



UNIVERSITÀ DI PISA

PROJECT DESIGN & MANAGEMENT FOR DATA
SCIENCE

Final Report

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Academic Year 2021/2022

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1 Introduction

Nowadays, every product that is placed on the market, whether it is a material product or service good, must necessarily be designed not only in order to satisfy the user but in order to become *that* specific product selected by the user. This is the only way to achieve favourable results and bring an unknown and newly born product on the way to success. To do this is therefore necessary not to leave anything to chance, but to proceed through precise data-driven steps, since representing real phenomena will allow a better understanding of potential products that are *actually being chosen* by users, without wasting important resources in the process, both in terms of time and money.

The aim of this paper is to describe and report the details of a data science solution in the field of *education* that has the user as its focal point. This is why the first two sections of the report will be dedicated to the most delicate and important part, which is outlining who the “target” user of the final solution will be.

The research was conducted, first of all, by extracting a list of possible user types that may have a particular need, solvable by using the tools of data science to shape a brand-new solution; then, the next step will consist in analysing every single type of users in this list and find advantages and disadvantages of electing one over the others.

Once the user type has been decided, the third step has been to find out which data science-based tool could be applied in order to produce a useful solution to the final users. To do so, as it will be outlined in the section 2.1, there are different and varied methodologies that may provide a guide to designers. In this report will be presented the two different techniques used to draw up the final solution, outlining their pros and cons and defining how it is thought to solve a users’ problem by exploiting machine learning and the data science paradigm in general.

In the later section, the solution found through *prototyping* has been validated: it is an innovative set of tools and techniques elaborated by Alberto Savoia and then formalized in the so-called *Pretotype manifesto*, that is driven by the will to test - in an accessible way - a product, even before making a prototype, that would mean investing much more resources. By using the prototyping tools, it may be easier to find out if there are people really interested in the solution, and it will avoid the flop of the product once realized and commercialized.

Finally, there will be the final discussion of the whole report, in which a summary of what has been done will be made, pointing out possible issues of the obtained result; also, any further development of the work will be outlined.

2 Users’ list identification

2.1 Users’ identification methods

In this first section of the report will be explored three different frameworks. These frameworks will be used to carry out the analysis of the current state of the education

field and the challenges that it currently faces. Since education is an extensive field of study, it was decided to use **quantitative methods** to collect some real data about possible groups of users and their needs and select the most interesting ones for our research.

At this early stage of the study, it was preferred to focus only on quantitative methods because numbers and data are more reliable than quality, even if this can be useful, too. Data, instead, are fundamental to go on in a structured and deterministic way.

It has been decided to use different quantitative methods, namely *scientific literature*, *Google Trends* and **World Bank Open Data** in order to have a well-informed overview of the main users in the education field and also the evolution of these needs during the time.

Scientific literature is the first method that has been used for research in education. This has provided a large source of research, and previous studies that can provide historical context, decades-long information about Education, its actors, and real tangible results from previous (and illustrious) literature. Useful websites consulted were *Elsevier*, *Google Scholar*, and *ResearchGate*.

Recent world events have made it increasingly clear the level of inequality in the access and level of education for students across the world, within the same country, region, or, even, school. Education is not neutral: it is a provider of opportunities to increase equality or inequality. The almost omnipresent usage of digital tools and the preparedness of academic institutions and educators to provide the resources and access to quality education has brought a turning point for which students within vulnerable populations can be even more disadvantaged compared with other students (Engelbrecht, 2020).

Unfortunately, the fast pace of changes in technology in the last few years might have rendered some of the aspects in these academic articles (particularly, the older papers) outdated for the depiction of the users and the reality they live in. In some cases, it was possible to identify not only incorrect ways of addressing the disadvantaged students but presented solutions that do not address the real problems and needs of the user. One example is provided by the paper *Creating profits by creating failures: standards, markets, and inequality in education* published in the International Journal of Inclusive Education (White, 2010).

So it was almost imperative to further expand the quantitative investigation using Google Trends and information from the World Bank Open Data portal to sketch a more updated image of the users.

Google Trends is an important and helpful tool to analyse users' researches on the web in real-time, and therefore trends in the users' interests and curiosities. Nevertheless, it is quite known that this method can't offer specific information about users who search on the web, that is to say, it's impossible to have an overview of personas. However, it could be useful to adopt this method to understand some demographic features, for instance, about users searching for themes about education or even problems of that field on the web.

World Bank Open Data instead, offers access to analysis and visualisation tools that allow having a clear frame about the time evolution of certain phenomena through data.

2.2 Users' needs list

Once the users were found, the identification of their needs will be pointed out using the **SDG framework**, or Sustainable Development Goals framework, that comprises *17 goals* developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs), adopted by the United Nations in 2015 as a way to define long-term goals to protect the planet and the people they live in.



Figure 1: SDG framework icons by United Nations

It will be tried to point out all the possible needs of the identified users using this framework: the **fourth goal of SDG**, that is **quality education** will be taken as a guide and will be **crossed with other important goals**, as it will be concretely shown in paragraph 2.3.2. Here, in this specific section, will be described the most important contact points will be used in the results section.

First of all, among all the needs set, can be identified a small pool of needs that act as a base for all the other goals, such as the 2nd one which represents the elimination of hunger, and the 6th one, which refers to clean water and sanitization, even more, important because of the COVID-19 pandemic situation.

One first **contact point** can be found between the **4th, the 3rd, the 10th and the 16th goal**, and may be referred to students (but also teachers) with disabilities, who must be ensured with high-quality educational instruments and being helped with specific infrastructures in schools and a personal support teacher. If focused on teachers with disabilities, it can be found another focal point on the 8th goal, because they could need specific accommodations in their workplace to work properly.

There's also an **intersection between the 4th goal and the 1st one** because there can be poor students that may experience problems and discrimination for their shortage of money: in fact, not having economical wealth must not preclude the good quality of teaching.

Another useful SDG that has been taken into account for this research is ***gender equality***, that formally is described¹ as *gender equality and empower(ment of) all women and girls*, but for this specific purpose may be interpreted also as equality and respect of any gender identity (and even sexual orientation) in the workplace and/or in school's classes.

There is another SDG which is very closed and connected with this one, the 10th which is ***reduce inequality*** and is the perfect summarization of what it was briefly told above, seeing it from a more general point of view; in fact, (in)equality acts in different fields: ethnical, sexual, but also religious, cultural and physical.

In conclusion, those specific points of SGD can help explore more in-depth the needs and problems for every identified user in the users' list paragraph (see section 2.3.1).

