costly advertising or aggressive messaging." (Eyal and Hoover, 2014)

Eyal and Hoover (2014) proposes a model to understand and improve customer engagement, called the Hook Model. Eyal proposes that the first software that comes to users' minds wins. These softwares do not need to invest a lot in marketing or retargeting. These softwares also associate their products with user's routine tasks and their emotions. The most basic example of associating emotions is the large number of users that open Twitter or Reddit when they feel bored during the day. More than that, creating habits in users brings several advantages to a business:

1. Increases lifetime value, as users will use the platform more often and for longer times;
2. Increases the flexibility of price adjustments, as users become more dependent;
3. Improves organic growth as users are more likely to recommend your product. Some users become brand evangelists, spreading their business at zero cost;
4. Reduces churn and improves competitiveness. Due to dependency, users are less likely to abandon the platform or switch to a competitor;

The model, ilustrated in figure 5.9, is composed by four components: *trigger*, *action*, *variable reward* and *investment*.

5.2.1 The Habit Zone

The habit-forming potential of a product can be described as the combination of two factors: frequency in which the habit happens and the utility perceived by the user, whether for practicality, reward or advantage over other solutions.

As shown in figure 5.10, Google's search engine has become part of every user's routine due to its high frequency of use, and doing a Google search has little to no cost. Also, the difference in quality over other search engines, such as Microsoft's Bing [4], is so small (or

[4]Microsoft's Bing: https://bing.com

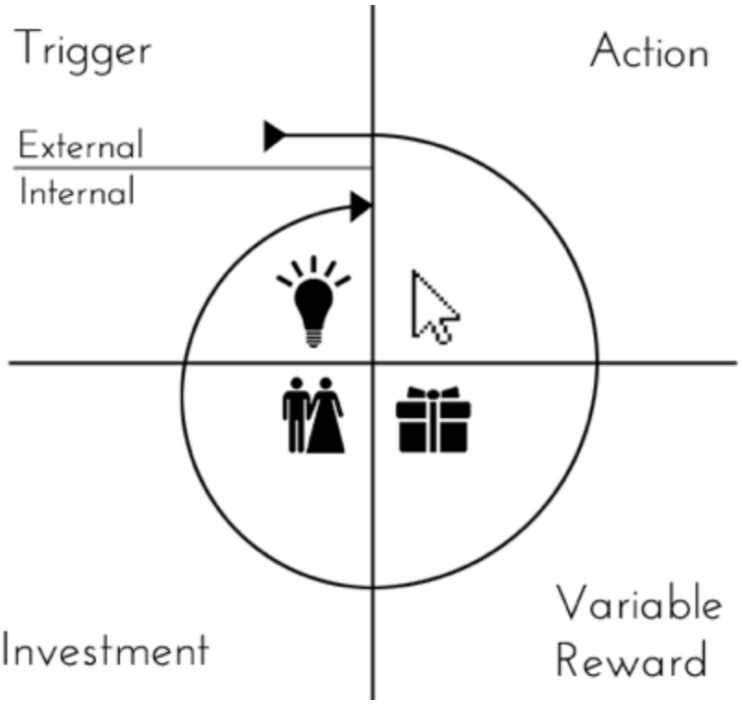

Figure 5.9: *The Hook Model. Source: Eyal and Hoover (2014)*

nil) that users ignore other solutions and those who have already adopted Google hardly change their habits and seek alternatives. Similarly, Amazon is a product with a much lower frequency of use than the Google search engine, but it has a substantial perceived utility, functioning as an aggregator of almost every product and usually providing better prices than their competition. Browse and buy products on Amazon, happens to be a natural choice, then forming a habit in those who search on the internet for prices and products to buy.

Eyal and Hoover (2014) brings an exciting discussion about products that are painkillers and products that are vitamins. The first deals with those who solve a glaring need, relieve pain and have a well-quantifiable market. The second, on the other hand, does not address an obvious problem or alleviate pain, but appeal to the user's emotional. For Eyal, when people take a multivitamin in the morning, they are not worried or knowing if they are getting healthier, but what matters is "checking it off your list" and psychological wellness, differently from a physical relief.

This comparison between product types, *painkillers versus vitamins*, is often discussed in business and marketing books, and Eyal and Hoover (2014) further argue that habit-forming products act as both painkillers and vitamins. The rationale is that these are nice-to-have products (vitamins), which you can live without but from the moment the habit is created, they begin to provide relief and dependence, just like painkillers.

5.2.2 Trigger

Eyal and Hoover (2014) defines trigger as the actuator of a behavior. It is what call a user to act. Eyal states that there are two types of triggers: external and internals.

The former one is embedded with information, guiding users to perform next actions, and can be presented in the form of a paid trigger (e.g, advertising), earned trigger (e.g., featured app store placements), relationship trigger (e.g., mouth to mouth recommendation) or owned trigger (e.g., app notification). Although external triggers can be quite useful —

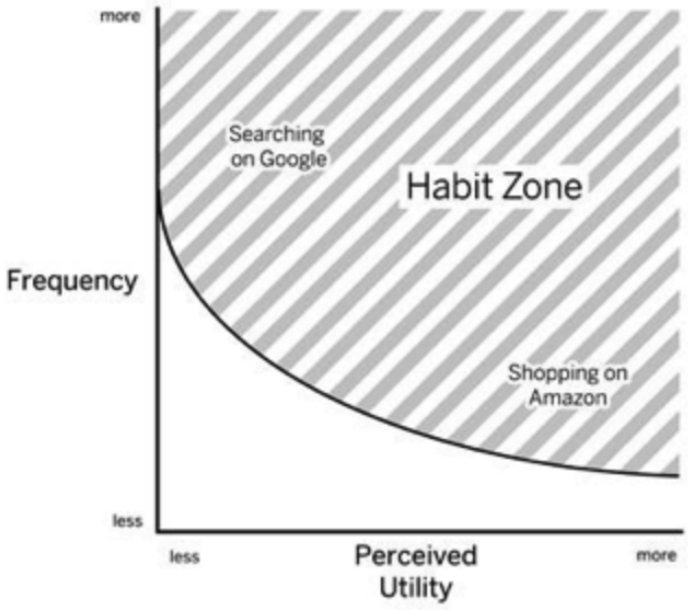

Figure 5.10: *A view on The Habit Zone. Source: Eyal and Hoover (2014)*

and most of the products use them —, the goal is to create internal triggers.

