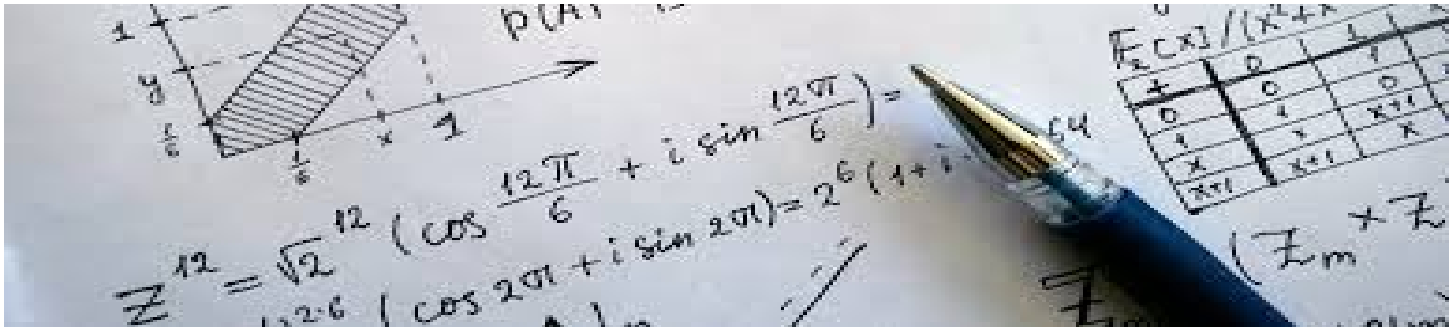

# Teaching mathematical models around the SDG

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Universidad de La Laguna

Co-funded by the European Union

***2nd Project Meeting***
*28 – 29 September, 2023*
*University of La Laguna*

Pythagoras
2021-1-RO01-KA220-HED-000032258

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2. **Our actions:**
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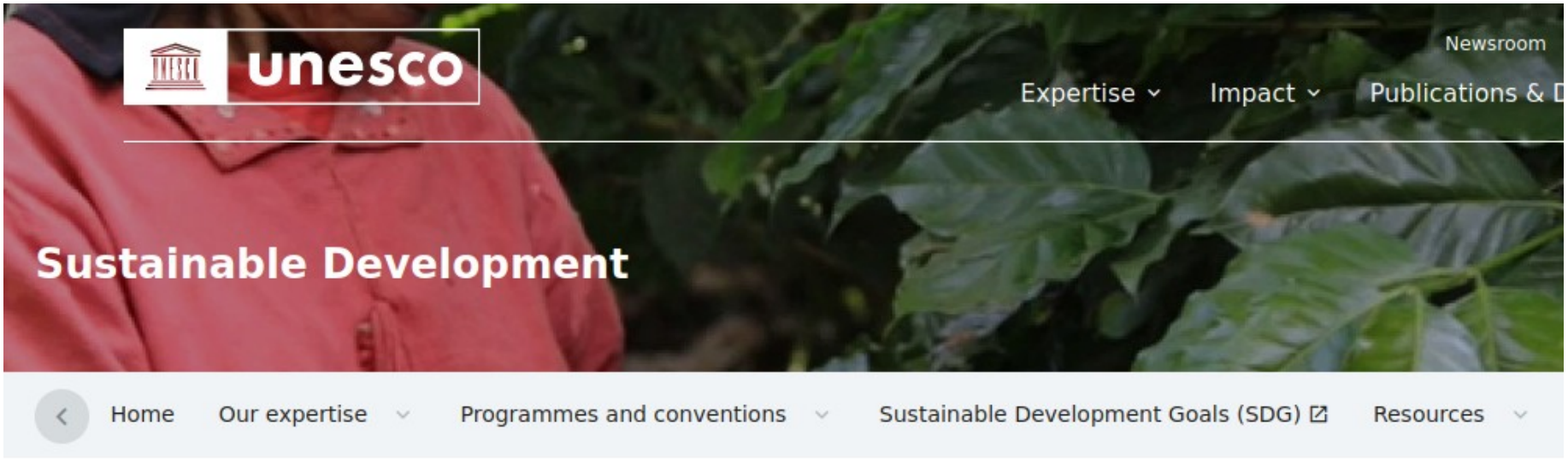
   b) Master's for future secondary school teachers: introduction on basics
   c) Degree in Mathematics: Three projects on the subject Modelisation (4rd course)
3. **Conclusions**

# 1. ESD Fundamentals




## Education for sustainable development

Education for sustainable development (ESD) is UNESCO's education sector response to the urgent and dramatic challenges the planet faces. The collective activities of human beings have altered the earth's ecosystems so that our very survival seems in danger because of changes more difficult to reverse every day. To contain global warming before it reaches catastrophic levels means addressing environmental, social and economic issues in a holistic way. UNESCO's ESD for 2030 education programme aims to bring about the personal and societal transformation that is necessary to change course.