2.3 Results

2.3.1 Users' list

As it was written before in paragraph 2.1, the education field is very huge and with many facets, therefore it can be really difficult to immediately choose specific groups of users in the wide range of possibilities. So, it was decided to be very general in this choice in this first phase of the project, at least.

At first, it was used Google Trends to find some interesting research terms related to the education field, such as *computer, master degree, physical education*: those words will be used in the next part of the user's identification task. In addition to this, the most searched terms showed that the countries where the word *education* was searched most are largely poor countries, such as Zambia and Niger or Algeria, which is considered as a rich country because of its export of gas and oil, but it has strong inequalities in the distribution of that wealth.

For this task, some reports were also used, as the contributes by (White, 2010) and (Yström et al., 2010), that gave a more precise insight about inequalities in this specific field.

With the specific purpose to keep the list as general as possible, the following five different and general types of users were identified:

- The first one includes **not wealthy students**, or **poor students**: they cannot afford school fees, such as book fees or expenses concerning computers, that in this specific period are indispensable in following online lessons;
- The second one comprises students or teachers with **disabilities** (that can be both cognitive and physical): students could have difficulties in following lessons in the same way their classmates do, due to causes concerning cognitive limitations or also movements in reaching the classrooms, instead teachers could have problems in doing their job due to the lack of specific workplace accommodations;

¹According to the official website: <https://sdgs.un.org/goals>

- The third group of users that has been identified is the one who comprises those students and educators who are victims of **discriminations due to gender identity, sexual orientation or ethnicity**: they can suffer from discrimination and be bullied, all things that can lead to even more serious problems and risks for them both at the scholastic level, pushing them to drop out of school early, and at the personal level causing traumas that are difficult to overcome;
- The fourth group of users comprises **teachers** who may need extra courses to update and improve their teaching skills in order to better train their students.
- The last group is represented by **workers** and people that for a variety of reasons didn't attend school but are willing to increase their level of knowledge or improve the quality of their skills.

User	Need	Goal
A non wealthy student	Needs an economical help to afford scholar and extracurricular expenses	to be able to extend his/hers/their education
A student with disabilities	Needs to receive same possibilities and assistance in education than other students	to feel included and accomplish their educational milestone as his/her/their peers
An LGBTQ+ student	Needs the educational institution to increase awareness about LGBTQ+ topic and to avoid possible acts of discrimination and violence against them	to feel safe, included and accepted by others
A teacher	Needs extra courses offered by school to learn new teaching methods and to stay up-to-date	to better involve students in his/her/their course
A professional	Needs to improve and update his/hers/their professional skills	to improve their professional process and employability

Table 1: Final list of identified users

2.3.2 Needs list

This section will be exposed the “exploratory” phase of the research in which the identified users’ needs list will be analysed according to the points given by the SDGs framework. As it was said in the introduction to the mentioned framework, all the potential users have the common need to receive a quality education, a goal absolutely consistent with the 4th goal of the SDG.

Another two SDGs goals that all the identified users have in common are the 6th SDG concerning the necessity for clean and hygienic environments, a primary need that has become even more important in the last periods due to the COVID-19 pandemic, and the 11th one, regarding *peace, justice, and strong institutions* a target that should cover all the different types of users (students, teachers, professionals, individuals with disabilities or persons facing some sort of discrimination).

In addition to these common goals, it is necessary to compare the needs of the identified users with the other goals of the SDG model to highlight and analyse further possible correlations.

The first possible user to analyse is the non-wealthy student that wants to extend his/her/their education, but doesn't have the opportunity of enrolling in a private school or to attend extra-curricular courses where the interesting skill is taught.

According to the SDGs, the need of such a user can be crossed with the 1st SDG concerning the *elimination of poverty* and the 10th concerning the *reduction of inequality*.

Another interesting case is that of the second category it has been found, that is students with disabilities who would like to receive the same education as their classmates without feeling discriminated.

Comparing these needs with the goals of the SDG, there is compatibility not only with the quality of education and the reduction of inequality but also with another goal: the need of *Sustainable cities and communities* (11th goal of the SDG), in particular, in this case, schools that have to be accessible as possible for students with motor and physical disabilities but also cognitive disabilities.

As for the third user, an LGBTQ+ one, instead, the problem is not only about education, but also about the relationship that this individual wants to have with the school itself. His need is to continue studying and going to school without being afraid of being discriminated by classmates and teachers.

From the perspective of the Suitable Development Goals, these needs can be found not only in the need to receive quality education but also in two other goals that are closely related to each other: *gender equality* (5th goal of the SDG) and again the *reduction of inequality* (10th goal of the SDG).

For the fourth identified user, the teacher, whose goal is to teach the subject to the students with the best pedagogical approach possible, in addition to the achievement of quality education, the need can also be crossed with a reduction of inequality, (the tenth goal of the SDG) but, also, with the *guarantee of decent work* corresponding to the eighth goal of the SDG for himself and his colleagues.

Moving to the last user identified, however, the school environment is changed for a working environment. Consequently, in this case, the needs of this user are not compatible with those of the previous ones, because the users identified exist within a different environment, the working one, which obviously has different needs than the school one.

In fact, the fifth type of identified user is someone who needs to improve and update skills.

Comparing one last time the needs of the users who have been identified in this first part of analysis with the goals of the SDG, at the centre remains the goal of receiving a quality education, but in addition to this, another fundamental goal is the possibility to have a *decent work and economic growth*, (8th goal of the SDG).

This goal had also been perceived in the case of the user that teaches at school, but in this case, it is even more important because the possibility of taking extra courses may also be linked to the possibility to increase the quality of the work and consequently the profits and the life.

Figure 2 shows a resume of correlations between the users' list and SDGs goal.



SUSTAINABLE DEVELOPMENT GOALS

	1 NO POVERTY	4 QUALITY EDUCATION	5 GENDER EQUALITY	6 CLEAN WATER AND SANITATION	8 DECENT WORK AND ECONOMIC GROWTH	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	16 PEACE, JUSTICE AND STRONG INSTITUTIONS
Poor student	X	X		X		X		X
Teachers		X	X	X	X	X		X
Discriminated Student	X		X	X		X		X
Student with disabilities	X			X		X	X	X
Professional		X		X	X			X

Figure 2: Cross-over between identified users and SDGs

3 Users' needs assessment

For this research, the needs assessment will be conducted starting from the evaluation of **three main metrics**: *number of users*, *importance* and *confidence*. For each of them, some needs analysis methods have been exploited.

Before starting, it is also useful to give a summary of the user needs list identified in the first part of this work since these user needs will act as a baseline for the further development of this report. The results of the previous work are presented in table 7.

3.1 Number of users

As for the first metric, the *number of users*, it has been decided to adopt a data-driven approach. *How many users exist for this need?* It is important to quantify them because this is the only way to conclude the final decision about users' needs on real, factual data, so on actual needs and problems of users.