Internal trigger is much more powerful, as they represent an emotional or functional dependency (or, as Eyal says, a hook). Moreover, an internal trigger can be leveraged by a preexisting routine or a thought associated with a product. This type of trigger is manifested automatically in the user's mind, without the need of an external trigger. Once it becomes part of a preexisting routine, after successive hook cycles, it is clear to the user what is the next action to perform.

Eyal suggests that "the ultimate goal of a habit-forming product is to solve the user's pain by creating an association so that the user identifies the company's product or service as the source of relief". Once a product achieves this goal, it is promoted from a vitamin status to a painkiller status.

To build a habit-forming product, entrepreneurs must understand which user emotions lead to an internal trigger and understand how to exploit it. Moreover, entrepreneurs must find a way to rely less on external triggers and more on internal ones.

At Ducante, we had a consistent external trigger that was teachers and colleagues requesting students to use our platform. We also understand that the most potent internal triggers we had was the *fear of missing out*, students fearing missing new content or activities, and the relief of completing activities. As we talked to our users, completing activities was pleasant (although sometimes hard to finish or find enough time). Because some of our students were in a position that they did not have much time to study, we noticed that emotions and thoughts were leading them to think about Ducante. The problem was then finding time to take actions. On top of that, we started to add gamified activities, that would create an itch that would later be relived by studying under the rules we created.

5.2.3 Action

Once a trigger is fired, if the user chooses to do not take action, then the trigger is useless. Eyal states that initiating an action should be more comfortable than thinking; hence having a small cognitive effort. Think about brushing your teeth: you don't think about it, you don't plan how to get it done, you merely brush your teeth. The more effort is required, the less

likely action is to be taken.

Eyal presents the Fogg Behavior Model (Fogg, 2018), that states three factors are considered to initiate any behaviors: (1) user's motivation; (2) user's ability to complete the desired action; and (3) a trigger must be present. If any of these factors are missing or inadequate, users will likely not behave as expected (that is, will not take action). Fogg describes six "elements of simplicity", where the simpler, the better (more likely a behavior will occur):

1. Time to complete an action;
2. Cost (money) to take an action;
3. Physical effort (amount of labor involved) required;
4. Brain cycles (mental effort and focus) required to complete an action;
5. Social deviance, or how socially acceptable;
6. Non-routine, or "how much the action matches or disrupts existing routines";

At Ducante, we usually had problems with users lacking motivation, for a couple of reasons such as lack of time and physical and mental energy (many students also had full-time jobs). We also had problems with users not being able to complete an action once a trigger happens, mostly because they are doing other activities that prevent them from studying, such as working or commuting.

The first problem was the toughest one to handle, as we were in a position that we could not do much to solve it. We attempted to make it exciting and fun to study, to appeal to the user's willingness to have a fun time rather than study time. We did so by creating small funny animations and some actions that were gamified.

The second problem was mainly led by the need for high physical and mental efforts. We attempted to tackle it by breaking big tasks into small ones. Moreover, we worked hard to increase user's ability to take actions by supporting offline usage, having easy-to-use interfaces and guiding them through their activities.

5.2.4 Variable Reward

Eyal and Hoover (2014) shows a study from James Olds and Peter Milner that revealed "what draws us to act is not the sensation we receive from the reward itself, but the need to alleviate the craving for that reward". Rewarding users once an action is completed, reinforces their motivation to seek it again later.

Eyal also introduces three types of rewards. The first one is *Reward of the Tribe* where rewarding is applied as social reinforcement. According to Eyal, our brains seek rewards that make us feel accepted, more attractive, valuable and included. Through an online discussion forum on Ducante, we rewarded students in a gamification system once they help other colleagues, similarly to how Quora and Stack Overflow work. Students had their online profiles with an associated score that increases as they help other people.

The second type, "Rewards of the Hunt", is related to instinctive emotions. We naturally seek to pursue and acquire physical objects, such as food and supplies. Hunting and finding new things is typically seen as exciting and this feeling is exploited by products like Pinterest, where people keep searching and scrolling, looking for new, unexpected things. At Ducante, we did not have put much effort to exploit this type of reward. We did, though, implemented a tool that allowed users to generate exercise lists, with problems from previous official University exams. This led some students to hunt new issues they haven't solved previously.

Finally, the last type, "Rewards of the Self", is related to a more personal form of gratification, raised from self-determination to gain a sense of competency. On top of that, mystery can turn to pursue an action more enticing and exciting. At Ducante, we attempt to offer this type of reward by giving digital mastery medals, that recognizes our users for mastering some topic.

5.2.5 Investment

Finally, the last step of the Hook Model is the investment phase. As users start to use a product or service, investing time and effort, more valuable these products and services become. As more investments happen, more likely the user is to return. Users start to accumulate value in the form of content, data, followers, reputation, or skill.

As Eyal states, "the big idea behind the investment phase is to leverage the user's understanding that the service will get better with use (and personal investment). Like a good friendship, the more effort people put in, the more booth parties benefit".

At Ducante, we aimed to create users profiles that would summarize their study progress, along with their contribution to their community. We believed that at some point on users progress, they would become less likely to stop using Ducante to switch to another product. We also thought that progress should not be limited from 0 to 100%, but instead continuous from 0 to infinity. This is important, as we did not want to have our users seeing Ducante as a book, where there are a begin and an end. However, instead, we wanted to be users study guide indefinitely, as long as they need to improve.

It is quite challenging to understand how well we did implement the Hook Model. As teachers were using Ducante as a work tool and requiring students to use, we had external triggers being inflated by external motivation. It makes it even harder to distinguish whether we were creating a habit or not.

Chapter 6

Agile Development

> Focus on doing the right things instead of a bunch of things.
>
> *Mike Krieger, 2015, Interview for Inc.com*

In this chapter, we discuss a few of the agile methodologies and how we managed to use them to speed up development on Ducante and how we mixed a few agile frameworks to fit our needs.