Acting as a global advocate and aiming to strengthen capacities of governments to provide quality Climate Change Education (CCE), UNESCO produces and shares knowledge, provides policy guidance and technical support to its Member States and implements projects on the ground. UNESCO encourages innovative approaches and enhances non-formal education programmes through media, networking and partnerships.

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"Building peace in the minds of men and women"

IN BRIEF | WHAT WE DO | WHERE WE WORK | PARTNERS | JOIN US | RESOURCES

Home › Education for Sustainable Development › Education for sustainable development for 2030 toolbox

# Education for sustainable development for 2030 toolbox


## Priority Action Areas

Priority action area 1
Advancing policy

Priority action area 2
Transforming learning environments

Priority action area 3
Building capacities of educators

Priority action area 4
Empowering and mobilizing youth

Priority action area 5
Accelerating local level actions

United Nations Educational, Scientific and Cultural Organization

Sustainable Development Goals

2017

# Education for Sustainable Development Learning Objectives

United Nations Educational, Scientific and Cultural Organization

Organisation des Nations Unies pour l'éducation, la science et la culture

Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura

Организация Объединенных Наций по вопросам образования, науки и культуры

منظمة الأمم المتحدة للتربية والعلم والثقافة

联合国教育、科学及文化组织

**General Conference**
40th Session, Paris, 2019

2019

40 C/23
3 September 2019
Original: English

Item **5.9** of the provisional agenda

**FRAMEWORK FOR THE IMPLEMENTATION OF EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) BEYOND 2019**

**OUTLINE**

**Background:** In compliance with 204 EX/Decision 28 an 206 EX/Decision 6.II, the Director-General transmits to the Genera Conference at its 40th session the proposal for a draft framework, entitle Education for Sustainable Development: towards achieving the SDG (ESD for 2030), as a follow-up to the Global Action Programme o ether with comments by th

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Federal Ministry of Education and Research

sal for a new framework fc SD) beyond 2019 and th Board thereon.


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2022

MATHEMATICS FOR ACTION
Supporting Science-Based Decision-Making

United Nations Educational, Scientific and Cultural Organization


**Berlin Declaration on Education for Sustainable Development**

# The main challenge: new competences to develop

## Box 1.1. Key competencies for sustainability

**Systems thinking competency:** the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.

**Anticipatory competency:** the abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.

**Normative competency:** the abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.

**Strategic competency:** the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.

**Collaboration competency:** the abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.

**Critical thinking competency:** the ability to question norms, practices and opinions; to reflect on own one's values, perceptions and actions; and to take a position in the sustainability discourse.

**Self-awareness competency:** the ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.

**Integrated problem-solving competency:** the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the above-mentioned competences.

# 2. Our actions

## a) Degree in Environmental Sciences: first strategies for the introduction of EDS elements.

- Subject: Fundamentals of Mathematics (6 ECTS)
- Schedule: 1st semester – First course
- Profile of students:
  - *Lowest level of all School of Science*
  - *Mainly access as alternative to other studies whith higher demand (e.g. Biology, Pharmacy)*
  - *About 10% coming from Vocational Training (Env.& Health, Env. Education), which means at least two years without mathematics, but, most of them, with job experience*
  - *In general, very low interest on Mathematics, null vision of utility of Mathematics, and mostly bad experience with the subject (bad records, bad teaching-learning experiences, etc)*

## Professor's challenges:

- Recover the interest and taste for Mathematics.
- Establish clear ideas of the importance of Mathematics in (Enviromental) Sciences.
- Provide examples and applications which increase the knowledge of the students, promoting the self-esteem and empowerment (*"Please, tell this example at home"*).
- Try to propose always applied problems at the level of their skills and knowledge.
- Highlight the value and significance of the High Education with the view in the future (labour market, leadership, pro-active behaviour,...)


Education for

Sustainable Development Goals


- Weekly post of news or reports related with the SDG, taking into account the local and the global vision.
- In classroom, without previous announcement, we open newspapers o reports “on-fire” and open debates, always trying to make appears the scientifc method and the mathematics.

Co-funded by the European Union

- Reference to SDG in the list of problems of each chapter

8. You are working with a group modelling forest growth, and you find that for your location, the amount of sunlight available (on cloudless days) varies roughly sinusoidally, with a maximum of about 500 $cal/(cm^2 day)$ on day 91 of the year and the minimum of about 160 $cal/(cm^2 day)$ on day 273 of the year. To simphfy matters, you may assume that all years have 364 days (to make it an even number). You decide to model this relationship using $Q = a + b\sin[ct + d]$, where Q is the radiation $[cal/(cm^2 day)]$ and t is time [days] from the start of each year. (A rough sketch will doubtlessly be helpful.)

HELP: Check the Chapter 10, Theorem 10.23, pag. 795 of the *Precalculus* book to study this problem.