In order to do so, some official websites have been consulted. The first one was the Sustainable Development Goals Report², written in 2021, which was helpful to understand data about each of the SDG indicators it has been decided to focus on.

It has been also decided to focus only on European Union and, in particular, the most useful data source was the FRA website³ and the Eurostat⁴.

²The report may be found at the following link: <https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf>

³European Union Agency for Fundamental Rights website: <https://fra.europa.eu/en/about-fra>

⁴Eurostat website: <https://ec.europa.eu/eurostat/web/main/home>

3.2 Importance

As for the second metric, *importance*, it has been chosen to start from two different qualitative methods, that, for this specific purpose were adapted into quantitative ones by assigning a numeric value, as it will be described in section 3.2.3. These methods are the *Maslow hierarchy of needs* and the *ERG theory*.

3.2.1 Maslow hierarchy of needs

The **Maslow hierarchy of needs** was created by Abraham Maslow in 1943, when it was introduced in his research work *A Theory of Human Motivation* and lately formalized in the book *Motivation and Personality*.

His theory stems from the assumption that every person is driven by specific types of needs, that can be structured in the shape of a pyramid or two-dimensional triangle with five different steps.

The interesting part of the theory is that, according to Maslow, each individual has to fulfil a certain “threshold” of a more *basilar type of needs* before moving on to other needs in the higher levels of this pyramid. Furthermore, those needs don’t stem from the lack of something, but, instead, from an inner desire to grow as a person.

3.2.2 ERG Theory

After the formalization of the Maslow theory and the creation of the Maslow Pyramid, Clayton Alderfer redefined it in his own terms, applying it in the empirical field: his reworking is best known as the **ERG theory of motivation**.

His merit is the recategorization of Maslow’s hierarchy of needs into three simpler classes:

- **Existence needs:** needs for basic material necessities.
In short, they include an individual’s physiological and physical safety needs;
- **Relatedness needs:** the needs of each individual to develop interpersonal relationships (with family, friends, colleagues, superiors);
- **Growth needs:** individuals’ needs for self-development and personal growth and advancement. The importance of these three classes of needs may vary for each individual.

A representation of Maslow hierarchy of needs and ERG theory is provided in figure 3

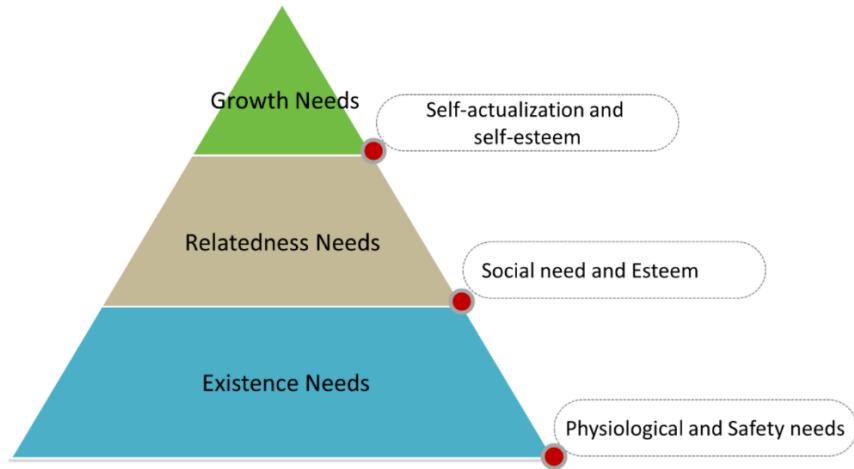


Figure 3: ERG theory and Maslow hierarchy of needs

3.2.3 From qualitative to quantitative measures

Since having numeric values based on data is always more reliable than having numbers result of a mere opinion, it was decided to adapt those two methods described in the two sections 3.2.1 and 3.2.2 from qualitative to quantitative ones. To do so, it was decided to assign a number to each step of the two pyramids, as it can be seen in table 2.

Those “importance points” will be used in the final assessment table, in order to have a more precise estimate of the most important need between the ones that will be explored.

Maslow's pyramid		ERG theory	
Needs	Importance value	Needs	Importance value
Physiological needs	10		
Safety needs	8	Existence needs	10
Love, need and relatedness	6		
Esteem needs	4	Relatedness needs	5
Self-actualization	2	Growth needs	2

Table 2: Importance points assigned to the various steps of Maslow's pyramid and ERG theory

3.3 Confidence

In the first part of the report, several methods were used so as to find and - especially - analyse user needs. As the summary table above (see table 7) reports, there were 5 categories of needs: the need of a student to learn a language, the need of a teacher to find a new teaching method, the need of a student with disability to access schools and lessons, the need of an LGBTQ+ community to be accepted, and finally the need of a professional worker to improve her personal skills.

It has been necessary to quantify this assumptions and therefore to start collecting data, but before ending the data collection phase, it has been necessary to have a break and find an answer to these questions: *are the collected data reliable and valid? Do they come from trusted sources? How dependable is this data?*

All these questions are the key factor for the concept of **confidence**, which has been interpreted as a measure of the validity of data.

Most of all data that will be presented are reliable because of the fact that they come from internationally accredited sources: as for data about students belonging to the LGBTQ+ community, the fundamental resources were the *International Lesbian, Gay, Trans, and Intersex Association* and the *European Union Agency For Fundamental Rights*. In addition to this, it is important to point out that the data are also valid in terms of time because they are updated to 2020. In conclusion, for these reasons, there is overall good confidence about this specific information.

Also for students with disabilities, it was chosen to take the data from reliable sources to be sure to do as much data-centred research as possible. A very important source for this research was the *Eurostat* databases⁵, which contains several databases regarding people with diverse disabilities and, specifically students with disabilities, that allowed to refine even more the research.

As for the three remaining types of user needs (to have a new teaching method, to learn a new language quickly, to improve the CAD quality), it has been very hard to find a reliable source for data. This is why the three types of users with these needs can be merely isolated in precise and quantifiable groups, so, after trying collecting data unsuccessfully, it has been decided to hazard a numerical estimation, as it will be explained in section 3.4.

3.4 Assessing the number of users

Assessing the number of users is really useful for the analysis since it can be possible to attest how many people stand to benefit from the solution, and, then, to understand if it is worth studying it.

3.4.1 LGBTQ+ students

Moving to another type of users, it was necessary to explore information about LGBTQ+ students in order to have an idea of the profiles within this category and to quantify them. The research was based just on the European circle of students. Three different reports were consulted.