6.1 Methodologies

The agile development methodology is a software engineering approach that has become very popular due to its effectiveness as a process for building and maintaining software. This methodology became popular after the *Agile Manifesto* (Beck *et al.*, 2001) was published, which enumerated four fundamental values:

- **Individuals and interactions** over processes and tools;
- **Working software** over comprehensive documentation;
- **Customer collaboration** over contract negotiation;
- **Responding to change** over following a plan;

These values supported the creation of some process frameworks to optimally develop products, often breaking down the entire work into a small set of tasks to reduce the need for planning and design in the long run. These tools can be focused on both practical development issues and workflow management. This methodology's philosophy requires a dynamism, allowing decisions changes along the way, combined with efficiency, seeking to complete tasks and iterate very quickly.

Several tools have been created around the Agile methodology, and we used some of them that suited us best on Ducante's development.

Scrum

Scrum is a framework that provides a variety of tools for iterative and incremental development where the future is uncertain, making long-term planning difficult. This framework

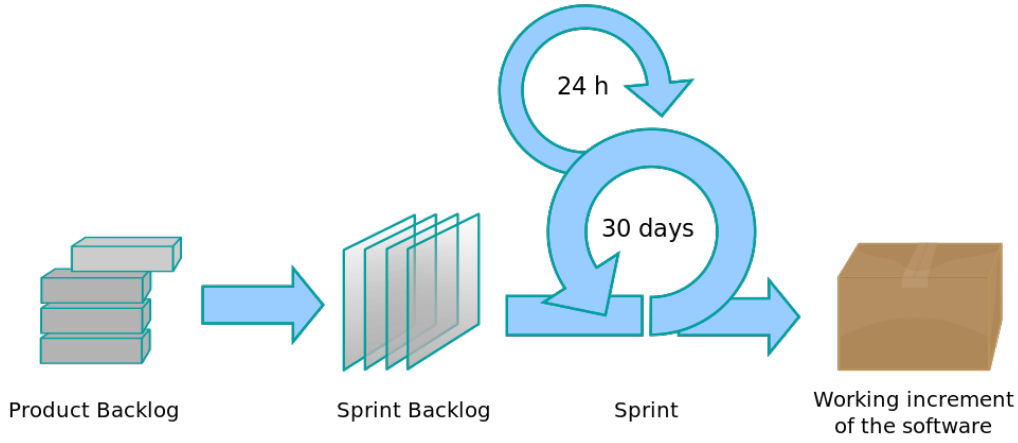

Figure 6.1: *Scrum ilustrated. Source: Wikipedia contributors (2018b)*

was proposed by Sutherland and Schwaber (2010) in *Scrum Guide*, and is the object of study and application in startups as a project management solution, where the final product is unknown, and the discovery takes place during the process of building the company. Figure 6.1 illustrates how the framework works. It defines three leading roles:

1. Scrum Master, which maintains and facilitates processes, unblocking the team, improving the team's ability to deliver the sprint goal.
2. Product Owner (PO), who represents the stakeholders and the business and is responsible for ensuring that the team adds value to the business. It is also his responsibility to prioritize all tasks in the backlog;
3. Engineering team, a multifunctional group of usually 3 to 9 people that perform analysis, design, implementation, testing and other activities related to software development.

Scrum Guide defines two key artifacts that allow this framework to work:

1. Product Backlog, maintained by the PO, is a list of requirements that typically come from the customer, outcome of a validation process or desire to validate some hypothesis;
2. Sprint Backlog, is a set of selected tasks from the Product Backlog that contains concrete, isolated tasks that will be implemented during the next sprint.

A sprint is usually a weekday window. Typically it is defined as a working week but can vary from project to project or even based on the startup's moment. It is up to the Product Owner to prioritize the tasks and, along with the engineering team, to define the size of the sprint and what activities will be performed in such a sprint.

Kanban

Although Kanban is an old methodology that is employed in many industries (such as automotive and retail), it has become a popular framework used to implement agile software

development. Traditionally, Kanban aims to communicate real-time workload. Work items are visually represented in a Kanban frame, allowing team members to see the status of each part of the job at any time. The idea is to keep a balance of work demand restricted to the available flow capacity. Another advantage of using Kanban is to avoid bottlenecks and locks since it allows organizing activities (cards) leading to a better work organization. Figure 6.2 illustrates a Kanban frame, where the cards are organized by columns.

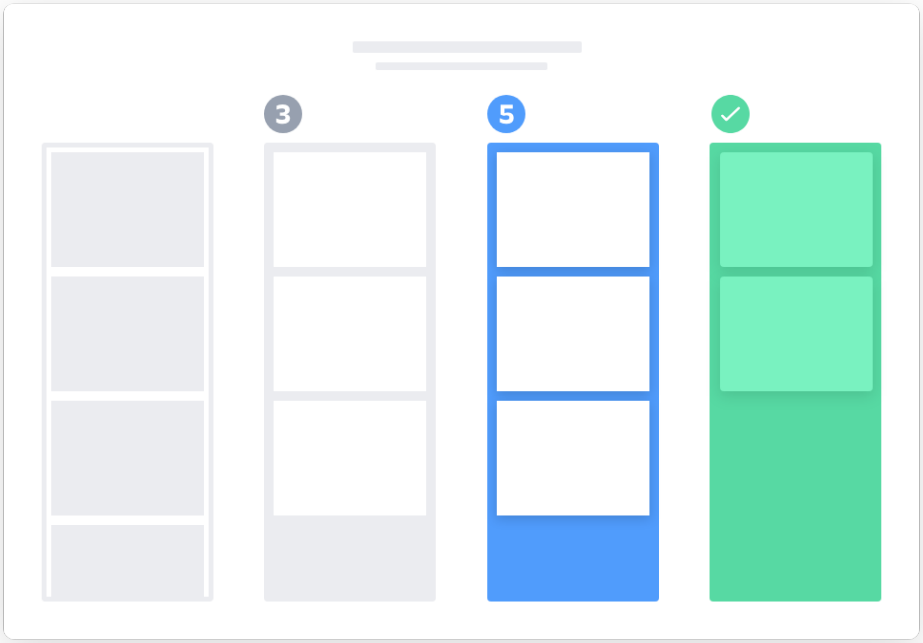

Figure 6.2: *Kanban board. Source: Atlassian (2018)*

Scrumban

Scrumban is a framework that uses Scrum to control backlog and Kanban boards to organize the backlog visually. Mainly the board and cards are used to represent the product backlog, sprint backlog, what has already been done, what is being done and tasks that are blocked by external factors.

