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The revolution of education in Industry 4.0
From past to future: 2022. A sudden breakthrough

Relatori: Candidata:

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Acknowledgements:

On Thursday March 10, I passed my last exam of the masters – which also stands for the last exam of many many years of education. 21 to be exact.

The feeling that followed was something that would not repeat twice in a lifetime.

A feeling of accomplishment, success, pride, mixed with joy and relief.

~

I dedicate this work entirely to my mother and my father who have worked so hard and who were so implied during my years of higher education, day in and day out.

It has not been easy, I am sorry, but here is our success that makes up for all of it. All the merit goes to you for putting me in the position I am in today. My reason for fighting for this diploma and not giving up even during the frustration of failure during the pandemic was you.

Mom, Dad, I hope I made you proud. This degree is my way of saying thank you for everything.

My sisters, who motivate me every day to do better and be better, I hope I set an example for you. I hope you are proud of me. A special thanks to Sabine who helped me revise for what I used to call "nightmares". Without you, I do not know how I would have understood so many things! You do make miracles happen (in 48 hours) Mimo, thanks for the sandwiches and the smiles that go with it! Your simple presence helps me in ways you cannot imagine. A warm environment makes anything feel amazing. I have a word for both you: when things get hard, remember how special you were both chosen to be. This is your strength.

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A last word to myself. I am proud of you for finishing what you started. I know the end was not easy. I know that sometimes you felt alone in your battles. However, here you are, at the other side of the mission now. Remember the feeling of finishing a life-long goal, the masters. How proudly accomplished you feel. How unique of a feeling it is.

For my future self, if you feel in doubt, remember who you are. You are capable of doing impossible things. Only you, know that. Trust in yourself and trust in God, because it is with his help that you can accomplish the logically impossible.

If your mind can see it, you can do it. If their minds do not see it, it's for a reason.

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List of acronyms:

(AI) Artificial Intelligence

(I.4.0) Industry 4.0

(Ed.4.0, E.4.0) Education 4.0

(VR) Virtual reality

(ICT) Information and communication technology

(PBL) (PBA) Project-based learning

Project-based assessment

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Introduction

Wuhan, China, 2019.

Three words that will forever be engraved in our memories. A big breakthrough has hit the world and has set off a pandemic as never seen before. Society as we know has been completely disrupted and transformed.

Coronavirus, covid-19, CoV are one of the few names given to this virus. The World Health Organization categorizes it as an infectious virus that mostly causes gastrointestinal and respiratory tract infections. Death counts were so elevated, and contagion rates were so out of control that the world, whole countries, full economies had to stop all activity for a while, to be able to absorb and reflect on solutions.

One of the sectors which was most affected was the education sector. Millions and more than a billion children's education was at risk. Many institutions had suspending activity, waiting for governments to give out clearance for future dispositions. Yet governments were not in the measure to give out such unknown information, especially at the beginning of events.

Slowly, matters started to find a sense of balance, and things started falling back into place. Some educational instances started opening up again and then had to close. This made them transition from regular teaching methods to new ones. Thanks to technology, they were able to adapt and offer a temporary solution to their students, thus enabling them continuity in their studies.

This analysis has been thought out in a manner that tries to englobe history from the educational point of view as well as the pandemic point. The goal is to be able to compare the current situation of both variables (education and pandemics), in order to deeply understand the subject, to deliver the best adapted solution. This is why a special focus is out on understanding rather than proposing directly.

After having understood the history of education from its root phases, and the same for pandemics, we will try to identify the three problematics that any proposed solution should be able to tackle. (Crisis situations, inequalities, fourth

revolution) the last part focuses on innovative solutions and examples of their applications. This work enables a lot of future research to develop the best solutions and applicable developments. It enables a method of fully understanding a complex subject to find simple, effective and problem-solving centered solutions,

"We cannot solve our problems with the same level

Of thinking that created them."

-Albert Einstein

Chapter 1: A history of education: since the ancient civilization

1.1 The genesis of education

Education has emerged - as to be seen further below – as a tool of transmission and formation, but was very restricted to certain groups of individuals and presented exclusively. Restricted historically as by gender, background, social status (royalty and rich families), social role (physicists, scientists, religious figures etc.), as well as political ones.

This approach helps us identify one of the problematics that education should be able to respond to.

1.1.1 Examples in the Middle-East

2061-2-1 BC (Marie Parsons). In the Middle=East, emanate schools. Schools that will teach young boys, sons of traders or royalty, the job of scribes. Thus enabling them the quality of reading, writing, as well as the professional aspect of the job. It is to be reminded that scribes roles include the copying of all of the records of the pharaoh's administration. It existed before the Chinese invention of printing which took place in 206-220 BC under the Han dynasty. Indeed, it was at the time, one of the highest functions in society.

Chronologically speaking, in the Roman Palestine, the Torah highlighted the importance of ones education with the relevance of reading, writing and the teaching of the Torah in itself overall. It is to be mentioned that the girls did not attend the schools, but were required to know the fundamentals and be educated.

Regarding the first forms of education, as we know it, it is the Muslims had already spread their civilization from China through Spain who built the University of "al Qurawiyin" in 857-859 in Morocco. (Al Hassani, 2011)

Though in 622, which is the first year of the Islamic calendar, were born the first schools in the Prophet's city Medina. It was as a result of how the Quran encourages Muslims to be educated, as the first word revealed was the word "Iqraa" in Arabic which means read. (imperative form)

[1] Marie Parsons, "Education in Ancient Egypt", Tour Egypt

[2] Al Hassani, 2011 « 1001 inventions: Muslim heritage in our world" foundation for science, technology and civilization Ltd

Schooling was done in mosques. They had buildings close to mosques but separated. In Baghdad, later on, the first separated school was built. It was tuition-free and children would start school from the age of six.

1.1.2 Ancient Greece and Rome (500-400 BC)

In the ancient Greek and Roman empires, education existed, all though illiteracy levels were of 98 per cent. (Ancient literacy, Harvard university press, 1989)Different forms of education existed. Parents had the choice of sending their children to school since a young age, to matters they chose to be relevant. It was mainly physical abilities, arts, literacy, music, poetry, sculptures and other forms of education that were provided by anyone who had the means to open a school.

Curriculums were individual to the schools, and parents would insert their children into educational schemes up to the age of fourteen or to what they could afford. Their education would last for up to 7 years.

This was the case in all the city-states of Greece, for the exception of Sparta.

As one could guess, in Sparta, as their peers would be assimilating other courses of lively education, such as art or poetry, Spartan kids would be learning the art of war. Hierarchy, physical abilities and moral values were the main direction of their studies. They would spend their times in military dormitories, kept away from their parents.

1.2 The past centuries. From 1600 to the 21st century.

1.2.1 In China and the Soviet Union

Chinese and Soviets have a common ideology when it comes to education. In the 1950's, the communist parties in power redesigned primary education curriculums in order to serve the productivity of the economy chain; whereby Soviets we already in a crescent path into boosting their countries economical metrics. Education would improve the economy. Therefore, both countries put a lot of effort into education systems.

It was part of Vladimir Lenin's aims. It was then enlarged during the "five-year plan" Stalin had introduced.

In relation, the case of Japan can be yet another example to illustrate literacy objectives of governments.

During the 1600's, Japan entered an era of complete isolation under the Tokuguwa Regime that turned very beneficial to them, as to the spreading of education nationwide. Indeed, just like a number of other civilizations and cultures, school buildings were in fact the temples of the cities.

[3] (Ancient literacy, Harvard university press, 1989, p.328)

The Iwakura mission during the reforms of Meiji has had a major role in the studying of major European education systems, and thus the implementation of a European model of childhood in Japan.

1.2.2 Examples in the European continent

1.2.2.1 France

The most prominent name in the development of French education as it is known today is 1880's Jules Ferry. Minister of public instruction at the time, he was known as the anti-clerical man. He installed the model of the "republican school" during his years of function. It was based on the 'laique' concept which separates the church from the school and follows the principle of secularism from the French constitution (Article 1: French Constitution)

The abolition of the Catholic Church in schools came with the law obliging boys and girls, under the age of fifteen, to attend school. They would also be free.

French colonists also had access to many of the resources necessary for the implementation of school systems in their colonies. Indeed, they had access to cheap and trained administrative assistance. Teachers, physical resources, buildings and state support. Curriculums and principles were transferred and installed, mirrored from the mainland. The French language was the only language of instruction used by educators. This was specifically successful in the North of the continent where the catholic immigrants from motherland had installed themselves.

A policy from 1946 instructed to "bring the best students to Paris for advanced training". (Louisa Rice, "Between Empire and nation: francophone West-African students and decolonization". Atlantic studies 10.1, 2013, p. 131)

1.2.2.2 England and the Common Wealth

The three R's (reading, writing and arithmetic) were started being taught during the early nineteenth century free of charge. This term implies the basic competencies taught in schools since then. It is to be mentioned that up to the 20th century, education was delivered through church schools.

While in India, after the Islamic ruling, education was already quite widespread for boys. Boys would be taught the basic three R's as well as Law, Astrology, ethics, religion, metaphysics and medical science. All which have been dismissed by the British Common wealth who replaced traditional provincial schools during the 19th and 20th century.

[5] (Louisa Rice, "Between Empire and nation: francophone West-African students and decolonization". Atlantic studies 10.1, 2013, p. 131)

In other countries of the Common wealth like New Zealand and Australia, was introduced for the first time, the term of compulsory education in 1870. However, it was very hardly applicable at the time.

Contrary to the French, the British did not perceive as much access to resources for their purposes. (McGreadie, Marion "The evolution in Australia" IFHAA Australian schools)

1.3 Analysis of global education in quantitative metrics

1.3.1 Past to modern evolution

✓ Literacy rates

In reference to our previous description of the history of education through times, we can bear in mind that back in the 19th century; adult literacy rates averaged a mere 12 per cent globally.

Then, the general tendency was a 5 per cent gain each 5 years, reaching today an opposite rate of illiteracy of 15 per cent, worldwide (OECD, "How was life? Global wellbeing since 1820.")

[6] (McGreadie, Marion "The evolution in Australia" IFHAA Australian schools)

[7] OECD, "How was life? Global wellbeing since 1820."