For this specific purpose, three different reports were consulted. The first one is a research done in 2006 by ILGA-EU⁶, the International Lesbian, Gay, Bisexual, Trans, and

⁵<https://ec.europa.eu/eurostat/en/web/main/data/database>

⁶The report can be consulted here: https://ilga-europe.org/sites/default/files/Attachments/social_exclusion_of_young_lesbian_gay_bisexual_and_transgender_people_lgbt_in_europe_april_2006.pdf

Intersex Association, that was useful in order to understand a little better the phenomenon of social exclusion, even if the research was restricted to a small sample of the LGBT people in the European Union. The 61% of the research of survey respondents declared that they had suffered bad experiences at school related to their LGBT status; then the survey wanted to be even more specific and concluded that 53% of them reported bullying experiences at school, while 43% found prejudice or discriminations in the school presentation and curriculum.

The second consulted report was written in 2014 and attests that the problem of discrimination against LGBTQ+ young students were still existing (57% of all 18 to 24 years old say that they were victimized in this way).

The most useful consulted report, *A long way to go for LGBTI equality* is from the European Union Agency For Fundamental Rights, because it was written in 2020 (so it has more updated data) and it has useful insights and estimation about the number of LGBTQ+ people in Europe.

Country	Estimated target of population	Estimated target sample	Realised sample	Realised/target sample (%)
IE	160 147	1359	2433	179
IT	2 016 801	10 521	9881	94
UK	2 235 653	11 326	12 725	112
Total	17 559 647	100 000	141 621	142

Table 3: Sample of the table presenting the number of LGBTQ+ people in Europe from the report *A long way to go for LGBTI equality*, 2020

3.4.2 Students with disabilities

The second category explored is the one regarding students with **disabilities**, a special category of users that contains various types of disabilities that can be motor, cognitive, or a combination of both, and this can cause difficulties within the school environment and education in general.

In order to identify this type of students, diverse national (e.g. Istat) and international statistics (e.g. Eurostat) were consulted to identify the percentage of students with disabilities on the total number of young people between 13 and 25 years old.

As presented in table 4, according to statistics both in Europe and Italy about 25% of young people have disabilities, which exemplifies how important it is to provide these people with the education they need.

Geopolitical Region	Total number of young people	Number of students with disabilities
Italy	5.660 (appr.)	1.243
European Union	74.000 (appr.)	18.278

Table 4: Percentage of students with disabilities in Europe and Italy
(Source: Eurostat and Istat database)

The presence of appropriate education for students with disabilities is a very frequent problem and has become increasingly critical due to the pandemic and *distance learning*, a new teaching method that has caused problems for all students and, especially students with serious diseases who suddenly found themselves without a support teacher and began to fall behind their other classmates.

In Italy, this phenomenon was highlighted by an Istat report which stated that between April and June 2020 more than 23% of students with disabilities (about 70 thousand) did not take part in the lessons and this has increased the inequality of this type of student compared to other.

3.4.3 Students in risk of poverty in Italy and Europe

In Europe, another vulnerable group are the students at risk of poverty or social exclusion, whose financial situation might put them at a disadvantage compared with their wealthier peers. Fewer opportunities for extracurricular activities, access to exchange opportunities, and more are inaccessible to them, and even their academic performance and goals might be second place to the maintenance of living standards and material.

To outline the number of individuals that exemplify this type of user the information provided by Eurostat was highly useful, with this data it was possible to identify the following number of users that face this need.

Geopolitical Entity	Total number of young people	Total number of young people at risk of poverty
Italy	5.661.000	1.737.927
European Union	74.172.000	18.617.172

Table 5: Number of young people in Italy and Europe at risk of poverty or social exclusion in 2019. (Source: Eurostat Database)

3.4.4 Professionals willing to participate in education or training to improve personal skills

This category regards adults who want to participate in some sort of formal education or training to acquire skills to improve their professional prospects, earnings, and employability. By evaluating the data from *Eurostat* and *World Bank*, it was estimated the number of adults that want to access formal training or education in Europe. There are no data - in official statistics - about the number of teachers that want to change their methodology during classes, so it was decided to move on and try to assess the number of teachers in Europe. For this purpose, it was consulted the Eurostat website⁷, were it was found a more specific number.

⁷Eurostat, Teachers in EU: <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20201005-1>

Geopolitical Entity	Total working population	Professionals willing to participate in education or training	Number of teachers
European Union	214.556.974	69.087.345	5.200.000

Table 6: Number of working population willing to participate in education or training and estimated number of teachers in Europe (primary, lower secondary, and upper secondary education). (Source: Eurostat Database)

3.5 Final needs assessment table

In this subsection, it will be exposed and discussed the final assessment table of user needs. Starting from the data collection done in section 3, it has been filled a table with four different columns that expose all the five identified needs and the value for each of the three used metrics.

As regards the *number of users*, the final number is an estimation based on the data that have been found. This is valid especially for teachers since more precise data were not available.

The *importance* final value is obtained by calculating the average of the single values assigned by using the ERG theory and Maslow's pyramid as shown in table 2 and rounded up to the nearest integer number.

The *confidence* interval, instead, will act as a modifier to quantify the reliability of data.

The most peculiar cases were the ones of professionals and teachers because it was difficult to quantify how many of them wanted to access extra courses: it was arbitrarily decided to take 30% of the total number found. Even the LGBTQ+ community has been done this sampling, by taking into account only the 30% of the total people that were estimated.

The *importance* and *confidence* values have been also normalized into the range [0-1].

Needs	N. of Users (Estimated)	Importance	Confidence	Final Score
<i>Equality (gender and identity)</i>	35.100	0.83	0.85	1
<i>Equality (disabilities)</i>	22.200	1	1	0
<i>Expand personal knowledge without a lot of money</i>	510.000	0,5	0.28	0.8
<i>Find a new teaching method</i>	1.500.060	0,4	0	0.08
<i>Expand personal knowledge and balance work between courses and private life</i>	600.000	0,2	0.28	0.4

3.6 Final decision and conclusion

Since a data-driven approach was used, it has been necessary to analyse these data and to draw conclusions about which users and which needs to take into account. The less meaningful categories of user needs were the last three of Table ??, since for those weren't specific and reliable data, a problem that guided the research to give lower values of both importance and confidence.

As for the first two user needs, the data were more reliable and valid: that gave a higher

level of importance and confidence. At this point, it was needed to decide between these user needs. After careful consideration, it was concluded that people with disabilities had needs that concerned the field of education in a different way to the LGBTQ+ students. Students with disabilities need to be included in the process of learning in a friendly way and with methods and technological tools that can simplify their approach to reading, studying, and more in general, to Education.

So, it was finally decided to concentrate the attention and work on students with disabilities.