Continuous Delivery

Continuous Delivery (CD) is yet another process that aims to take the agile methodology to its desired end: deliver software that works and is ready to be used. Some authors, such as Binstock (2014), acknowledge that this process is an advance of agile practices and emerges as the preferred way to deliver software.

Practically, CD is a process, or a project pipeline, as suggested by Binstock (2014), that consists of developing and continuously deploying a tested and functional software, even if a feature is incomplete. In a practical application of this concept, companies like Google and Facebook have removed the concept of a branch and adopted a single repository with a single branch, where all the code is functional, guaranteeing delivery and continuous integration. In the case of incomplete features, a logical gate is added to prevent end-user access.

This approach avoids what some people call the *merge hell*, where engineers spend too much time working in their branches and once in a while they have to merge all code to a master branch, having many merge conflicts and software working with unexpected behaviors. Moreover, every engineer in the team can have a better view of how the codebase is progressing and can potentially share and discuss thoughts and ideas with other people in the team.

6.2 Method tailoring, *or simply doing our way*

During our undergrad and with our work experiences, we learned in several opportunities different agile methodologies. Because we were a tiny team - in some implementations, a single person did the whole process (development and deploy) - we decided to adopt few processes, that made sense to our moment. Our concern has always been to validate the right assumptions and work on the metrics that mattered, rather than doing too much or too fast.

Some good practices, although modified, were adopted regardless. We used Scrum with Kanban to organize our deliverable tasks, prioritize and define next steps. We used *Trello*[1] software as a tool to create a virtual Kanban frame. In this frame, we had five columns: product backlog, sprint backlog, currently doing (cards that were being implemented), currently blocked (tasks that could not be implemented by some external issue) and tasks are done (cards that were completed in that sprint). As we will see later in chapter 5.1, Ries (2011) proposes something similar, using Scrumban with four columns: backlog, in progress, built and validated.

Our sprint was feature-oriented. We defined the feature that we wanted to implement (or what hypothesis we wanted to validate), then we would think about the required tasks and create the respective cards. Under the assumption of good faith and high willingness to work on the project, we removed the time of a sprint due to the existence of secondary activities of the team, as we were still students with time constraints. In practice, the sprints had no pre-set time and were finalized when implementation was completed.

Finally, we also adopted CD as a solution to avoid integration problems, since all of us could eventually be working on the same functionality.

[1] https://trello.com

Chapter 7

Technological Aspects

In this chapter, we discuss all technological aspects of Ducante, including high-level architectured, stack technologies (language, frameworks, database), infrastructure and data modeling.

7.1 Software architecture

From the beginning, we aimed to have an architecture based on microservices that would allow us, beyond other advantages when scaling would become a problem, distribute work across the three founders (all software engineers).

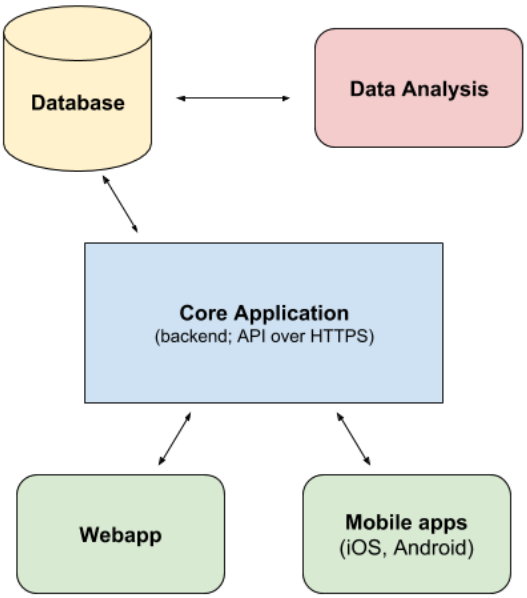

Figure 7.1: *Software architecture: common backend service across platforms*

We wanted to have a backend application offering an API to access data and business logic consistently throughout other applications. Ducante's architecture (figure 7.1) was centered on a core application that served all of our softwares (mobile apps and website), through an API over HTTPS. Initially, such core application was a monolithic application developed in Ruby on Rails containing all interfaces to any data or business logic, and we aimed to split this into a set of multiple services as we needed.

7.2 Technologies stack

Deciding the technology stack was something we spent some time thinking about. We wanted a stack that allowed us to quickly iterate over prototypes and allow us to ship our product with a reasonable amount of machine resources (as we did not want to spend too much money to support a few hundred users). Traditionally there is a trade-off in this decision: easier to develop over performance.

We decided to go with easiness to develop, as we wanted to iterate very quick over our product. We wanted to develop an idea as fast as we could. For this reason, we chose the following stack:

- **Ruby on Rails**. Our backend (mainly our API) was developed using the Ruby on Rails framework. The ecosystem around this framework is useful and well-developed, allowing us to develop ideas and test hypothesis quickly.
- **Angular JS (version 1)**. All our frontend software was built on top of Angular JS, from Google.
- **Ionic (version 1)**. This framework allowed us to port our frontend software across the web and mobile development. Choosing to develop a hybrid mobile app allowed us to develop, iterate and test our hypothesis quickly.
- **PostgreSQL**. We decided to use a relational database because we considered it was the best fit for our usage.

7.3 Data model

We designed Ducante's data model to be school-centered. Users, uploaded content, exercises lists, and other data that user-input was attached to a school. We preferred that way initially because it was easier to filter and protect data from being used across schools (this was a concern some teachers had). The main classes can be seen in table 7.1.