Adult literacy rate

The share of adults aged 15 and older who can both read and write.
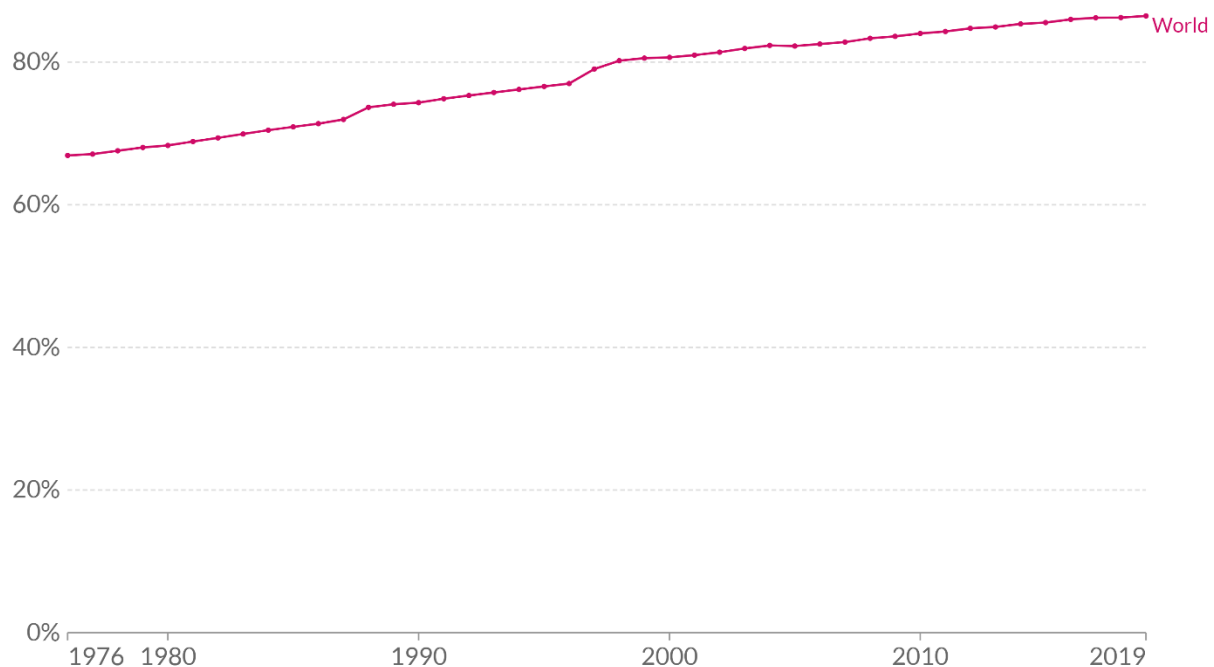
Source: UNESCO (via World Bank)   OurWorldInData.org/literacy • CC BY
Note: Under the UNESCO metric, someone who is literate can, with understanding, read and write a short, simple statement on their everyday life. However, definitions and criteria of literacy can vary by country. You can find further discussion on 'How is literacy measured?' in our post here: https://ourworldindata.org/how-is-literacy-measured

Figure 1: Global rates of adult's literacy in the past 50 years

A good increase in literacy rates can therefore be described. Nevertheless, if compared to gender based literacy levels, some differences can be noted in both sexes. These inequalities remains valid throughout the years. (See Table 1) In 2008, the worldly levels of Literate men were of 83.4 per cent, where women's rates varied by 78.9 per cent, falling ten points behind. When compared together, the evolution for females and males as referenced for the last 30 years by the UNESCO shows a noted evolution for both gender, but instead a 30 years gap between the rates of both (See Fig 2.1, 2.2)

According to Divyanshi Wadhwa (2019), "achieving gender parity in literacy is critical for women to effectively compete in the labor market and in turn help lift communities out of poverty." This statement is particularly true for Sub-Saharan females whose literacy rates compared to those of the males fell short 15 points. (see Table 1, Fig 2)

Table 1. Adult literacy rate by MDG region, 2008

MDG region	Adult literacy rate (%)				Number of adults unable to read and write (000s)			
	Total	Male	Female	GPI	Total	Male	Female	% F
Developed regions	99.0	99.2	98.9	1.00	8,358	3,438	4,921	58.9
Commonwealth of Independent States (CIS)	99.5	99.7	99.4	1.00	1,061	311	750	70.7
Northern Africa	67.3	76.7	58.1	0.76	36,290	12,882	23,408	64.5
Sub-Saharan Africa	62.5	71.6	53.6	0.75	175,871	65,748	110,123	62.6
Latin America and the Caribbean	91.0	91.9	90.3	0.98	36,056	15,945	20,111	55.8
Eastern Asia	93.8	96.8	90.7	0.94	70,233	18,656	51,577	73.4
Southern Asia	61.9	73.2	50.9	0.70	412,432	150,668	261,764	63.5
South-Eastern Asia	91.9	94.5	89.5	0.95	32,782	11,097	21,685	66.1
Western Asia	84.5	91.5	76.9	0.84	21,332	6,061	15,271	71.6
Oceania	66.4	70.2	62.6	0.89	1,750	783	967	55.3
World	83.4	88.2	78.9	0.90	796,165	285,588	510,577	64.1

Source: UNESCO Institute for Statistics, Data Centre, stats.uis.unesco.org

World literacy rates have not very much varied since 2011 to 2019 and have remained at an average 83 per cent global rate. (See Fig 2)

These are linked to the wellbeing of the states colored, their economic level, historical background (crisis, wars, old colonies, presence of terrorism etc.) this issue will be tackled more in detail in the next chapter, in the section where the problem we are aiming to relief and the solutions we propose, are exposed.

Literacy rate by country, 2011

Literacy rate for the entire population, 2011 or latest data from CIA Factbook.

No data 20% 30% 40% 50% 60% 70% 80% 85% 90% 95% 100%
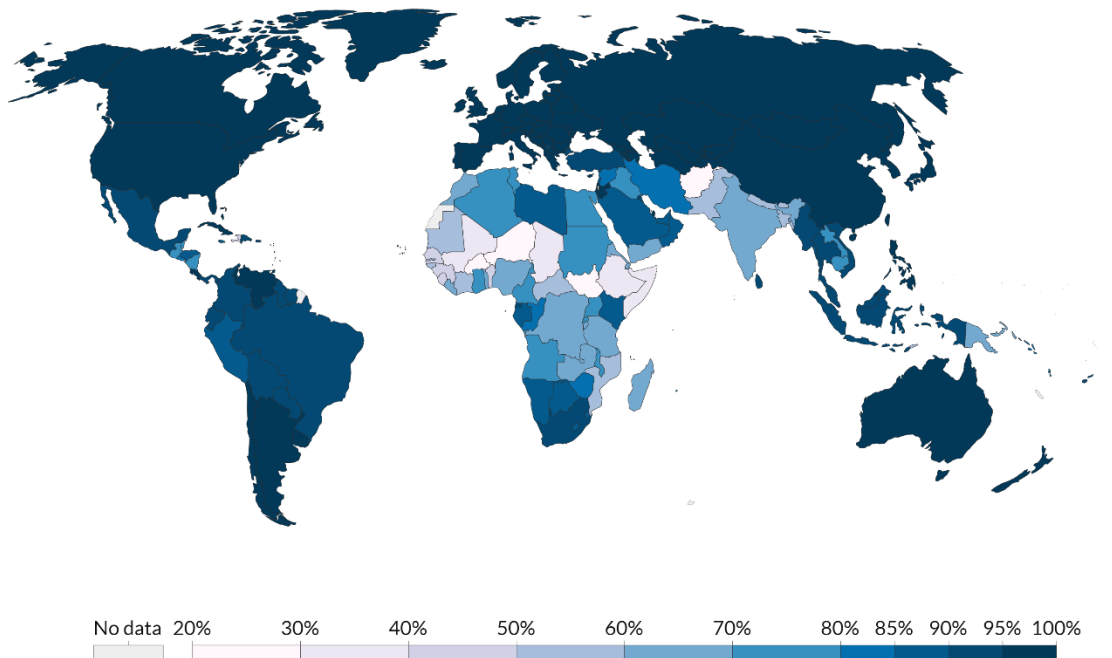
Source: CIA Factbook (2016)

OurWorldInData.org/global-rise-of-education • CC BY

Figure 2: literacy rates by country/region (2011)

Youth literacy rate, female, 1985 to 2014

Number of females age 15 to 24 years who can both read and write with understanding a short simple statement on their everyday life, divided by the female population in that age group. Generally, 'literacy' also encompasses 'numeracy', the ability to make simple arithmetic calculations.

Source: UNESCO   CC BY

Youth literacy rate, male, 1985 to 2014

Number of males age 15 to 24 years who can both read and write with understanding a short simple statement on their everyday life, divided by the male population in that age group. Generally, 'literacy' also encompasses 'numeracy', the ability to make simple arithmetic calculations.

Source: UNESCO   CC BY

Figure 3.1 female literacy rates for the past 3 decades
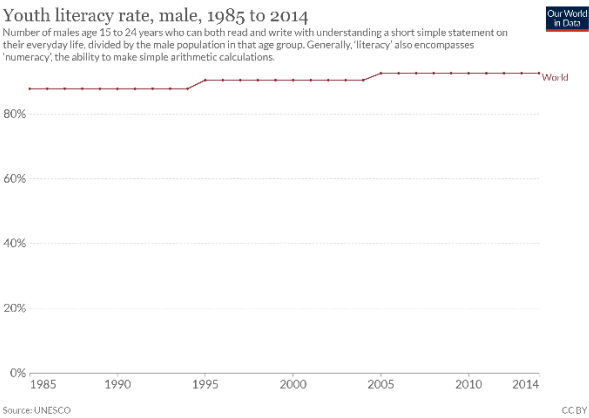
Figure 3.2 male literacy rates for the past 3 decades

1.3.2 Quantitative metrics useful in regards to the Covid-19 pandemic

1.3.2.1 Before pandemic

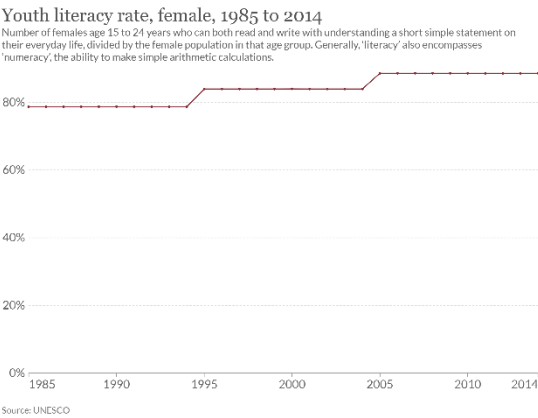It is by now clear the relevance of all aspects in the emergence of any global phenomenon. For instance, political regimes play a huge role in the direction of the emergency. Again as mentioned before, some observations can be made in regards to the average years of schooling since the Greek and Roman empires to the Chinese or the Soviet Union. For instance, the maximum years of schooling recorded worldwide in 1970 were those of the United-States (10 years), and it also coincided with the highest grade of the Fully-Autocratic to fully-Democratic scale. In India however, which is also considered a very highly democratic country, years of schooling are instead very low. (2-3 years)