User	Need	Goal
An LGBTQ+ student	Needs the educational institution to increase awareness about LGBTQ+ topic and to avoid possible acts of discrimination and violence against them	to feel safe, included and accepted by others
A student with disabilities	Needs to receive same possibilities and assistance in education than other students	to feel included and accomplish their educational milestone as his/her/their peers

Table 7: Final most important needs

Since disabilities are varied and a broad spread field, it has been chosen to focus only on a specific type of them, physical disabilities, and in particular on visual disabilities.

4 Solution identification methods

For the identification of possible solutions to the users need identifying in the previous section (namely *students with disabilities, whose need is to get an equal education without receiving any kind of discrimination*), it was decided to make use of two different design frameworks, both based on decks of cards: the first one is the **AI meets Design Toolkit** (Section 4.1), while the second one is **AI & Ethics** (Section 4.2).

Card-based methods are not new in “traditional” design, where they are used to inspire the designers, by including a gamification component. Since 1952, card decks have been used with the aim of inspiring design ideas in others. Since then, many other card decks have been created to enhance the UX and Human-Centred Design process.

According to Roy and Warren, 2019, there are several types of cards. Among them, different types can be distinguished:

- *Systematic design methods and procedures*: cards that represent approaches and techniques to solve design problems;
- *Creative thinking and problem solving*: general cards that may help to solve *any* kind of problem, even the design-related ones;
- *Human-centred design*: cards to help the designer is focusing on the user;

- *Domain-specific methods*: cards containing methods, information, or checklists for specific domains (e.g. game design, product or services design);
- *Team building and collaborative working*: cards that offer guidance for teamwork;
- *Futures thinking*: cards used for creative problem-solving about the future.

The decks are also different for the way they work:

- Cards that provide direct, cryptic, or random prompts to improve creative thinking, by stimulating individuals to think about things differently;
- Card sets that provide useful information and knowledge in summary form for specific design tasks;
- Card sets that provide summaries of design methods, applicable in a general or more specific way (such as the AI x Design deck presented in par. 4.1);
- Card decks that provide ideas and solutions for specific design problems or domains to improve the final product in various aspects, such as usability, security, or sustainability (this is the case of the AI & Ethics deck of cards, presented in par. 4.2).

4.1 AI meets Design toolkit

Ai x Design toolkit is a set of tools made by the *AixDesign Community* to promote the interaction between Design and Machine Intelligence (Artificial Intelligence, Machine Learning, and Data Analysis) in order to test new possible applications of Human-Centered Design and improve the user experience, but also to promote interaction between designers and other professionals such as data scientists and Machine Learning engineers.

This toolkit can be used in the various phases of the Design Process (Design, Define, Discover, Model, Map, Make, Control, Communicate and Collaborate) both to improve the characteristics of an existing product and to develop an innovative idea by combining design with the different computer intelligence.

Along with this toolkit comes to a deck of cards called **AI x Design Ideation Card Deck** consisting of 20 *What if? statements* that help in the development of ideas based on currently existing artificial intelligence and Machine Learning systems. These cards are divided into six categories representing possible new areas to be explored to improve the user experience. Each card provides, in addition to the *What-If* statement, an example of possible Machine Learning techniques to be used to answer that specific question and a series of examples from which to draw inspiration.

An example of the structure of these decks is shown in figure 4.



Figure 4: Example of Ai x Design ideation Card Deck (source: Ai x Design Community)

For this project, this tool was chosen in order to find possible solutions to the needs of our target users.

First, a brainstorming session was required. In this exercise, each of the cards was read and the ones that could best help meeting the needs of the users were selected. Subsequently, the focus shifted onto the chosen technologies and using the examples provided by the cards to find ideas from which to take inspiration to formulate possible solutions to the needs identified in the previous phases of the project.

The solutions identified using this tool will be presented in section 4.3

4.2 AI & Ethics

IDEO’s AI Ethics Cards is a tool designed to guarantee an ethically responsible, culturally considerate, and humanistic approach when designing with data. The cards’ deck consists of four design principles and ten activities, all meant to be used by teams working on the development of new, data-driven, smart products or services. An example of the structure of these cards is shown in figure 5.



Figure 5: Example of IDEO’s AI Ethics Cards (source Ideo)

This tool aims to answer the question: *how can it be ensured that people are the top priority when designing large-scale systems? Especially when those systems will change*

over time, even evolving without direct human supervision?

When using this method, it's really important to keep in mind four principles:

- *Data is not truth*: data are human-centred. Humans create, collect, capture, and extend data. The results are often incomplete and the process of analysing them can be messy.
Understanding human influence on data is essential to understand how it can best respond to the needs of the user;
- *Don't presume the desirability of AI*: just because AI can do something, it doesn't mean that it should. When AI is incorporated into a design, designers should continually pay attention to whether people's needs are changing, or an AI's behavior is changing;
- *Respect privacy and the collective good*: while some policies and laws shape the governance, collection, and use of data, designers and developers must hold themselves to a higher standard than "will we get sued?" It is imperative to consider the design, governance of data used for new purposes, and communication of how people's data will be used;
- *Unintended consequences of AI are design opportunities*: just as with any design endeavour, it is known that the first try will be successful. unanticipated consequences and new unknowns must be used as starting points for iteration.

This method aims to let dialogue, increase and provide concrete tools to help designers' community design intelligent and ethical systems, that respond to the good, the needs, and the behaviours of users.

4.3 Results

In this section, all the results achieved through using the methods presented in paragraph 4 will be described.

The most useful tool was the *AI x Design* deck, by which it was possible to have a clear overview of different Machine Learning solutions. Instead, the *AI & Ethic* cards were most useful to keep the work focused on possible consequences and drawbacks. Through the first deck of cards, it was chosen to focus only on two technologies: Facial Expression Recognition (FER) and Natural Language Processing (NLP).

4.3.1 Facial expression detection

Facial expressions are one method of human communication. Similarly, to text or speech human language, they can express an individual emotional state.

Based on machine learning and computer vision, the capabilities of computers to recognize and categorize these human expressions have increased drastically in recent years.

With this advance in technology, **Facial Expression Recognition** (FER) uses algorithms being developed that extract emotion scores from observed facial expressions. Generally, FER technology is made up of face detection (locating faces in a part), facial landmark detection (extracting information from the facial measures), and facial expression and emotion classification (analysis of facial features movement and their classification to different emotions).

Facial Expression Recognition provides an effective and raw emotional response to the stimulus the subject provides. This feedback has great value for applications in market research, video game testing, store cameras to detect emotion, and tailoring services in real-time.

4.3.2 Natural Language Processing

Natural language processing (NLP) is the branch of AI concerned with making computers capable of reading, understanding, and producing meaningful communication in the human language.