Name	Description
School	Attributes includes name, description and others
Classroom	Allowed us to group students by group; quite important as teachers had many students
User	Representation of a teacher or student. Attributes includes name, email, age, gender and others
List	Representation of an exercise list. Attributes includes title and description
Exercise	We provided a huge database with tens of thousands of exercises. Teachers could create their own exercises. Attributes includes title, possible answers, correct answer, related topic, difficulty level, owners and others
Content	Attributes includes title, description, number of views, state (hidden, published), topic, owner and others
Discussion	Attributes includes title, description, topic, number of views, number of comments, owner

Table 7.1: *Most relevant models*

Ducante's complete database model can be found as an *Unified Modeling Language* (UML) representation on figure 7.2. Such UML representation was generated with RailRoady, from Smaldone *et al.* (2011).

7.4 The infrastructure behind the software

A good infrastructure for Ducante would allow us to scale when needed, not charge us more than what we use, deliver good resources and high uptime. We found a few good options, and after Ducante joined YCombinator's Startup School, we earned USD 5,000.00 Amazon Web Services (AWS) credits and decided to use it.

AWS delivers a few good services that we used and served us well:

- **Elastic Compute (EC2)**. Scalable computing capacity in the AWS cloud that allowed us to develop and deploy applications without hardware constraints.
- **Relational Database Service (RDS)**. Allowed us to deploy a relational database with scalable capability quickly.
- **Simple Service Storage (S3)**. Provides a simple and secure file storage system.
- **Route 53**. According to AWS website, it is "*scalable domain name system (DNS) service intended to give business and developers a reliable way to direct end users to applications*"[1].

[1]URL: https://aws.amazon.com/route53/. Retrieved 27 October 2018

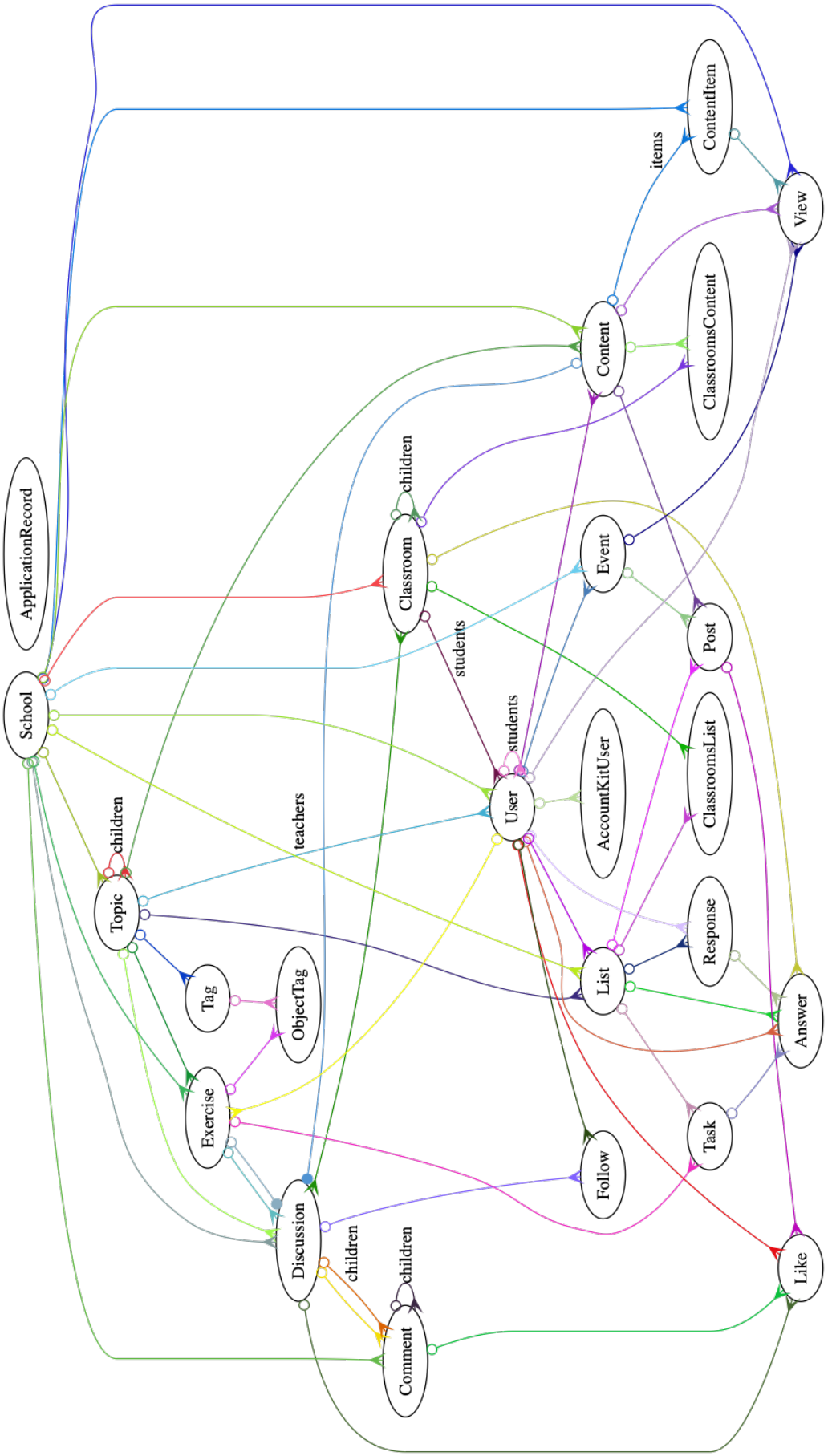

Figure 7.2: *Ducante's data representation in UML*

Chapter 8

Results

In this chapter, we discuss the growth and failure of Ducante. We also discuss some accomplishments we had during the days Ducante was up and running.

8.1 Growth and expansion

As we developed Ducante, we partnered with over ten schools (some of them can be seen on figure 8.1), with 1355 people (including 1110 students and 245 teachers) using our platform in a weekly basis. Over 260 content were published, summing over 10k views from students. Teachers created over 50 exercise lists, and students solved them over 1k times.

Figure 8.2 shows the number of content over time, showing a robust linear growth over time. Figure 8.3 shows the number of exercises list solver over time, with exponential growth. We have talked with teachers and students and, as our platform became more mature, they enjoyed using it.