This observation allows us to better understand the dynamic of the pandemics and how they link to the global regimes that govern the world.
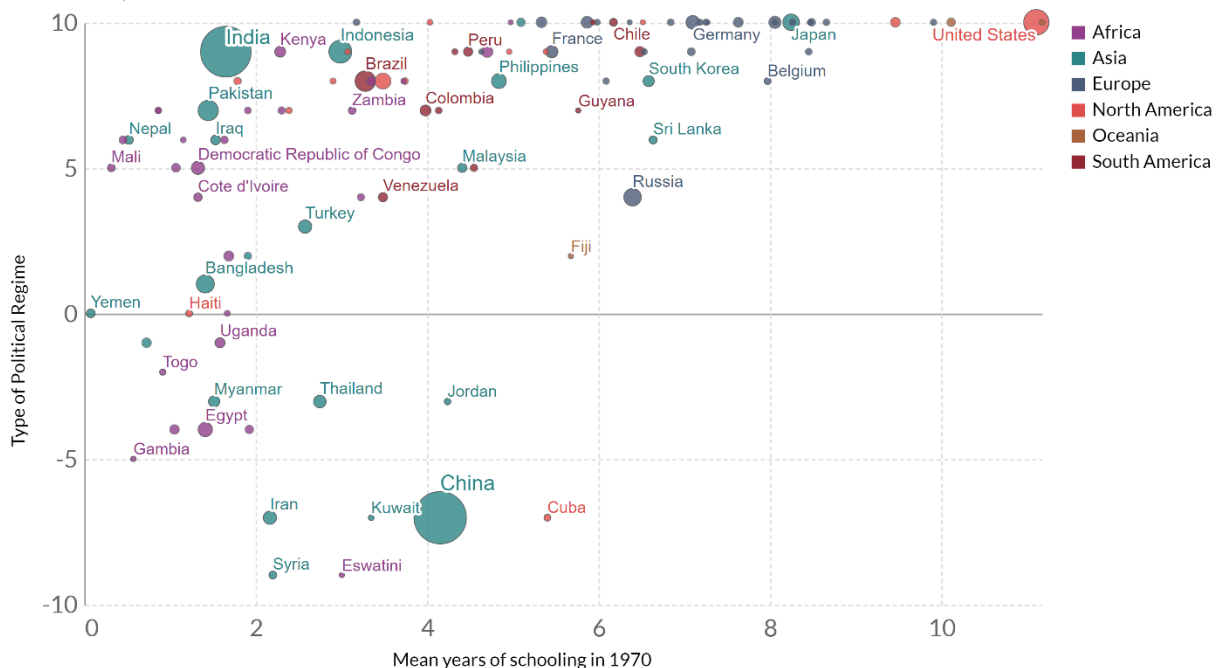
Figure 4: comparison of mean schooling years to political regime

Next, the completion rate of lower secondary levels are taken into account to further narrow down the metrics necessary for the monitoring of innovative solutions.

Before the pandemic, from 1986 to 2019, a marked growth is expected, as education was taking up more and more importance in the lives of families, rural-urban migration was also on a rise and the market requirements were tending to a progressively more demanding work force. (See Fig. 5)

Nowadays, the study of the market requirements, the new style of education that the world will follow post pandemic, will affect the new completion rate of higher and longer education models.

Completion rate of lower secondary education, 1986 to 2019

This is the ratio between the number of new entrants in the last grade of lower secondary education, regardless of age, and the total population of the theoretical entrance age to the last grade of lower secondary.
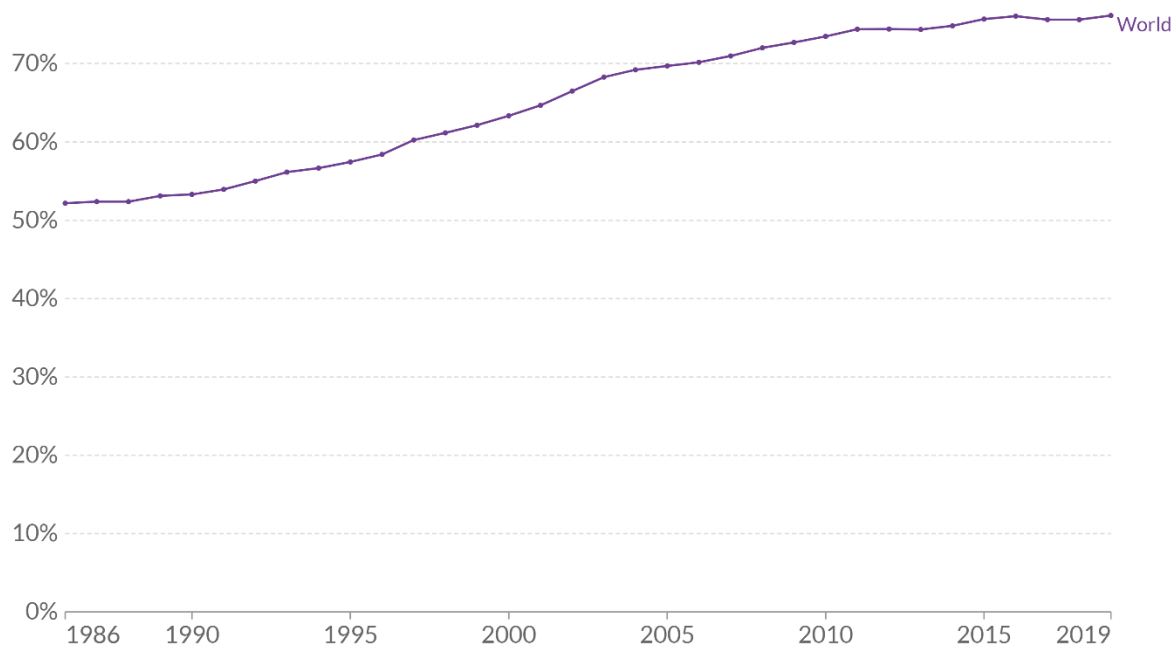
Source: UNESCO (via World Bank)   OurWorldInData.org/primary-and-secondary-education • CC BY
Note: The ratio can exceed 100 percent due to over-aged and under-aged children who enter lower secondary school late/early and/or repeat grades.

Figure 5: Completion rates for lower secondary

At the opposite side of the table, drop-out rates create a disturbance in the logic, as most countries shows a declining progress of the rates in the last 40 years, whereas other countries such as Ethiopia show a big spike of them. (Fig. 6)

This can be explained by the rising inequalities gap digging their way into our modern world.

Cumulative drop-out rate to the last grade of lower secondary general education, 1971 to 2013
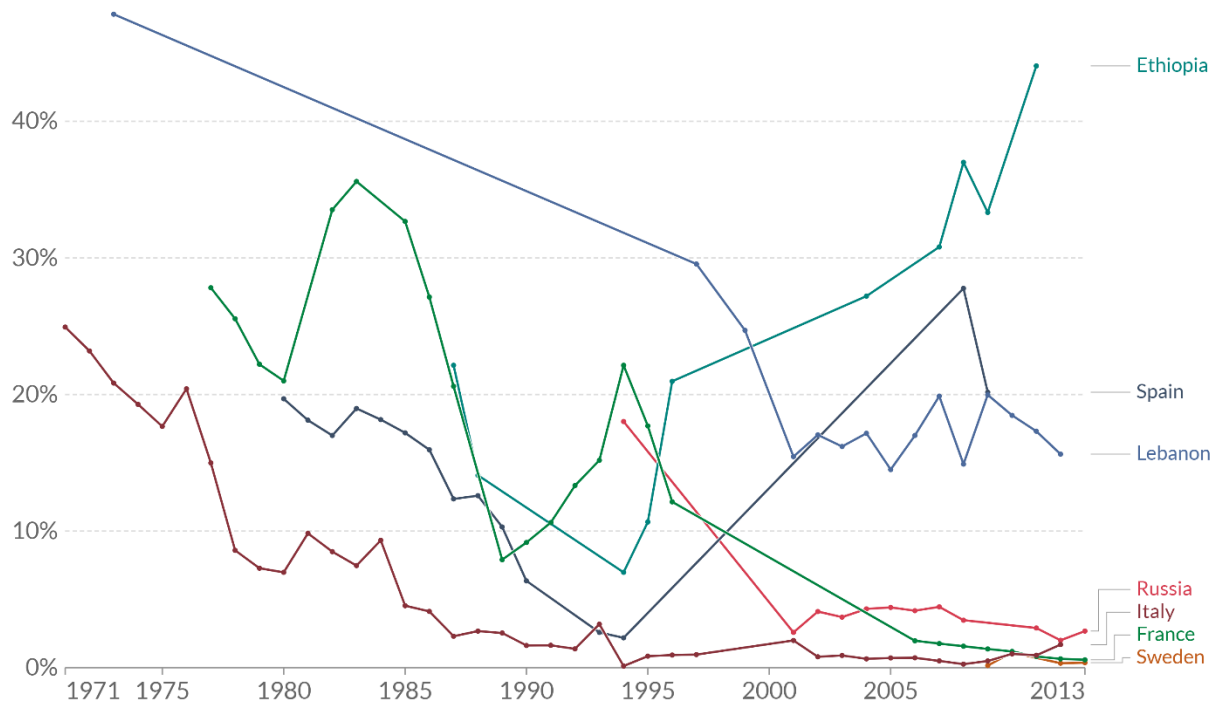
Figure 6: Dropout rates for lower secondary

Only 3 years ago, before the pandemic, numerous problematics were threatening the relevance of educational systems all over the world. As seen higher, rising dropout rates in some countries, the shortening of schooling years in other, the disparities between gender accesses to education are some of the most relevant ones.

The obsolescence of the programs, of the methods taught, and principles used have been in the center of debates for over a decade.

1.3.2.2 during pandemic

With the closing of businesses, small and medium enterprises, non-necessities stores, many households suffered from the economic situation, which was causing them to have lower incomes.

Children of modest families were the ones most affected by the sanitary crisis in regards to their access to internet stable connectivity, appropriate space for online interaction (study space, numerous families etc.) and compatible material support (laptops by kids/household)

Many children, but more specifically those coming from modest or low-income families missed school days which can be reported in the below figure.

On average, high-income groups reported 3 times more attendance rates (or non-missing rates) than low to middle-income families. It is to be noted that on average 47 days of school were missed during the period of July to October in 2020.

Average days of instruction missed, by income group
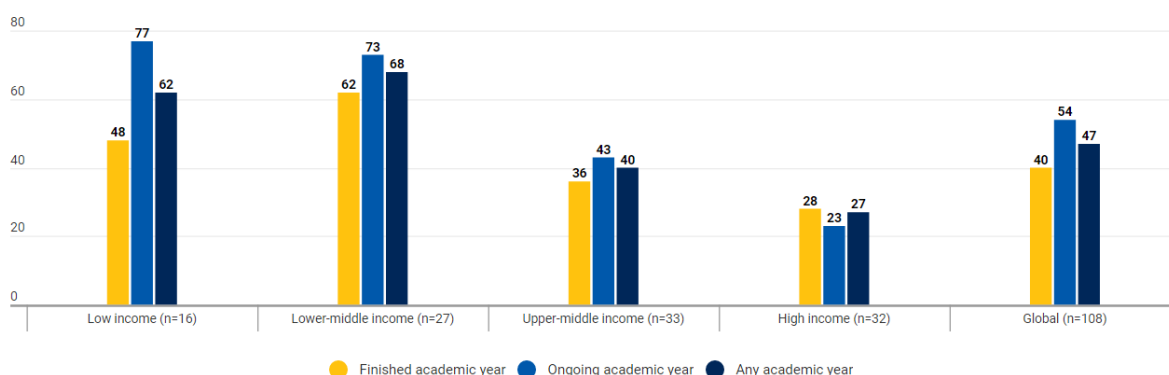
Notes: Respondents answered the surveys during the period July – October. While there is a possibility that durations of school closure could be correlated to when the survey was filled out, there is no clear pattern in the data that would indicate a bias in either direction in the numbers reported here. Caution is advised in generalizing the results represented in the figure as the countries that responded to this question cover less than 50 per cent of the total 4-17 year old population.