This computational area combines deep learning, machine learning, statistical models, and computational linguistics to process text and voice data.

By using these technologies, NLP can achieve tasks such as speech recognition, word sense disambiguation, named entity recognition, coreference resolution, sentiment, and natural language generation.

Currently, NLP is being used for machine translation (Google Translate being a prime example), virtual agents and chatbots, social media sentiment analysis, text summarization, and spam recognition.

4.3.3 Solutions Table

Table 8 shows the two possible solutions identified using the methods outlined in Section 4. As stated in the previous section, the two different technologies were chosen because they were the ones that would best suit the users and their needs: **Facial Expression Detection** and **Natural Language Processing**.

User + needs	Solution using AI and ML system	Description	Drawbacks
A visually impaired student who wants assistance with reading in the classroom	Facial Expression Used to recognize moments of difficulties while reading and studying in the class or at home	Recognition of difficulties The system recognizes a trigger (an expression of difficulty) and helps the user. Automatic text magnification While a visually impaired person reads a file (e.g., PDF) the system follows the movement of the eye and automatically enlarges the text.	Could be not so precise and reliable; Privacy issues; Expensive training of the algorithm
A visually impaired student who wants assistance with reading in the classroom	Natural Language Processing Can be used to sum up the text in order to give to the student a simplified and bigger text to read.	Text-to-Speech Systems Automatically sum up of the text read by the student so that it can be easily understood by both blind and visually impaired people	Problems in detecting the topics of the text Problems in correctly usage of syntax and morphology

Table 8: Identified solutions for the problems of the users using Card-based methods

As for the recognition of facial expressions, it was thought of as a system that could recognize expressions of doubt or difficulty (the so-called *triggers*) by a student with visual impairments and automatically solve his problem, for example, by recognizing the direction in which the user's gaze rests and automatically increasing the size of the text he is reading, making it accessible. One trigger may also be the proximity of the device to the face of the user because visual impairment can bring also to get close to the screen to read better.

However, this solution has some drawbacks such as privacy issues (in particular for the facial expression recognition part) and the operation of the algorithm, which may not always be accurate or reliable. Also, it may need a large training cost.

The second solution identified, instead, is about using Natural Language Processing to solve problems related to the difficulty in understanding the text.

Specifically, it was thought of solving the users' problems by using an algorithm that takes a text in natural language as input, and automatically summarize it. But, later in a discussion phase, emerged a lot of drawbacks related both to the NLP itself, like problems in correctly recognize the syntax or, for example, homonyms and to the need's itself, because it cannot correctly solve the problem of this kind of user. Moreover, there is another problem, because the algorithm may not be able to correctly recognize the topics contained in the document.

After a careful evaluation of the *pros* and *cons* of the two solutions identified, it was decided to focus on the use of *facial expression recognition* because there are already many programs that automatically synthesize the text and because the second solution is very general since it can be useful for all students and not only for those with visual disabilities.

5 Pretotyping

As stated in the previous section, the optimal solution to solve the problems of the users, i.e. visually impaired students who wish to achieve the same education as their peers, was to create a system that, through the use of the device internal camera, would manage to automatically increase the size of the text and modify some of its characteristics (e.g. background colour, natural and device brightness, etc.) whenever the user shows an expression of difficulty in reading such as, for example, approaching the screen or straining their eyes.

However, before implementing the idea it is necessary to assess its interest within the market, i.e., how many people would be willing to use it. In order to test this idea and assess the interest, it was decided to create *prototypes*.

A **pretotype** is a quick and low-cost mock-up of a product or, in this case, a solution developed and tested in a short period, which makes it possible to immediately verify the interest of users and to understand whether that product or service can be realized. In this way, the questions and doubt can stay (*Thoughtland*), made up of and collect some real data and concrete information from the end-users (*Actionland*) without investing a lot of time and money and thus avoiding their failure on the market. (A. Savoia, 2014)

To test the idea, two different prototyping solutions were identified (as will be mentioned in 5.1) and tested (section 5.2), in order to collect data on the possible interest of the product to the end-users and understand whether it was necessary to continue or abandon the idea.

5.1 Prototyping Techniques

There are a very large number of prototyping techniques to assess the interest of products and solutions of various kinds, both those that want to improve existing products and those that are more innovative and not yet on the market. Their purpose is to collect as much data as possible in the interest of users in the idea, trying to make it as concrete as possible without investing too much time in realizing and testing it.

Among these techniques, it has been decided to use the Fake Door.

Fake Door is one of the most used prototyping techniques and consists of advertising a product as if it were to be launched in the future, inviting people who are interested to sign up.

In this way, it is possible to understand, based on the number of responses received, whether the solution is worth implementing.

Firstly, it has been thought of some quick and clear tools for collecting opinions and data about our end users.

The first tool utilized is a survey made by using Google Form⁸, in which the idea is presented to the potential users, pretending that the app would soon be launched on the Apple App Store and asked them if they were interested or not in using it by asking personal questions (e.g. if they had disabilities and problems encountered while reading with a digital device) and asking for opinions on some aspects of the product (e.g. if they were willing to grant permission to be filmed while reading). The survey was spread on Reddit (subreddit r/blind), Twitter, Ko-Fi, Survey Circle.

The second tool utilized was the realization of two short videos of about 15/20 seconds, in which the app called “easy read” is introduced as a new application to improve user reading experiences, that would soon be released to digital stores. The second video aims to explain, in a more accurate and clear manner, the functions that will be implemented in the app.

This “social choice” is justified by the drive to test the solution in an even narrower time than the survey and see how much data could be collected. Initially, the video was posted on TikTok⁹, within a new profile titled @appdeveloperforfuture (Figure 6), also trying to use hashtags both pertinent to the topic treated (blindness, visual disturbances, etc.), that aimed at getting the video into a trend, in the so-called *for you* page.

The choice of the use of TikTok might seem risky given that it is a new social and has rarely been used to test prototypes, but it had to be tried because it is the idea developed for the educational field, TikTok is one of the social networks where the majority of users are very young, between 8 and 22/23 years old.