More than 100 discussions were created, generating over 1300 commentaries from both teachers and students. These discussions were not only related to topics covered in class but also regarding choosing a major[1] or University to apply for.

8.2 Accomplishments

As we developed Ducante, we met many people and had the opportunity to talk at some events. Moreover, we also competed and won an undergraduate-level entrepreneurship competition from Instituto NET Claro Embratel[2] (an América Móvil company), called *Campus Mobile*[3].

8.2.1 Campus Mobile

Campus Mobile is an initiative from NET Claro Embratel Institute, in partnership with the Association of the Integrated Technological Systems Laboratory (in Portuguese, "Associação do Laboratório de Sistemas Integráveis Tecnológico", or simply LSI-TEC) and support of the Integral Systems Laboratory of the Polytechnic School of the University of São Paulo

[1] In Brazil, we must choose the major we want to study before joining a University. This leads to many people having problems to decide it, as this choice is blind most of the times.

[2] Instituto NET Claro Embratel: https://www.institutonetclaroembratel.org.br/

[3] Campus Mobile website on Instituto NET Claro Embratel: https://www.institutonetclaroembratel.org.br/campus-mobile/

Figure 8.1: *Schools and group of schools that we had partnered with*

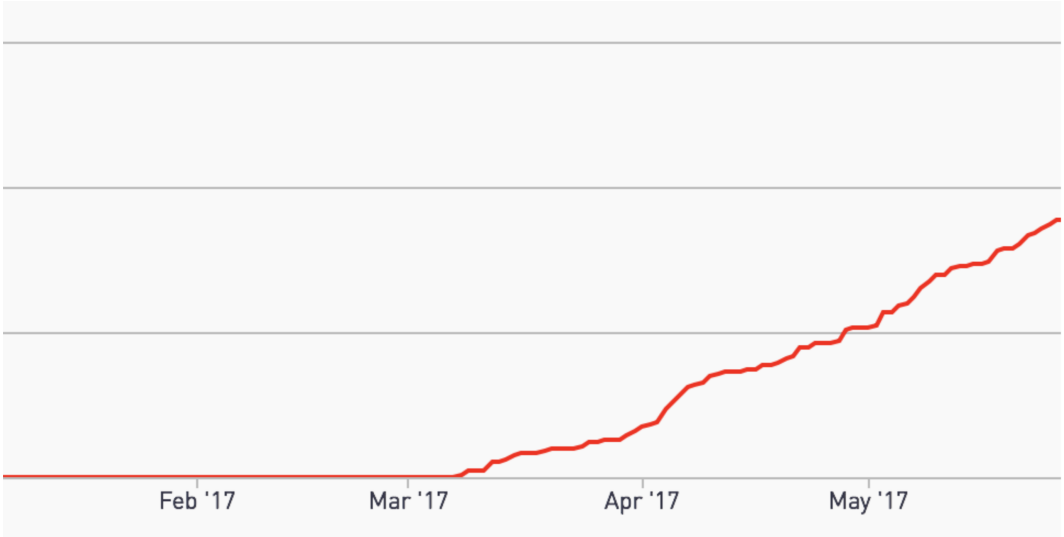

Figure 8.2: *Content creation over time*

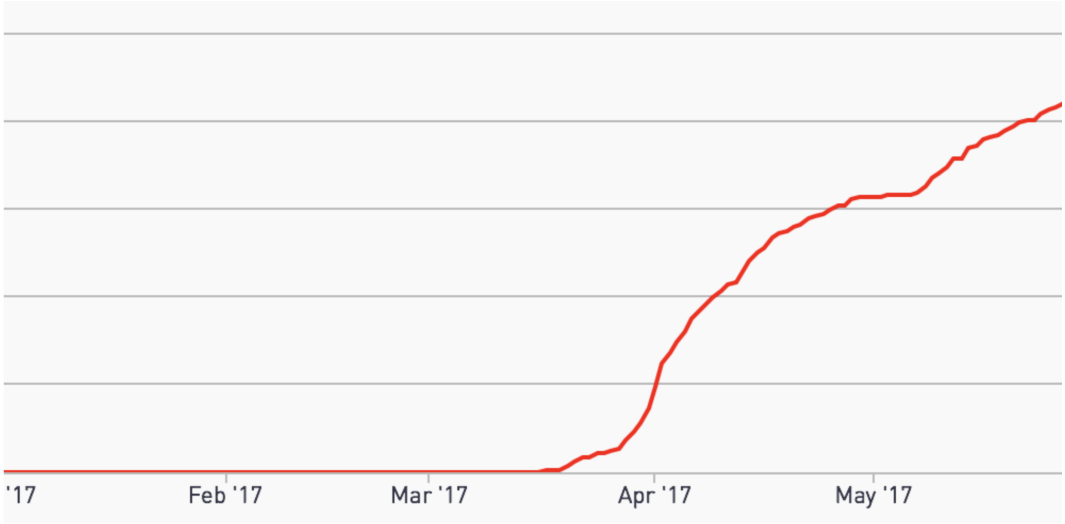

Figure 8.3: *Exercise lists solved over time*

(in Portuguese, "Laboratório de Sistemas Integráveis da Escola Politécnica da Universidade de São Paulo", or simply LSI-USP), to promote innovation and young entrepreneurship. To this end, it encourages students to develop education, facilities, and gaming solutions for society through mobile applications, products, and services through an entrepreneurship competition for undergraduate students.

We registered the Ducante project, presented our proposal and solution between November 2016 and April 2017. This allowed us to be awarded as the best solution in the education category, earning more than 7,000 Brazilian reais, a fully-sponsored trip to Silicon Valley and mentoring from executives of NET Claro Embratel Institute.

During our visit to Silicon Valley, we had the opportunity to visit Stanford University and the Lemann Center, Google's and Facebook's headquarters, and attend a design conference (San Francisco Design Week). The figure 8.4 is a picture we took during a visit to Fab Learn, and a laboratory focused on technological tools to improve the learning of science, engineering, and mathematics, that has a Brazilian professor, Paulo Blikstein, as one of the professors maintaining the laboratory. Visiting Stanford was, in my opinion, the best opportunity we had during our visit to Silicon Valley. It summarized how well the region is developed and prepared to support new solutions to social problems.