Source: UNESCO, UNICEF and the World Bank (2020). Survey on National Education Responses to COVID-19 School Closures, round 2. Paris, New York, Washington D.C.: UNESCO, UNICEF, World Bank.

Figure 7: Days of instruction missed my income group

To remedy some of those income related problems, different remote learning tools were set by institutions in order to offer the most access and comply to solve the suspension of studies for prolonged period of time.

They ranged from take-home packages, whereby teachers would have prepared beforehand a series of educational content to be taken and used at home by students.

In lower middle-income household and the lowest, television broadcasting was a major tool of diffusion. In morocco, the governments used this channel to reach to all high school senior students who were set to pass state exams. The radio as one may guess was used in the p1 income households.

Online platform allowed most high-income groups to continue their education, while missing out the minimum amount of days of instruction. Online platforms allowed for a relatively rapid response in most cases. (Consider UNICEF Annex 1 for detailed list of countries response)

Online platforms and TV were the most used remote learning methods, offered in 90 per cent and 87 per cent of countries, respectively

Provision of remote learning modalities, by income group
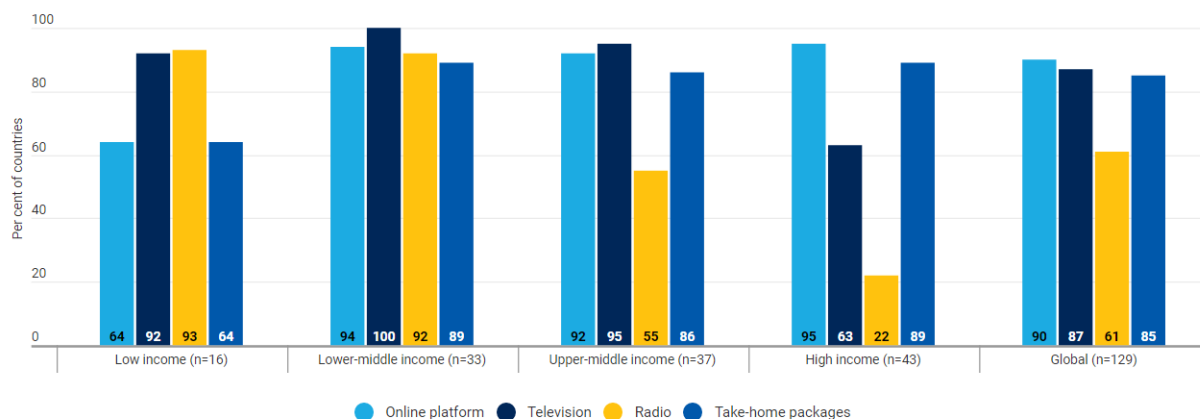
Notes: Countries were not asked directly about remote learning modalities. Responses to the question on the effectiveness of remote learning (which included: very effective, fairly effective, not effective, we don't have such systems) were used to develop a proxy indicator.

Source: UNESCO, UNICEF and the World Bank (2020). Survey on National Education Responses to COVID-19 School Closures, round 2. Paris, New York, Washington D.C.: UNESCO, UNICEF, World Bank.

Figure 8: various remote learning tools used by different income groups

Narrowing it down to online platforms and online learning, governments and institutions who wished to expand their connectivity levels provided free internet access in some cases, increased access to electronic and connected devices by subsidizing them or helping families get their hands on them easily.

This allowed a big shake down and leveling of household's connectivity and access.

Mobile phones played a big role in the success of this objective. Nevertheless, some groups (30 per cent of low revenue families) did not benefit any measures taken and were sometimes left out marginalized from any form of digital integration. (See Fig. 9)

2 in 3 high- and upper-middle-income countries provided subsidized or free Internet access, while this was less common in low- and lower-middle-income countries

Actions taken to improve connectivity, by income group
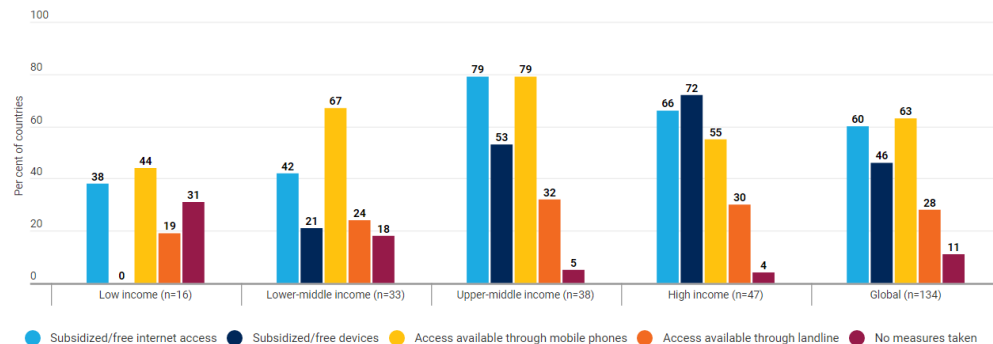
Source: UNESCO, UNICEF and the World Bank (2020). Survey on National Education Responses to COVID-19 School Closures, round 2. Paris, New York, Washington D.C.: UNESCO, UNICEF, World Bank.

Figure 9: actions to improve connectivity by income group

As school start to reopen, many are envisaging to mix up their back to school teaching methods. At least the half of them will continue to deliver classes fully in-person, while the other half estimates that it will consider the combination of distance and in-person learning as methods of instruction delivery.

Nb: The figure below is not fully representative of reality, as the representation levels of the population do not exceed 50 per cent in this graph.

Globally, more than half of countries report combining distance and in-person education as they reopen schools

Teaching and learning approaches as schools reopen, by income group
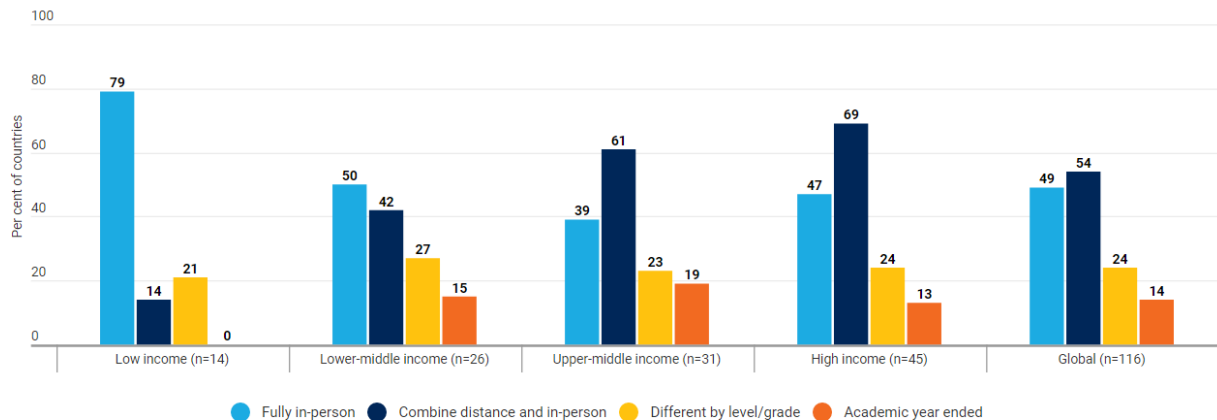
Note: Caution is advised in generalizing the results represented in the figure as the countries that responded to this question cover less than 50 per cent of the total 4-17 year old population.

Source: UNESCO, UNICEF and the World Bank (2020). Survey on National Education Responses to COVID-19 School Closures, round 2. Paris, New York, Washington D.C.: UNESCO, UNICEF, World Bank.

Figure 10: blended learning at school reopening

During the covd-19 pandemic, many unseen changes have been used and set-up as schools reopened gradually. The adaptation occurred very fast and relatively smoothly for certain groups, while others suffered from the deepening of the inequality gap, regarding their wealth levels, or digital involvement.

1.3.3 Qualitative approach: SWOT and PESTEL ANALYSIS

1.3.3.1 SWOT of tradition educational systems

Strength:

- ✓ Historical longevity of educational systems. Makes a strong-based institutions which is not fragile and adapt to period and evolvement.
- ✓ Mass engagement, involvement. Huge figures in the processes and in the industry as a Macro-entity.
- ✓ Availability and pre-existence of necessary tools, human capital, experience and past reference that effectively create a force to finding solutions

Weaknesses:

- ✖ Since it is so deeply rooted → obsolete principles/methods: it makes adequate creative modifications hard to think of and the process more complicated overall. But it is also a strength as mentioned above.
- ✖ High political and governmental reliance and funding
- ✖ Low collaboration levels between various institutions
- ✖ Shortage in instructors in subjects like compute science, finance. → recruiting abroad highly related to governmental immigration policies

Opportunities:

- ☑ The rising attractiveness of studying abroad
- ☑ Multi-disciplinary and international collaboration on multi-levels (multi-scales)
- ☑ Big margin for development
- ☑ Remote teaching

Threats:

- ☒ Businessification of knowledge, school and education on the rise. May lead to privatization of certain fields of study and slow down the objective of equal access to everybody
- ☒ Environments change too fast and our responses are not adapted to the rhythm of change
- ☒ The international context we live in being unstable means higher education suffers from instability too

1.3.3.2 PESTEL (Political-economical-social-technological-environmental-and legislative or legal)

A thorough PESTEL analysis can be key in the comprehension of many of the factors and variables that can influence a particular industry. It is also an optimal tool that enables the understanding of chronological evolution. This is possibly done when comparing an analysis of a referent time to that of today, almost in the form of a benchmarking.

Moreover, it can be used in the comparison of different situations and solutions. (As a primary simulation accessory).

Political

Political context could be of a big influence on the educational aspect, whereby laws governing schools can derive from governmental origin. (Such as school opening hours, number of schooling hours, curriculums, years of schooling-classes) (According to UNESCO "what you might need to know about the right to education (2020))

A 155 countries around the world, guarantee 9 or more years of compulsory education , while only 99 countries guarantee at least 12 years of free education" (M. Rahman, 2021)

National wages levels also play an important role in the teaching function. They affect the quality of education delivered, job satisfaction, instructors mental and physical wellbeing. National requirements for the job of teaching make the population more or less likely to choose this career path. For instance, primary and secondary school teachers in Italy are required a university qualification

Moreover, the status of national immigration policies often affect the diversity of the specialization of the country.

Economical

National households' wages also fall down the economical umbrella. They affect kid's pathways into education, enabling to access the schools of their choice, or more often than not, doesn't.

Wages also affect the expenses of everyday school expenses such as commuting, cost of transport, school supplies.

Higher education can be more or less attractive to locals, as well as to foreigners in the scope of international mobility agreements with other countries or international universities.

In countries like the United Kingdom or the United States, loans and education are extremely highly correlated. Because of the elevated costs of studying in those countries, many students opted for "student's loans", giving them a penalty at the kick-start of their professional careers.

The pursuit of higher education in the population is also negatively impacted by the unemployment rates in the country.

Social

The social factor is one of the most interesting to analyze in the scope of the analysis of educational systems.