⁸Italian and english version of the surveys

⁹The two videos can be seen here: [TikTok video](#)

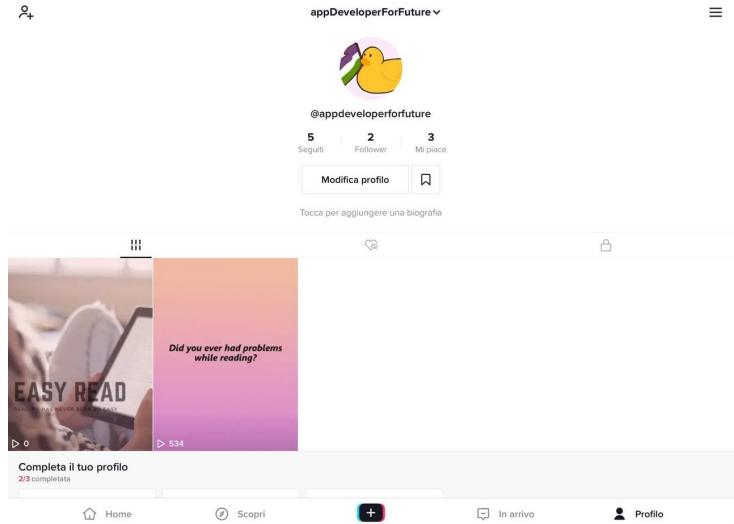


Figure 6: @appdeveloperforfuture TikTok profile

In order to make this idea even more concrete in the eyes of the users, it was decided to collect these tools on a landing page (Figure 7), created using the website *carrd.co* and including, in addition to the links to the surveys and the TikTok profile, the possibility of subscribing to a *newsletter* so as to collect the latest data on the potential number of interested users.

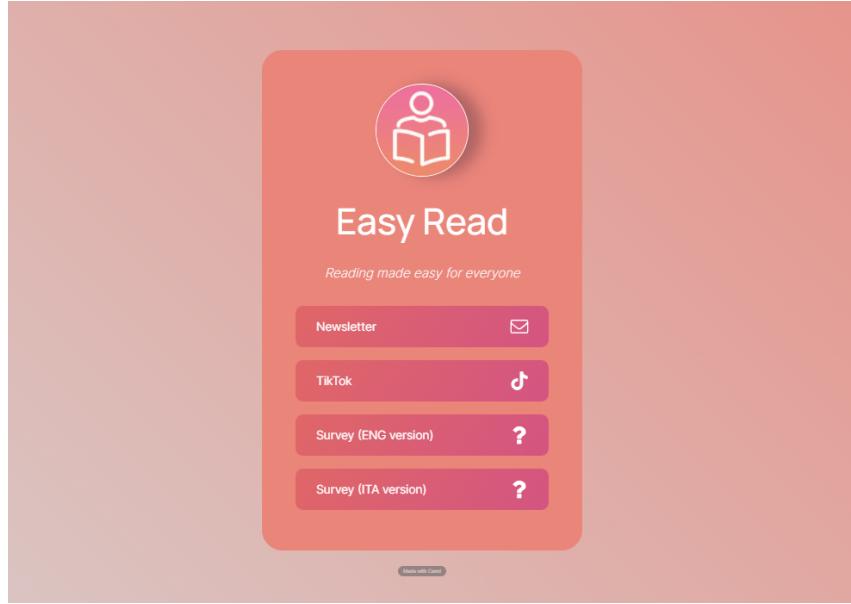


Figure 7: Landing page of our solution made with *carrd.co* (<https://readyeasy.carrd.co/>)

5.2 Results

5.2.1 Fake door: survey

The solution found gave different insights both on the criticities of the application and on possible ways to improve it furthermore.

After one week of tests, it can be stated that the fake survey gave the best results: it spread fast (over 100 answers to the survey after 6 hours) and it gave lots of appreciative and enthusiastic comments because the application was found useful as it was presented. As shown in table 9, most answers came from the Italian survey, maybe because the survey was spread also through *Unione Italiana dei Ciechi e degli Ipovedenti Onlus* where maybe it elicited the interest of that particular community. The Italian survey, on average, has gathered more positive opinions about the app, while the English version - although they contained the same questions - gathered some more sceptical answers.

An interesting part of the survey, that gave different insights on what may be implemented during the later phases, was about the main problems while reading, that have been identified in natural light and device brightness, screen type, font size and in the colour of the reading application background.

One of the main concerns about the app during the prototyping phase was the part related to the authorization to use the internal camera only with the purpose of using the *facial expression* feature (Figure 8). Surprisingly, the majority of the Italian respondents agreed with the usage of the camera, but only for the proper functioning of the app. Those that didn't agree, also specified why they didn't agree: mainly, as postulated at the beginning, they fear that their personal and sensitive data will be used or sold to other bigger companies. Also, there's one person that would feel embarrassed by having the face recorded by an application, so this is another problem that must be taken into account. In the English survey, there's instead a perfect split between criticism about this camera feature (that brought people to answer *no*) and affirmative answers.

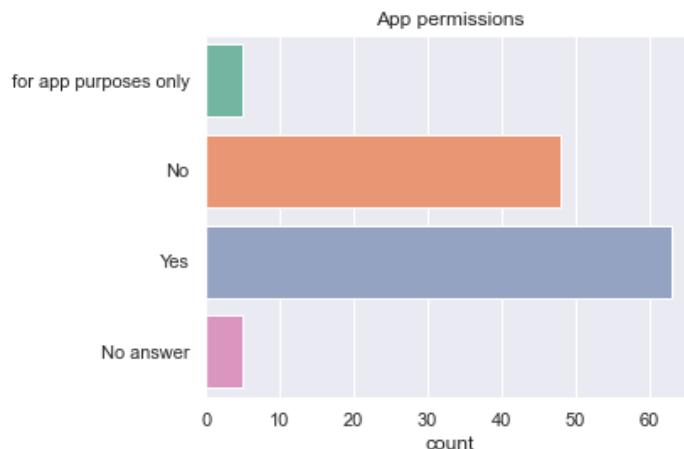


Figure 8: Users' willingness to give permissions to the app according to the survey

The next step was to aggregate the answers coming from the two surveys, in order to

obtain some insights and estimation about the possible disabilities and/or impairments and to check the interest regarding the application. In figure 9, is displayed that only a small part of the sample has visual impairments, but there is still the majority of them having wide spread visual difficulties such as myopia, presbyopia etc.

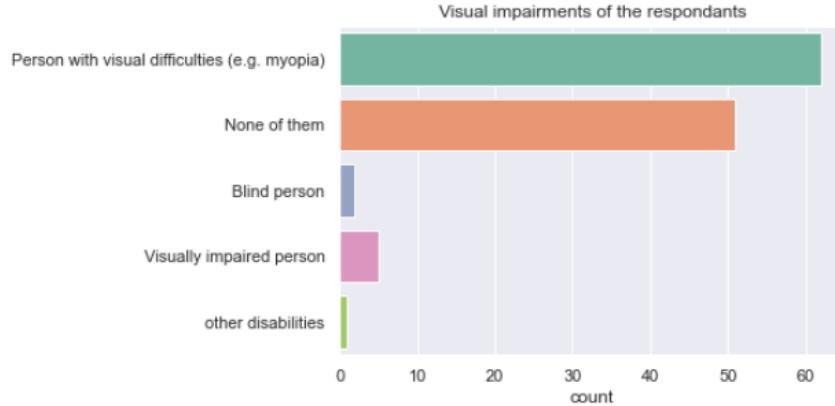


Figure 9: Users' disabilities or visual impairment according to the survey

As it shown in figure 10 and in particular in table 9, the app seems to have caught mainly the attention of the Italian participants: on a total of 121 answers, only 10 international participants are very interested in the app, while other 8 people manifested a low and mild interest in the app.