8.2.2 Talks

As we start to meet teachers and students, we start to build a network of people interested in building new technologies focused on education and improve education standards in Brazil. We were later invited to give a talk on Education Week at School of Education at the University of São Paulo, an annual event that brings different people to discuss education. We were thrilled to present new technical solutions that were being developed around the world, and we took that opportunity to share our vision and mission, as well.

As we become Campus Mobile winner in the education category, we were also invited to attend Greenk, one of the biggest technological and sustainability conferences in Brazil, to speak about what we were working on. It was amazing, we, later on, talked on some radio shows and gave some 1-on-1 interviews to independent blogs. Figure 8.5 shows the moment we were answering some questions from the public.

We were also interviewed by Campus Mobile's organization in early 2018 to give some tips

Figure 8.4: *Beyond bits and atoms: a visit to Fab Lab at Stanford University*

Figure 8.5: *Lucas Santos answering a question from the public at Greenk conference*

to contestants in the 2018 edition. The interview, in Portuguese, can be found on YouTube[4].

8.2.3 Press release

We were featured in a few large newspapers in Brazil, such as the following:

1. Diário Oficial de São Paulo (cover of August 29, 2017; figure 8.6): https://www.imprensaoficial.com.br/DO/BuscaDO2001Documento_11_4.aspx?link=/2017/executivo%2520secao%2520i/agosto/29/pagnot_0001_EHF8SOE8N3BOFe0LU6KF7S5DSPG.pdf&pagina=I&data=29/08/2017&caderno=Executivo%20I&paginaordenacao=1

[4]https://www.youtube.com/watch?v=3oPx0wM90xs

2. Estadão: https://educacao.estadao.com.br/blogs/ponto-edu/alunos-da-fgv-e-da-usp-desenvolvem-app-para-auxiliar-escolas-e-cursinhos/
3. Jornal da USP: https://jornal.usp.br/universidade/extensao/aplicativo-criado-na-usp-ajuda-alunos-a-estudar-para-o-vestibular/
4. Último Segundo, from IG: https://ultimosegundo.ig.com.br/educacao/2017-08-10/usp.html
5. Painel Acadêmico, from UOL: https://painelacademico.uol.com.br/painel-academico/9420-aplicativo-criado-por-alunos-da-usp-ajuda-alunos-a-estudar-para-o-vestibular

8.3 Failing

On July 2017, Gustavo, Leonardo and I mutually decided to discontinue the project. We continued to give support to all our customers and users throughout 2017, helping them using Ducante or developing fixes for any bugs, but we stopped to develop new features or validate new hypotheses.

The first and most significant issue was the problems we were facing to monetize: all our clients were not paying anything, and none of us had experience selling. We were running out of money after one year working on the project and making money was a must for us. The decision we had to pivot would take us a few more months to adjust the product to new hypotheses before starting to monetize it properly.

On top of that, it was tough to keep studying with working on Ducante. Both activities were attention and time consuming, requiring us to stress out for an extended period. All of us were pretty sure that we wanted to continue pursuing our degree and that was unnegotiable.

When we discontinued the project, we were shifting our platform to reach students directly, on a B2C strategy. We were developing some gamification features, including the medals systems (students could earn medals as they achieve some goals).

At more mature startups ecosystems, failing is seen as a positive thing. You learn a lot from your experience, are likely to avoid the same mistakes in the future and get to know better about the market you have worked at. During Ducante's construction, all founders had an excellent opportunity to learn more about software engineering, product, and business development and also meet a lot of great people. The experiences we had, such as visiting the Silicon Valley and talking to many interesting people both in the Valley and in Brazil, will have a positive impact in our careers, either as engineers or entrepreneurs.

Diário Oficial
Estado de São Paulo
Geraldo Alckmin - Governador
Poder Executivo seção I
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GOVERNO DO ESTADO DE SÃO PAULO
Palácio dos Bandeirantes • Av. Morumbi 4.500 • Morumbi • São Paulo • CEP 05650-000 • Tel. 2193-8000
Volume 127 • Número 163 • São Paulo, terça-feira, 29 de agosto de 2017
www.imprensaoficial.com.br

Aplicativo criado no IME-USP torna o celular um aliado do vestibulando

Os smartphones costumam ser alvo de polêmicas quanto ao seu uso em sala de aula, mas esse cenário atual está prestes a mudar, ao menos para quem está se preparando para o vestibular. O aplicativo Ducante para aparelhos celulares é uma ferramenta pedagógica de estudos, e sua finalidade é tornar mais dinâmico o aprendizado nos cursinhos preparatórios. Os responsáveis pelo uso do telefone móvel nas salas de aula são três alunos do curso de Ciências da Computação do Instituto de Matemática e Estatística (IME-USP): Gustavo Silva, Leonardo Padilha e Lucas Santos.


PAULO CESAR DA SILVA

Plataforma dispõe de conteúdo pré-vestibular especialmente para celulares

Plataforma de estudos reúne 50 mil questões de vestibulares e permite compartilhamento de informações e resolução de dúvidas on-line

Por meio do aplicativo, o aluno mantém contato com os estudos, ainda que a distância, podendo acessar a qualquer momento, seja no ônibus, na hora do almoço ou na fila do banco. A plataforma – a única com conteúdo pré-vestibular pensada especialmente para celulares – reúne 50 mil questões de vestibulares e exames, como Fuvest, Enem e Comvest (Unicamp). Entre as funcionalidades está a possibilidade de o aluno criar listas com matérias nas quais tem mais dificuldade e ainda acompanha o próprio progresso, por meio de estatísticas sobre seu desempenho.

Pontos e troféus – A aprendizagem é também colaborativa, uma vez que a ferramenta permite aos estudantes compartilhar suas dúvidas e respostas, com a mediação dos professores. "Colocamos uma espécie de fórum, onde os usuários publicam suas dúvidas para que outros tentem responder e ficamos surpresos com o engajamento, com alunos resolvendo os problemas quando não estavam na escola. O professor atua como mediador do fórum", afirma Santos, um dos desenvolvedores.