[8] According to UNESCO, "what you might need to know about the right to education (2020)

[9] M. Rahman, 2021

Social background plays a major role in the choice of parents and students. Whether it be the choice of private vs public, quality of studies, degree recognition, teacher mental health and wellbeing, work/home balance, number of students by classroom, safety of the working environments and premises, possibility of studying abroad, existence of scholarship etc. (Simpson, *et al*, 2015)

A big number of institutions worldwide do not offer appropriate infrastructures or even proper educational support such as for students in difficulty, learning difficulty or students with disabilities.

The privatizing of many schools and higher education institutions has created the tendency for parents to send their children to very costly establishments, sometimes, even beyond of their financial capacities. The rapid emergence of these private institutions has created inadequate conditions for the delivery of high quality education.

Technology

In regards to the core of our thematic, this is most inevitably the most crucial factor.

Technology has always been relevant in educational systems contrary to popular and recent belief. For instance, we like to cite the popular use of projection technologies, as well as the existence of online school platforms for facilitated communication and information exchange between the three concerned parties: parents-teachers-students.

However, it is accurate that the access to study material was solely reserved o higher education students and was an unreliable mean.

On one hand, technology offers facilitation. However, on the other, the harm and impairments that it can cause is predominant in today's society, and should always be taken into account, considering the great impacts in it causing.

Technological risks, like the exposure to sensitive or disturbing content, diseases that are technology-related/caused, and other mental health threats such as cyberbullying, can be a big issue.

Environment

In the general run of events nowadays, the environmental aspect should always be studied and taken into account.

The problematic is more often than not, the amount of pollution caused by analyzed institutions.

[10] Simpson, *et al*, 2015

Schools, universities and similar establishments generate a huge amount of consumption of paper, photocopies ink, which are not the most eco-friendly materials that exist. Many alternatives can be taken into account, to reduce the amount of waste produced. Alternatively, counter-measures can be deployed, to increase one's positive impact on the environment.

Legally, many regulations have emerged in the more stable institutions, regarding recycling, and other applicable environmental measures.

The introduction of this environment-aimed aspect could also mean the building of a more eco-friendly ecosystem by providing the means to build sustainable infrastructure, since the design phase/process.

Legal

The legal factor play the majority of its role, in the recruiting and teaching criteria.

Regulations by the ministries and governments in traditional teaching (on the rules followed by educational institutions) influence the methods and means of delivery of educative content.

1.3.3.3 Conclusions from qualitative analysis

Concerning traditional and educational models, many aspects remain of interest for the next step of this study. They concern the implementation of online, remote schooling.

For instance, the internal analysis, allows us to establish state of the matter facts, whereby we can have a sense of the deep rooting of curriculums, and the obsolescence of many aspects such as innovative (or at least updated), tools for learning and teaching. Knowledge assessment tools remain to be upgraded too.

External observations, in return, highlight an immense margin to change and development and put in evidence the main factors that influence this change. Whether it be the economic and political situation of the country or even of the world if we are talking of a bigger scale, social tendencies, status of innovation levels.

It is therefore crucial to take into account all existing past data, what we know about the present situation and future predictions, to plan out and envisage a secure and correct direction to take, in the reform of an entire system, at a global scale.

Chapter 2: The three criticalities making education revolution integration, a necessity

2.1 The future is full of unpredictable surprises

2.1.1 Sanitary crisis, health emergencies and pandemics

The past decades and even history in itself, have showed us at many occasions, how out of humans hands situations really are. Whether it be wars, drought (caused famines), economic crisis (poverty), tsunamis-earthquakes-natural disasters (infrastructure destruction, population movement, displacement). All of these unpredictable and shaky events have something in common. They have disrupted our daily lives every time they occurred, and have reshaped how the future looks ahead for us.

Pandemic have existed, and will still continue to exist. They could first be recalled to the plague of Athens (429-426 BC) ("Plague of Athens: another medical mystery solved at the university of Maryland", University of Maryland archives – medical center, 2015-12-04).

Across the planet, hundreds of epidemics continued to emerge, with sometimes local spreads, other times nation wide spreads, and sometimes worldwide. They have ranged from Plagues to smallpox, fevers, cholera, influenzas, malaria, the flu and other form of infections and contaminations. (See Annex 2) Surprisingly enough, the measures local governments always took in current history, all resonate with the ones in vigor today. Quarantine, distancing, isolation, surveillance, disinfection, fumigation. (See photograph 1)

[11] "Plague of Athens: another medical mystery solved at the university of Maryland", University of Maryland archives – medical center, 2015-12-04

Photograph 1. disinfecting clothing. France-Italy
border during the cholera epidemic of 1865-1866.

The first plague hospital (*lazaretto*) was introduced in Venice in 1423 after the first measures of quarantine were set in place in 1377 ("the beginnings of maritime quarantine" Honoré champion, 1997, p 39-60). The plague being a disease propagated by the maritime industry, and medicine being at the time ineffective with it, quarantine, from Italian "quaranta" (meaning 40), was the only way to protect the population from the spread and control the disease. A sanitary cordon accomplished through the repressive police forces, menaced lawbreakers under the threat of death penalty.

Surveillance networks of Mediterranean consuls merged. They would surveil the big ports of the Mediterranean Sea. (Cipolla CM. Fighting the plague in the seventeenth century Italy. Madison, University of Wisconsin press, 1981)

[12] "The beginnings of maritime quarantine" Honoré champion, 1997, p 39-60

[13] Cipolla CM. Fighting the plague in the seventeenth century Italy. Madison, University of Wisconsin press, 1981

During the same period, the outbreak of smallpox in certain territories had appeared. That is when the first measures of inoculation to protect against the disease appeared, but were too controversial to be applied. Inoculation is the means of introducing voluntarily or accidentally, a foreign microorganism, to an unusual environment, there for creating change in this same environment. (Artificially inducing immunity against various infectious diseases)

Even during the times of the cholera, the strategy finally adopted was the same as the one for the past outbreak. However, social context had changed since the French revolution (5th of may 1789), which cause a mass awakening of citizens to their rights and their freedom. Quarantine measures and compulsory vaccination were both the methods contested by the citizens. ("Epidemics and revolutions: cholera in the nineteenth century Europe. Evan RJ, 1988, p 123-146). Social and political tensions increased as police interventions were becoming more and more repressive.

Another method used during that time, was the updated monitoring through the sanitary cordon, which, based on maritime separation of the sick, would allow the containment of the disease on islands. Only Sardinia, who had escaped the cholera, had this maritime sanitary cordon separating it since the beginning of the pandemic.

This helped us to expose to the reader and show him, the extent to which ideas reached, and how they relate to todays adopted strategies.

The influenza, during the years of 1918-1919, would mark an implementation of various virus-containment measures such as closing of schools, churches, etc.

Schools were shutting down at the mere suspicion of an infection case. These decisions were not

For example, public gatherings were postponed such as the Youth international games of Paris. In Italy, were infection rates were high, confessions, and funeral ceremonies were canceled. always well received. ("epidemic of influenza, Rome: Minister of Interior, 1918, "head office of public health", Central State archives, folder 178)

The role of the media as we know it today (influencing publics opinion) started growing at this time as well. The media was criticized for creating great anxiety. That is why, "the largest and most influential newspaper in Italy, "Corriere della sera", was forced by civil authorities to stop reporting the number of deaths which were of 150-180 deaths per day." (www.ncbi.nln.nih.gov/pmc/articles/PMC3559034/)

In the beginnings of the twenty first century, some of us may remember both influenzas that struck. The birds and the swine's flu, known as H1N2 and H1N1). We can also remember at this period, schools closing for several months, the emergence of technology in our lives via school systems who adopted them to keep education uninterrupted.

They would also use this tool to communicate governmental directives to children and parents.

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[14] "Epidemics and revolutions: cholera in the nineteenth century Europe. Evan RJ, 1988, p 123-146

[15] www.ncbi.nln.nih.gov/pmc/articles/PMC3559034/

 The duration of a pandemic is usually an unknown at the time of events, this creating this need, to deploy long to medium term measures. This also catalyzes the reshaping of our post-pandemic future world.

With globalization, the speed with which almost anything spreads is multiplied. Other than the biggest catalyzer for spread (globalization), climate change and the speed at which it is developing, indicates a new energizer for infection spread.

Viruses and epidemics are expected to remain on the rise, with the increase of human activity and their hanging effect on our global environments.

2.1.2 Natural disasters

Climate natural disasters cause each day, 202 Million US$ losses according to a report from the WMO (World meteoroidal organization).

In the past 50 years only, they have caused 3.64 Trillion US$ and over 2 million in death count (WMO Atlas o mortality and economic losses from weather, climate and water extremes 1970-2019, WMO-no. 126, 2021)

The most economically damaging are storms (521 billion US$). Second place are floods (115 billion). Hurricane Harvey by itself costed a record 96.9 billion in 2017, followed by hurricane Maria (69.4 billion US$) and hurricane Irma (58.2 billion US$) all in the same year.

Thanks to progress in technology, the number of unfortunate deaths, vividly decreased by x3.

Technology has allowed responsible authorities to track preliminary signs of a disaster, effectively communicate to populations, and correctly report the hazards.

Even though we can humbly state that more than ever, we are safer from climate disasters, we are not shielded from them, as they are becoming more and more frequent. Their effect on children's education varies in different arrays, in regards to the nature of the disaster itself. For instance, floods, storms and droughts do not manifest in the same way as frosts, hailstorms or wildfires.

Educational resources, infrastructures, are bound to be destructed or affected, directly or indirectly. Students, teachers, are more often than not, left with disruptive PTSD's due to death, displacement, loss, shock, etc.

General infrastructure and daily life habitats, more widely speaking, are completely thrown into disorder. All the consequences are far fetched from human control, but, rapid response and preparedness, can help alternate the effects. Whether they be immediate effects, or long term effects. Rapid response indeed derives from preparedness. From taking into account the school

[16] WMO Atlas o mortality and economic losses from weather, climate and water extremes 1970-2019, WMO-no. 126, 2021

structure to be able to withstand disasters, to insuring continuity of instruction on days-off, teachers and students should be ready for sudden changes of plans.

Thanks to past data, expert boards should be able to collaborate with schools and educational institutions in order to assess emergency procedures.

In Minnesota, in Farmington public school, teachers have found new and unique approaches to keep their students engaged during the big snow days. "physical-education teachers for example, instruct students to shovel neighborhood driveways on snow days while monitoring their heart rate, and art instructors teach children to take selfies as part photography classes." (Modam,2019)

Let's note that one of the conditions for considering a remote approach successful, is the fact that parents don't need to become third-party instructors, or part of the classrooms. Children learn how to manage their time in more autonomous environment than at school.

- **The case of floods in Bangladesh**

In certain communities in Bangladesh, the risk of flood is very elevated. During the Corona pandemic, floods have not ceased, and added up with the on-going crisis situation. This meant that for the first time, the search for a definitive solution needed to be closed.

"Alternative methods for lesson delivery", as brilliantly expressed by the University of Disaster Management and vulnerability. Teachers and students had to adapt to untraditional teaching methods. The new lessons included more: "assignment based assessments, distance education recorded classes" (Farid, 2021). A common practice in Bangladesh, which is indeed a particularity of the country is volunteering teacher, university (educated) students and staff, who contribute immensely to the national disaster efforts.