Language	Total answers	Low interest	Medium interest	High interest	No answers
Italian	101	7	17	72	5
English	20	4	4	10	2

Table 9: Final answers to the survey

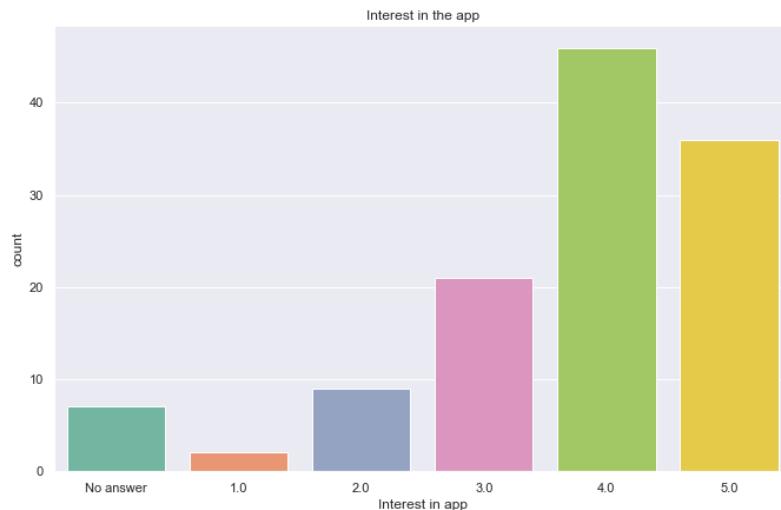


Figure 10: Users' interest in Easy Read according to the survey

5.2.2 TikTok

The TikTok-based approach, which gave life to two different videos, wasn't very successful: the first video received 534 views and two likes, while the second one received 318 views and 5 likes. The main criticism of this method is that it is very difficult to find a baseline through which to validate these results, due to the wide range of the factors that influence the success of content on social media and on the social media itself, because it's difficult to get an overview of the number of views of small accounts.

It can be affirmed, though, that TikTok may be used for spreading the newly created product, with an *ad hoc* campaign combined with other social networks like Instagram and LinkedIn.

Therefore, it can be, qualitatively speaking, said that those are good results for a newly created account, although they still need to be validated.

6 Final discussion

In this report it was discussed the design process of a brand new application in the field of education, starting from the identification of the target users up to the definition of its features and fast testing through prototyping.

The first part was composed by a process of exploration and the discovery of possible users, that has made use of several frameworks, quantitative whenever possible, in order to identify the specific set of users interested in use the final product.

Here, after an assessment part, strictly conducted using official datasets and authoritative reports, it was finally decided to consider exclusively on people with disabilities. Since there is a wide range of disabilities, each type with specific and different needs from the others, it was arbitrarily decided to focus the attention only on people with visual impairments.

Then, the next step was to think about a possible solution to help people with visual impairments, so that they didn't feel discriminated. In order to do so, two card-based frameworks were used: the *AI meets Design toolkit* and the *AI & Ethics* deck of cards. The first method was useful to identify the data science techniques (namely, NLP and Facial Expression Recognition) used in the proposed solution, while the second one was used to exploit possible ethic problems, that may stem from the usage of the data science techniques. It was here decided to design an application for tablet and mobile phones able to automatically detect moments of difficulty of the user while reading. The difficulty acts as a trigger for the application, that automatically enlarge the text and/or changes the background color according to the specific needs of the user.

Finally, after the design process, the very last step was to transform this volatile idea into a prototype, a faster, low-cost and simpler prototype. It was decided to apply a prototyping method called *fake door* and to use it by pretending that the product was an existing one and was going to be released soon. In this phase were created a feedback survey and two TikTok videos, in order to collect opinions and check the interest of people.

While the survey went very well in terms of number of answers, for the TikTok video was not very convincing, mainly for problems of the social media itself, because it's difficult to get noticed with a new account with no followers. Though, the increasing number of likes in the second video, may be considered as a small, positive result.

The use of the survey was useful also to focus on the problem of privacy, that would be a drag for many to use the EasyRead app. In addition to this, it was useful because it gave additional informations about the most common problems while reading, that may be addressed in the further steps of design. There were also appreciative comments as answers to the survey, so it may be considered an overall good result.

In conclusion, it can be said that this solution encountered the interest of people, but it should be explored and re-elaborated even more using other prototyping methods.

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Appendix 1

Here, in this appendix, will be presented some infographic that were not included in the main report.

In the first place, there are some hypothetic infographic about the *personas* identified in the report, in which are exposed their possible *needs* and *goals*.



Figure 11: Hypothetic infographic about Patrizia

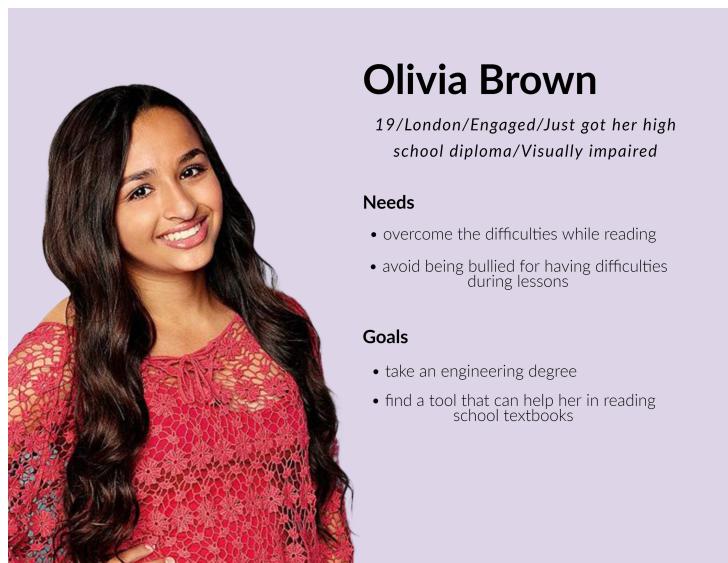


Figure 12: Hypothetic infographic about Olivia



Figure 13: Hypothetic infographic about Thomas