Os resultados têm sido tão positivos que os criadores planejam introduzir outras funcionalidades em novas versões do aplicativo. É o caso do Gamefication, em que, assim como num jogo por computador, o usuário pode ganhar pontos e até troféus à medida que resolve questões. "Tentamos escutar os usuários para realmente entender quais são suas necessidades. A cada dia, buscamos fazer uma plataforma ideal para todos", ressalta Padilha.

Outra atualização prevista é o compartilhamento de conteúdos e materiais em redes sociais. "Nosso foco é manter o aluno motivado a chegar ao seu objetivo maior, que é passar no vestibular", destacam os criadores da ferramenta.

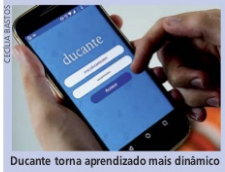
Conteúdo extra – O Ducante permite ainda que os professores compartilhem conteúdos extras com seus alunos, mecanismo criado a partir da demanda de estudantes e professores das escolas cadastradas. "Além de dispor de uma variedade maior de materiais de apoio – vídeos do Youtube, textos, arquivos em pdf, links de notícias –, o professor consegue entender o que funciona em aula para, assim, aprimorar o conteúdo", explica Santos. "O número de materiais criados e vistos cresce diariamente. Somente no primeiro semestre, foram publicados 266 materiais, que geraram mais de 7,2 mil visualizações e 1,3 mil comentários", informa Silva.

O aplicativo é utilizado por dez cursinhos em São Paulo, Brasília e Santos. São mais de mil alunos e cem professores conectados. "Começamos a efetivação pelos cursinhos populares, em que os professores são os próprios alunos da universidade, mas a ideia é que qualquer escola possa se beneficiar da plataforma", afirma Santos. As instituições interessadas podem adquirir o aplicativo. Basta entrar em contato com os desenvolvedores por meio do site do Ducante (*https://goo.gl/LMN2q2*), no qual é possível, inclusive, testar a ferramenta, ou ainda pelos e-mails *gustavo@ducante.com, leonardo@ducante.com* e *lucas@ducante.com*.


CECILIA BASTOS

Leonardo Padilha e Gustavo Silva, dois dos três alunos que criaram o aplicativo Ducante

Vencedor do Campus Móbile



CECILIA BASTOS

Ducante torna aprendizado mais dinâmico

O projeto Ducante nasceu nas aulas da disciplina optativa de empreendedorismo digital do curso de Ciências da Computação do IME – USP, ministrado em parceria com a Faculdade Getúlio Vargas (FGV) com a participação de professores e alunos das duas instituições de ensino.

O aplicativo foi apresentado como trabalho final de curso no ano passado e consagrou-se vencedor na categoria Educação no concurso de empreendedorismo Campus Móbile – parceria entre o Instituto NET Claro Embratel e o Laboratório de Sistemas Integráveis Tecnológico (LSI-TEC), com apoio da Escola Politécnica (Poli) da USP.

Como prêmio, os desenvolvedores ganharam uma viagem de imersão ao Vale do Silício para se aprofundarem em técnicas de empreendedorismo. Durante dez dias, os estudantes conheceram outras iniciativas, entraram em contato com a cultura empreendedora local e ainda tiveram a oportunidade de visitar as sedes do Google e do Facebook. Como lembrança da viagem, os jovens trouxeram diversas ideias para aprimorar o Ducante.

Roseane Barreiros
Imprensa Oficial – Conteúdo Editorial

Figure 8.6: *Cover of Diário Oficial de São Paulo (official newspaper of the state of São Paulo)*

Chapter 9

Conclusion

When we first started working on Ducante, we had no idea how far we would go. At first, we aimed to do our best at "Digital Entrepreneurship" (MAC0467) class and build the best solution we could. We were excited with the idea of helping students and local schools to have better performances: somehow we believed that we could see value in our work and everything we were studying at USP. We had no idea how much we would learn about software engineering, product development or business development. We had no idea that we would help over 1000 students across different states in Brazil or that we would go to Silicon Valley, to show our progress to other people.

According to Gustavo Silva, working at Ducante "gave me great learning about vision over a product, lots of opportunities to get in touch with customers. All of this is very important but are not well developed during our undergrad. I also learned to work better with web technologies, and to work under pressure, in quick cycles and prioritizing some tasks over others". We also agree that, although the bachelors degree helped us develop a strong theoretical basis in computer science, we were not well prepared to work in the industry or, even worse, start our businesses.

The real, albeit limited, impact we had undoubtedly was the best result we got from that experience. For Leonardo Padilha, "tracking the growth of the product and how it managed to help several students was undoubtedly a great achievement". In our visit to Stanford University, we realize that it is not only the excess of capital available that American universities have that make them stand out worldwide but also support and mentality aimed at building companies and a better society.

We can agree that we learned a lot from this experience, but moreover, we firmly believe that using technology to innovate in University admission preparatory courses is possible. Although we have failed to find a way to monetize our business properly, we have proved that the industry, especially the students, is seeking innovation. The traditional way of teaching and learning in Brazil have not followed people's new way of living: many students have internet and smartphones access, but they do not exploit this tool to improve their studies efficiently. That is, at a high-school level, most of the smartphone usage in schools are related to calculator or dictionary usage. Students are misusing these devices, that are capable of connecting to the Internet. A vast and healthy blue ocean is yet to be explored by future entrepreneurs.

We found the market to be huge, both in capital and the opportunity to make a social impact. We were thrilled to know a little bit better how it works and understand better the opportunities that exist. We believe that the presented methods we applied showed to be very valuable and we highly recommend that other entrepreneurs should learn and apply them.

It is a shared feeling of the three of us that we want to start our own business again in the future and, if possible, in markets with high social impacts. Building Ducante with Gustavo and Leonardo was one of the unique and beloved days of the time I spent at USP, and I am proud of having made part of that team. We highly recommend other computer science students (and students from all other majors) to give it a try and start an educational startup by yourself. The learning and great moments we had undoubtedly paid off all four years we had at USP by itself (not including all we learned from classes, professors and other colleagues).

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