That is why; offering them compensation for their effort can play a major role in the effective return of students to normality. Going back to school brings back a sense of normality to those children. Given the fact of the overwhelming of situations like these on local governments, this strategy could constitutes one the bases of the remedy to consequent disasters.

Thanks to the above contemplations, we can consider that **the cost of keeping schools and institutions closed, are our children and youth.**

[17] Modam, 2019 ← www.k12dive.com/new/563226/

2.2 Yes, in 2022, social inequalities still exist!

Speaking to the past generations, one might think that the future would be set in terms of "lessons learned from human mistakes" and that the society would be adapted to acknowledge differences between individuals and treat all humans equally. Difference include gender, looks, ethnicity, health conditions, social status. Yet it is not the case yet. Unfortunately, systems are very far from accomplishing these goals, which by the way relates to the fundamentals and basics rights of human being according to UNESCO.

Looking for solutions in order to be able to offer more accessibility to education in difficult times, of disaster and pandemics, we should incorporate the problematic of inequalities, if we are being strategic.

Although, the three, (pandemics/disaster and social inequalities) do not fall under the same umbrella, their solutions do.

2.2.1 Social background inequalities and gender based

As seen in previous points (See 1.1.1) education being selective has been described for scribes in Ancient Egypt for example, children of the clergy or of political genitor.

In more recent time, such as the 1800's black communities were segregated, and children of the communities were denied access to schools. In the French and European colonies, education was used to "strip people of their cultural heritage and relegate them to a future of menial labor." (Hughes, 2021)

We can clearly establish that education system present inequalities, and those have resurfaced during the Covid situation. Many agree on the fact, access to education remains a privilege today, and still resonate with ancient times in some aspects.

Is it estimated that roughly, 130 million girls should be at school, but are not. About 32 million of them in primary schools, and 97 million in high school. (UNESCO, 2022)

Even though a number of betterments have been made from the past, the numbers speak for themselves.

These numbers should be related to primary/high school enrollment rates VS primary/high school completion rates. As the first seems to bring a sense of equality, the reality is that very few enrolled girls for the studied population complete the cycle. (Low income)

[18] Hughes, 2021

The main factors explaining girl's unequal access to education are poverty, gender bias, sexual assaults and with an increase in girl's violence and abuse. The lack of caregivers at home and disruption that emerged in them, created this tendency to not complete studies and to drop out.
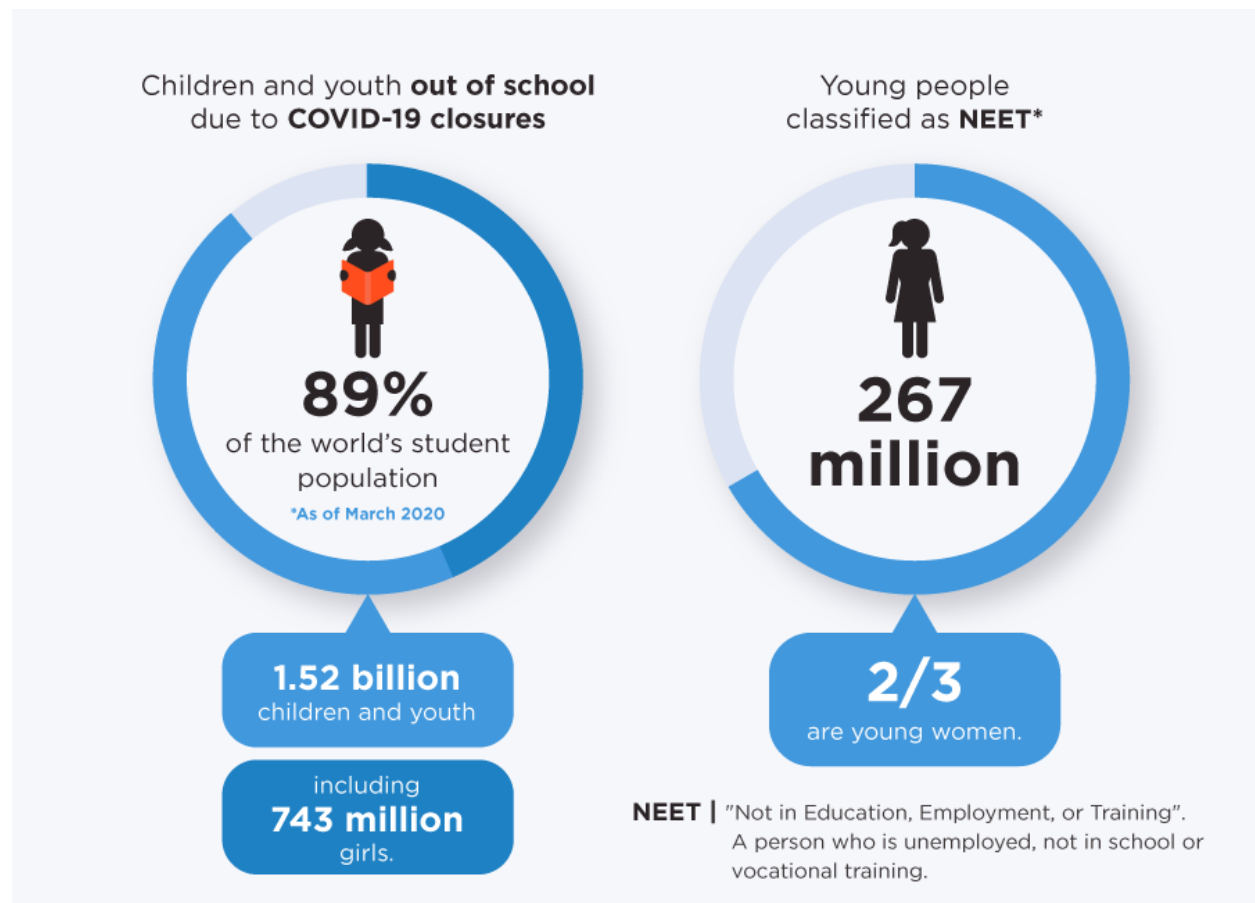

Figure 11 effect of Covid-19 on women population

2.2.2 Home-schooling, disabled population, special needs, professional sports: different perspectives, same approach

This title enlists a sample of reasons, where human-tailored design comes to interest.

The new approach will help us achieve levels pf education personalization never attained before. Thanks to the resources we own, we are able to start tailoring many independent curriculums and pedagogies for individual cases. Each one, opening up a vast world for discovery and improvement.

Let us take the example of the case of professional sports. In the United States, student-athlete models clearly exist and have been established since over a century. But when teachers and coaches need to assist their student or their athlete, they operate is separate ways making the student not feel fully integrated academically with other students in class. This is why; old models should be reframed into joining both entities into one general aspect, which can be defined but the general meaning of an educator. These educators will therefore have a more vast understanding of their students. That is how tailor-made can be a part of these kids educations and meet their needs.

Other marginalized groups of students include one with disabilities ranging from physical impairments/reduced mobility, to vision/hearing or cognitive/learning disabilities. They can restrain them from accessing a continuous education, and following properly. R=that is why, a solution with innovative technology can help teachers communicate with students, whether it be to home directly or to hospitals. Special agreements and programs can be arranged between hospital institutions and educational instances via the different ministries of health and education. Children who often have to miss many school days or have continuous periods off studies can benefit from a such project.

Last but not least, we can set an illustration, by citing as an example, cases like home-schooling. Whole adapted programs and unique pedagogic systems can be tailored.

Another special need case are students with learning disorders, who have known a rise in their number since the emergence of internet. Most common ones on the rise are:

- ◆ Dyslexia: which affects language-based tasks
- ◆ ADD or ADHD: essentially related to attention and distraction
- ◆ Dyscalculia: which affects the learning of mathematical concepts and numerical concepts (Lai, 2019)

Of course, a number of other learning disorders exist and may evolve in the future. This is why finding innovative solutions turns out to be very useful at this stage of revolution.

This short enumeration shows us the importance of "special cases" in the share they constitute in any sector of action in society. By creating an innovative system and integrating them in the early phases of design, we strategically tackle a more sustainable and more durable future for our world.

2.3 Industry 4.0: the perfect reason for the revolution of education

"The fourth industrial revolution; will take what we started in the third, with the adoption of computers and automation, and enhance it with smart and autonomous systems fueled by data and machine learning." (Marr, 2018) (www.forbes.com/sites/bernardmarr/2018/09/02/)

Manufacturing processes have therefore transformed since the introduction of computers in production. This transition is better known under the term "Industry 4.0".incresed connectivity of production chain and supply chain is highly observed in these environments.

Northern countries seem to be the most implied in this industrial uprising, although, developing countries could extremely benefit from it if they are being strategic enough, and willing to cease the opportunity.

2.3.1 Applications

The application of this revolution can vary among sectors.

To illustrate it, we can cite the case of the gold mine in Africa where the sensor technology was installed to monitor several variables. Personnel and operators succeeded to identify unusual levels of oxygen in the phase of gold cyanidation (which involves gold extraction by cyanide).

When taking into account this information, they were able to fix the problem and increased their total yield by 3.37 per cent. This simple modification allowed an annual gain of 22 million US$ to the company.

By this case, we were able to identify fields of gains for companies. This is what optimizing the process can do for businesses of diverse sectors.

Amongst the large scope of utilization opportunities that manufacturers can seek to adopt in their strategies, some of them include additive manufacturing, autonomous equipment and

machines, AI, connected and smart objects, IoT – internet of things, IoS – internet of systems, and computer clouds.

The main industries it operates in are predicted to be:

- mass production and manufacturing (food and beverage industry)
- commodities (agriculture, metals)
- precision exigent (pharmaceutical, electronics)

What this means, what the fourth industrial revolution means is that we have to re-think our businesses. To take them from the third industrial revolution model to 4.0. "Companies are expected to increase spending on Industry 4.0 solutions. Companies are tempted by promising efficiency gains and possibility to re-adjust business models and create new revenue streams." (https://www.euromonitor.com/industry-4.0-the-future-impact-of-the-fourth-industrial-revolution/report). We need to redefine the roles people can play in this new industry. The success of this measure will be depending on the joining actions of governments, technology providers and manufacturers.

2.3.2 The need for Education 4.0

As computers were created, typewriters disappeared. This is the case for old skilled jobs. They will disappear with the creation of new Industry 4.0 jobs.

Unemployment in some areas, confronted with shortage in data skilled workers, will create a disruption in the labor market. "It is not the lack of employees that will cause the problem, but the shortage of skills that new jobs demand" (www.restart-project.eu/industry-4-0-impact-education/). This will have an effect on making governments act on, in the sector of education to comply with the needs of the market. According to a UNESCO report on the future of global education, educational systems will be rethought to "encourage life-long learning in order to make human resources competitive, and succeed in the fourth industrial revolution." (April 2016) "Education 4.0 is a direct consequence of the emergence of industry 4.0."

Students will mainly be required to be able to develop in autonomous ways, and diversify the application of diverse set of skills. This will be achieved through cross-functional knowledge that

derives from problem-solving projects and critical thinking skills. These two areas englobe a set of new requirements to new students: imagination, creativity, creation, adaptability, flexibility, and plasticity.

To reach such highly innovative skills, teachers have to be pro-active with governmental instances and collaborate. It is said that students will have a role too in the elaboration of curriculums, with the partnership of their teachers.

All these models of inter-interactions mirror well the inter-connected world students will have to live and work in.

Instead of the education systems to be producing around the world traditional workers, it needs to start producing knowledgeable-workers. The future employees, employers, managers and leaders of tomorrow need to have the knowledge to drive business in I.4.0 business models. The project-driven education (4.0) supports this idea of thinking. In addition to theoretical knowledge, a set of skills are induced to them when starting their formation. A set of skills that inspires from time management, organizational skills, communicative, collaboration etc.

In conclusion, the need for education 4.0 clearly emerges from the fourth industrial revolution I.4.0. It complies with needs of numerous jobs of the future that rely on automation and technological innovation and thinking.

2.3.3 The limits to Education 4.0

1- E.4.0 is indeed very promising, but it is new. New means mistakes, means new learning curve as well. Therefore, we can state that without a doubt, mistakes will be made. The risk is that some minorities might suffer from it as a consequence, and the consequences are yet unknown. This is why precautious advancements have to made. The level of risk one is willing to usually accept in going to be reevaluated. Precautionary thinking will necessarily have to be included in all decision making aspects, when transitioning to generation 4.

Thanks to history and past data, we can start identifying functional patterns that are undermining present society and work with their regard.

2- Moreover, Ed. 4.0 needs physical capacities. This englobes physical tools and infrastructure, as well as personnel in order to deploy and operate fully.

This aspect can slow down some countries development as they do not have the necessities for building up, and create a bigger gap between them and the rest of the world.

Global funding programs surely exist and will continue to help, but their capacity is only limited and they can only help so much.

3- Ed. 4.0 needs competent facilitators, and educators. To guide the revolution and transition fully and correctly, competent facilitators are compulsory, but the reality is that they are rare, and we lack of them. In an optic to integrate the new era of learning, a number of them will slowly start to emerge from education facilities and institutes, thanks to adaptive formation.

Not only Ed. 4.0 will rely on this strategy to employ, but many other sectors will require their "facilitators" (as in, person who helps transition into 4.0) to be formed and educated

4- Dependability can cause a problem. This problem relates to responsibility owed from entities to society in and to the future. Here, lies an aspect of Ethicality, which should also be taken into consideration when option for a 4.0 deployment and transition.

5- There is not public record of any public discussion regarding the transition. Instead, it has been, and is still been done in underlying schemes (deployment -and now disappearance of 3G- of 3rd to 5th generation network: 3G-4G-5G)

In a world where transformation is set to happen and to change the daily lives of billions of people, discussion should be up and the population concerned.

Effective communication indeed, should be part of the fourth industrial revolution. That is why one must concede that it is necessary to start the transition with a public debate, exchange and discussion.

Chapter 3: illustration of improvement actions will be undertaken; focus on the most interesting ones (focus on higher education).

The evolution of the world can be followed through the industrial revolutions, at least for the world, as we know it today. We have seen education before and during those times. In the second decade of the 21^{rst} century, human kind is going through a new industrial revolution. It brings with it a lot of changes through all sectors. Our main focus will be on the educational sector, also named after the Industry 4.0; Education 4.0.

In this chapter we will focus on discussing the main practices of this new era. We will illustrate various tools that could be used in knowledge transmission, and in learning activities. We will also include illustrations of some assessment tools that hold an important part on educational system. We will go through another important component, which is the subject to change that is the curriculums followed by the institutions.

Finally, we will highlight the main limits in the applications of the various methods. The chosen methods are ones that respect human differences and that are conceived in an optic to integrate all the students.

3.1 : Innovative tools for content delivery and learning

Using the term content delivery seems more adequate than the traditional teaching approach. This is because in the traditional teaching approach, material instead of content was picked from limited resources: books, manuals, websites. In the new approach, content will be created, and the options will be infinite. The need for it to be created, emerges from the extraordinary content required in order to comply with the needs of the new emerging society. In addition, this new era of content will have the most diversified forms. We are talking in terms of audio, video, image content, interactive image, simulation, etc.…. Each of those materials, present significant advantages in the way they are used and with the public it is destined to.

3.1.1: Example 1: Experience – based leaning through VR

The first idea that comes to mind when using the term VR are video games.

Yet VR's (virtual reality) camps of application can extend as much as creativity and imagination do. Indeed, the term itself means that.

Virtual reality can be applied to any sector of activity really, but the dangers exist. They underlie in the precautions of functioning itself, whereby people, and kids particularly can be exposed to the risks of injuring themselves. That is specifically why we have chosen to use VR, in particular camps and for higher education students only.

Execution technique training

In fields like medicine, surgery, technical maintenance, mechanics, aeronautic, their use could elevate the level of experience of students.

In situation of medicine where lab mice or other animals' dissection are used for surgical operations, institution can step it up by adding a step to student's experiences. Thanks to VR, surgeon students can follow real surgeries with real surgeons, in real time, without the constraints of space or limitations.

Mechanical can apply the same principle, as they are operating on cars, machines, airplanes, etc.

Recorded procedures can be used to indulge the student in the art of the matter since early stages of his formation. This permits them to have hands-on experiences (with somebody's else hands) without the present risk of putting people's life in danger or so.

Graduating law students can break the fear of first public representations, by immersing themselves in mock trials and getting the used of their gradually.

If able to create safe-environments for kids, children can benefit from experience-based leaning.

Traditionally, reading or writing about something has been built on by imagining things and past events, and trying to understand. This, in comparison to seeing the stories and living them, are two completely different experiences.

As well as letting students have the experience of past events, creative activities can be made up to enhance the experience of teaching. One example is, when going over the student's professional career path, having the option to immerse them in the future choice can help determine the exactitude of their choices.

To achieve this, physical resources and capital are necessary; but VR offers many returns in its applications. By using VR, repetitive operations tend to be less wasteful and more cost – friendly. Particularly in the case of execution – training, where applicants waste rates are generally high.

Remote – leaning enhancing software

Immediately after the lockdown, schools and universities were all advised to find remote learning solutions to comply with pandemic and still offer education. In 2021, 75% of schools want to carry out online education operations, while 60% of higher universities would like to keep the momentum going (Burt 2021) (www.universitybusiness.com/nearly-60-percent/).

While the emergency of events obliged us to find quick solutions, the betterment of them has been non-stop since the beginnings. Institutions and universities were seen making unusual and unprecedented effort to keep up the educational system and not interrupt student leaning. One of the most used was the classical video conference tool that most of us were used to for daily use.

Many institutions had to face ups and downs of their system spending on IT, big involvements of the IT department, which allows students to keep leaning, and teachers on delivering.

Then new issues emerged from examination passing rules, procedures and technicalities. Again, multi-way collaboration needed to be done to resolve this task.

In the mean time, new tools were introduced to traditional classrooms, such as streaming equipment, new devices. In the period of 3 years, both delivering and receiving parties had to adapt to various modifications.

One part of it still has a lot of progress to make but offers immense potential. Video editing software. With the use of AI power, video editing can be done autonomously, rapidly and at a big scale use thanks to AI software's. Examples of utilization revolve mainly around Netflix-like options, which the public is very intuitive with. Automatic subtitling, subtitling in various languages, blank sections tracking (when nothing is happening for 10 or more seconds) video segmentation in chapters or themes live video editing for professors; student interactions options, student shout-out or award system; disturbance notifying unusual movement or sound tracking.

LMS -Learning management systems

This amelioration will bring out this deployed new tool to as new level of application. What we have been using in an exploratory manner during the years of the lockdowns will become the central tool towards which education revolves. From there will emanate all the necessary content and options, and to there will connect all the complementary tools and smart objects, in an IoT (Internet of Things) vision.

An array of types of tools that can be added (as ads on), to enhance remote-meaning or to personalize their remote experience. As mentioned above, tools for video conference enhancement.

[22] (Burt 2021) (www.universitybusiness.com/nearly-60-

Additionally, tools for classroom monitoring and class management, ones for collaborating. Another interesting one is a space for data sharing and remote access used by the students of engineering in laboratory application classes at the Politecnico di Torino. This tool uses already existing technology to give access to students, to their working spaces at their universities from home or anywhere on the planet. They can access their PC's initiate projects; use software's and share with their professors, as if they were at their desks at university. In non – lockdown days, thins non existing usage in the past could benefit sick students for instance, who are reestablishing at.

These two methods if correctly applied and explored to their fully extent, have the power to completely transform the idea of classrooms and their functioning. Even though a consequent investment remains necessary to obtain the tools, but the environmental impact (by no waste approach) and the cost saving on the long run is what makes it so important and interesting in the actual context.

3.2 Leaning/ knowledge assessment methods

Since the system is drifting from traditional to knowledgeable, it becomes more accurate to use the expression "knowledge assessment" instead of learning assessments.

As much as the tools of teaching plat an important role in classrooms, as much as those of assessing do too. Because if one is trying to integrate technological tools in this teaching it is most likely he will do in the assessing, which we will see below, but can AI, digital experimental leaning and program software replace human evaluation in high stakes tests?

Different skills acquired during their formation present themselves as follow:

- Problem solving

- Solution oriented

- Critical thinking

- Scratch designing

- Time management / organizational management

- Organizational abilities

Thanks to project – based assessment, teachers can evaluate students' self sufficiency in project-bases study models (sometimes also referred to as MAKER Education). These development and adoption of new content standards will allow teachers to evaluate the ability of students to build up by crossing his skills and interpret information.

PBA Examples (Trach, 2018) (schoology.cours/blog/how-students-benefit-projet-based-leaning)

1. *Design a society.*

Depending on areas of focus of the project, cross knowledge use can be enabled. High engagement with the students, whether they choose to develop a moon colony, a new school or a medieval monastery.

2. *Solve a local problem.*

This approach seems to be undoubtedly successful in solving local and proximity environmental problems as for example "young leaners can tackle a problem as simple as making the school library easier to use to kindergartners, while older leaners can work on an issue in the community ".

3. *Publish something.*

Challenge your creativity in choosing the appropriate activity for your students. Whether it be a monthly magazine, the local school's newsletter or a scientific review. All means are good to allow children to express their interests and engage on a deeper level with them

4. *Community based or nature based.*

Exchanging with the habitat where we live and connect with it bringing a heightened sense of rooting to the children in times of virtual ascensions.

5. Using technology.

PBL, based on technology such as documentary-series projects, YouTube channel, blogging / writing, online content making (drawing and designing tools).

When tailored correctly PBL and PBA allows for new creative expression and critical thinking.

[23] (Trach, 2018) (schoology.cours/blog/how-students-benefit-projet-based-leaning)

Performance assessment softwares

Performance assessment software, in relation with class management and evaluation tools, allows teachers, parents and students to identify strengths and weakness, to better adopt his or her education to their profile. With help of intuitive graphs, teachers can better comprehend their classes needs as well as have an insight on individual cases.

This tool also allows students to better understand their profile and where they should focus more. It constitutes an important function regarding the real motivation to perform and to genuine understanding of oneself. It helps build real understanding and can determine career paths and majors' choices. Each student falls in the category he chooses to work on, regarding his natural predispositions. Meaning more competent professionals in the future, with a real sense of belonging and understanding. Thins enables personalized leaning depending on students' capabilities. Intermediary software allows students to understand what they have a predisposition towards.

Evidently, whether it be in- class / on paper assessment, or online, PBA, these solutions present limits that's we will discuss further below.

PBA also allows for adaptive exams creation based on cross AI systems such as student performance and results.

3.3. Curriculums 4.0

In response to the global call for jobs of future and emergences of Ed4.0, the idea of curriculums 4.0 had naturally appeared.

It calls for the adoption and creation of new curricula's, to replace the old ones. These new curricula would be fit to teach the jobs of the future. They will be based on the main skills of the future. It will allow students and teachers to participate together and collaborate. Multi – level collaboration will emerge with governmental to be formalized at one stage.

Firstly, terms like "design thinking "are starting to surface. They could be introduced in learning processes and could help companies to attract individuals who are able to critically solve everyday problems by creative means. Higher education institutes or universities could collaborate with partner industries to train and achieve with one another.

This translates into solving real world problems instead of solely focusing on studying past problems; "Educational institutions will have to work more closely with industry, governments

and social organizations to develop a system of mutual interdependence "(Beekman.2021) ("iotmktg.com/curriculum-4-0-brings-sweepin-changes-to-education/).

In curriculums 4.0, not only the actual focus on concepts will change, but also and thankfully the long-criticized-by-some pedagogy. Since the whole perspective and orientation of education is changing, the traditional roles affected to students and teachers are also likely bound to change. This exciting new change comes from the fact that since "almost all course content will be available online, faculty will be more engaged in coaching and mentoring rather than lecturing".

[…] Curriculum 4.0 students will be expected to develop their imaginations as teachers lean how to facilitate the process of discovery. This change will shift the student's tale from simply being a passive listener in the classroom to an active creator of insights "(Beekman,2021)

With all this change in the integrality of the latter, the teaching-leaning tools, assessment methods and upgraded curricula's, limitation tend to appear.

3.4 Limits of the solutions proposed

All this technology accumulation, and this lack of interpersonal connections and engagements doesn't go unnoticed. They bring with them a lot of potential risk which should be carefully studied by field specialist and predictive experts.

Indeed, the use of technology, especially since a young and even a young age can cause development issues. They usually don't limit themselves to the physical aspect of things. They tend to start from physical development issues much as MSD (Musculoskeletal disorder disorders), small deformations, lack of strength, sight or auditory issues.

They could easily extend to lack of human interaction symptoms such as the growing phenomenon of social anxiety issues. General anxiety and the discouragement of students to go back to physical classrooms has been felt out in the past years, due to long periods of lockdown, and prolonged school closures.

Other lifestyle and technology-based disorders risk to arise like the attention deficit disorder which characterizes a short – attention -span generations.

Therefore, this study would like to conclude and to emphasize the critical importance of the newest innovation and probably one of the most important ones: risk assessment and precautions – measures development.

These two, if well developed and set in place at the right time, could save humanity for disastrous consequences of the fourth industrial revolution, led on by Industry 3.0 in a less contrasted manner than the last.

Conclusion

This period has taught us how to respond to change very quickly.

By understanding the macro evolution of different variables that englobe our core subject, and by setting the right problematics to solve and objectives, one can demonstrate an array of solutions that constitute a response.

Solutions are not static. They are in fact dynamic, with the ability to adapt and with the flexibility to respond to new challenging demands.

To respond to the forth industrial revolution requirements - automation and high skill requirements – the core of any society has to constitute the fundamental of evolution, and that is the educational system.

This is how education 4.0 emerged – to respond to a growing futuristic approach, jobs of the future, skillsets, competence, inter-capabilities, and growing technology.

Solutions proposed are yet exploratory and non-definitive. Here lies their biggest limit. Some social groups could be left out because of the rapidness of the transition. Precautionary systems and vision should be applied and should take into measure, the different limits of the generation 4.

Another important limit is that often this way of doing relies on access to outside data sets. What if data sets become centralized? All the world data been under the control of one entity is not the least dangerous thing in the world, and the idea of it could repel many parties.

The old, long contested traditional approach to education has suddenly been disrupted, bringing actually a positive impact to it. No one could predict how to fix the traditional and obsolete system, but a pandemic.

"Rien ne vaut une bonne guerre pour relancer l'économie et sauver les emplois ». Without been mistaken to encourage war, the famous French proverb translates into "Nothing beats a good war to revive the economy and save jobs" and allows us to make a metaphor with the educational system, whereby nothing could beat a pandemic to reform our obsolete educational systems.

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ANNEX 1: COUNTRIES IMPLEMENTING VARIOUS COVID-19 RESPONSES

(Source: UNICEF – COVID-19 education response survey)

Govt supported digital website/apps with content (No. of countries=86)	Other self-learning based digital learning apps/websites (No. of countries=38)	TV programmes (No. of countries=93)	Radio learning programmes (No. of countries=74)	Paper-based response with take-home packages (No. of countries=61)
Afghanistan	Botswana	Afghanistan	Afghanistan	Afghanistan
Albania	Bulgaria	Albania	Algeria	Argentina
Algeria	Burkina Faso	Algeria	Argentina	Bosnia and Herzegovina
Argentina	Cambodia	Argentina	Armenia	Botswana
Armenia	Cameroon	Armenia	Botswana	Brazil
Azerbaijan	Cook Islands	Azerbaijan	Brazil	Bulgaria
Bosnia and Herzegovina	Croatia	Bangladesh	Burkina Faso	Cameroon
Botswana	Djibouti	Bosnia and Herzegovina	Burundi	Colombia
Brazil	Egypt	Botswana	Cambodia	Congo
Bulgaria	Fiji	Brazil	Cameroon	Democratic Republic of the Congo
Burkina Faso	Ghana	Bulgaria	Central African Republic	Dominican Republic
Cambodia	Guatemala	Burkina Faso	Chad	El Salvador
Cameroon	Guinea	Cambodia	Colombia	Eritrea
Chad	India	Cameroon	Congo	Ethiopia
China	Indonesia	Chad	Côte d'Ivoire	Fiji
Colombia	Jamaica	China	Democratic Republic of the Congo	Gabon
Costa Rica	Jordan	Colombia	Djibouti	Georgia
Côte d'Ivoire	Kazakhstan	Congo	Dominican Republic	Guatemala
Croatia	Kiribati	Côte d'Ivoire	Ecuador	Guyana
Cuba	Malaysia	Croatia	El Salvador	Haiti
Democratic Republic of the Congo	Maldives	Cuba	Equatorial Guinea	Indonesia
Djibouti	Montenegro	Democratic Republic of the Congo	Eritrea	Jamaica
Dominican Republic	Morocco	Djibouti	Ethiopia	Jordan
Ecuador	Namibia	Dominican Republic	Fiji	Kazakhstan
Egypt	Nepal	Ecuador	Gabon	Kenya
El Salvador	Niger	Egypt	Gambia, The	Kiribati
Gabon	Nigeria	El Salvador	Ghana	Lebanon
Ghana	North Macedonia	Equatorial Guinea	Guatemala	Lesotho
Guatemala	Palestine	Ethiopia	Guinea	Liberia
Guyana	Panama	Fiji	Guinea-Bissau	Madagascar
Haiti	Philippines	Gabon	Guyana	Malawi
Honduras	Republic of Moldova	Gambia, The	Haiti	Maldives

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Govt supported digital website/apps with content (No. of countries=86)	Other self-learning based digital learning apps/websites (No. of countries=38)	TV programmes (No. of countries=93)	Radio learning programmes (No. of countries=74)	Paper-based response with take-home packages (No. of countries=61)
India	Samoa	Georgia	Indonesia	Mali
Indonesia	Senegal	Ghana	Iraq	Mauritania
Iraq	Suriname	Guatemala	Jamaica	Mexico
Jamaica	United Republic of Tanzania	Guinea	Kazakhstan	Micronesia (Federated States of)
Jordan	Vanuatu	Guinea-Bissau	Kenya	Morocco
Kazakhstan	Viet Nam	Guyana	Kiribati	Mozambique
Kenya		Haiti	Kosovo	Myanmar
Kiribati		Honduras	Lao People's Democratic Republic	Namibia
Kosovo		India	Lesotho	Nepal
Lao People's Democratic Republic		Indonesia	Liberia	Niger
Lebanon		Iran (Islamic Republic of)	Madagascar	Nigeria
Libya		Iraq	Malawi	Pakistan
Madagascar		Jamaica	Mali	Panama
Malawi		Jordan	Mauritania	Paraguay
Malaysia		Kazakhstan	Morocco	Senegal
Maldives		Kenya	Mozambique	Serbia
Mali		Kiribati	Myanmar	Sierra Leone
Mexico		Kosovo	Namibia	Solomon Islands
Montenegro		Lao People's Democratic Republic	Nepal	Somalia
Morocco		Lebanon	Niger	Sri Lanka
Mozambique		Lesotho	Nigeria	Syrian Arab Republic
Myanmar		Libya	Pakistan	Tajikistan
Namibia		Malaysia	Palestine	Timor-Leste
Nepal		Maldives	Panama	Tonga
Niger		Mali	Papua New Guinea	Tunisia
Nigeria		Mauritania	Paraguay	Vanuatu
North Macedonia		Montenegro	Peru	Viet Nam
Oman		Morocco	Republic of Moldova	Zambia
Pakistan		Mozambique	Rwanda	Zimbabwe
Palestine		Myanmar	Samoa	
Panama		Namibia	Senegal	
Paraguay		Nepal	Sierra Leone	
Peru		Niger	Somalia	

ANNEX two List of infections epidemics

Years	Pandemics	Pathogens	Vectors
541–543	Plague of Justinian	*Yersinia pestis*	Fleas associated to wild rodents
1347–1351	Black Death	*Yersinia pestis*	Fleas associated to wild rodents
1817–1824	First cholera pandemic	*Vibrio cholerae*	Contaminated water
1827–1835	Second cholera pandemic	*Vibrio cholerae*	Contaminated water
1839–1856	Third cholera pandemic	*Vibrio cholerae*	Contaminated water
1863–1875	Fourth cholera pandemic	*Vibrio cholerae*	Contaminated water
1881–1886	Fifth cholera pandemic	*Vibrio cholerae*	Contaminated water
1885–ongoing	Third plague	*Yersinia pestis*	Fleas associated to wild rodents
1889–1893	Russian flu	Influenza A/H3N8?	Avian?
1899–1923	Sixth cholera pandemic	*Vibrio cholerae*	Contaminated water
1918–1919	Spanish flu	Influenza A/H1N1	Avian
1957–1959	Asian flu	Influenza A/H2N2	Avian
1961-ongoing	Seventh cholera pandemic	*Vibrio cholerae*	Contaminated water
1968–1970	Hong Kong flu	Influenza A/H3N2	Avian
2002–2003	Severe acute respiratory syndrome (SARS)	SARS-CoV	Bats, palm civets
2009–2010	Swine flu	Influenza A/H1N1	Pigs
2015-ongoing	Middle East respiratory syndrome (MERS)	MERS-CoV	Bats, dromedary camels
2019-ongoing	COVID-19	SARS-CoV-2	Bats, pangolins?

CoV, coronavirus; COVID-19, coronavirus disease 2019.