(a) In terms of quantities given above, what are the values

(b) What are the values of $c$ and $d$? What are the units of

9. We considered the chemical reaction $A + B \longrightarrow$

Assume that initially only A and B are in the reaction vesse $a = [A] = 3$ and $b = [B] = 4$.

(a) We found that the reaction rate $R(x)$, where $x$ is the c

$$R(x) = k(a - x)(b$$

where $a$ is the initial concentration of $A$, $b$ is the initial c of proportionality.

Suppose that the reaction rate $R(x)$ is equal to 9 when this relationship to find the reaction rate $R(x)$.

(b) Determine the appropriate domain of $R(x)$, and use a of $R(x)$.

10. Use a graphing tool to investigate the Monod g concentration $N$

$$r(N) = \frac{aN}{k + N}, \quad N \geq$$

5. Supongase que una enzima[2] actúa sobre un sustrato y $A(t) = 45\sqrt{t}$ es la función que da en cada instante la cantidad de sustrato transformado, se pide:

a) Calcular la tasa media de variación en el intervalo [1,25].

b) Calcular la velocidad de transformación. ¿Cómo describirías el proceso de transformación?

6. Un tanque tiene forma de cono invertido, con base de 6 m de radio y 2 m de profundidad. Se vierte agua en el tanque a razón de 20 $l/min$. ¿Con qué velocidad aumenta el nivel del agua cuando éste es de 1 metro sobre el fondo?

7. La fórmula para la potencia $P$ de una batería está dada por $P = VI - RI^2$, donde $V$ es el voltaje, $R$ la resistencia e $I$ la intensidad. Hallar la intensidad (medida en amperios, A) que corresponde a un máximo de $P$ en una batería en que $V = 12$ volts (V) y $R = 0.5$ ohms($\Omega$).

8. La concentración $C(t)$ de una cierta sustancia química en la sangre, tras $t$ horas de su inyección en el tejido muscular, está dado por: $C(t) = \frac{3t}{27+t^3}$. ¿Cuándo es máxima la concentración?.

- Show real and on-time data and measures

**The Keeling Curve** HISTORY MEASUREMENT NOTES VIDEOS OTHER CLIMATE INDICATORS

*Latest $CO_2$ reading: 417.36 ppm

ONE WEEK | ONE MONTH | SIX MONTHS | ONE YEAR | TWO YEARS | FULL RECORD | 1700-PRESENT | 2K YEARS | 10K YEARS | 800K YEARS

Carbon dioxide concentration at Mauna Loa Observatory*

Full record ending September 22

*Mauna Kea data in blue

$CO_2$ Concentration (ppm)

*Latest $CO_2$ reading: 421.10 ppm

WEEK | ONE MONTH | SIX MONTHS | ONE YEAR | TWO YEARS | FULL RECORD | 1700-PRESENT | 2K YEARS | 10K YEARS | 800K

Carbon dioxide concentration at Mauna Loa Observatory

Two years ending June 9, 2022

Daily average
Weekly average
Monthly average

UC San Diego | SCRIPPS INSTITUTION OF OCEANOGRAPHY

Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2022

Air Pollution in Canary Islands: Real-time Air Quality Index Visual Map

World | Asia | Europe | North America | South America | Africa | Australia | Middle East | India | China | Japan | South Korea | Thailand | Mexico | Poland


Península - Seguimiento de la demanda de energía eléctrica
Demanda (MW) a las 00:00 - 14/09/2023
-
Real
25.076
Prevista
24.369
Programada
-
Emisiones (t CO2 eq / MWh)
00:00
Demanda (MW)
34000
33000
32000
31000
30000
29000
28000
27000
26000
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23000
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21000
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02
04
06
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18
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22
00
02
Máximo diario 30.142 a las 13:27 - 13/09/2023
Mínimo diario 21.877 a las 04:32 - 13/09/2023
13/09/2023
Estructura de generación (MW)
Solar fotovoltaica
00:00
12760
38,29 %
Generación
CO2 eq. asociado
Solar fotovoltaica
01:00
Solar fotovoltaica (MW)
15000
12500
10000
7500
5000
2500
0

# 2. Our actions

## b) Master's for future secondary school teachers: Introduction on basics

- One activity related with Design of Activities
- Profile of students:
  - *Graduated in Mathematics at ULL without teaching experience*
  - *Highly conditioned by the way of teaching at the university level:*
    - *Product from traditional T&L method*
    - *low use of ICT,*
    - *low[2] group working experience,*
    - *low[3] creative activities,*
    - *low[4] innovatives T&L activities*

**Activity posted:**
In this activity we analyzed how an exemplification of mathematics teaching with a focus on ESD **modifies the perspective of future teachers about sustainability** and its incorporation in the mathematics class.

The results show that future teachers **recognize the need to incorporate the SDGs in mathematics teaching as a means of building sustainability competencies.**

But, in addition, the exemplification followed constitutes a tool of great value for the **acquisition of tools and strategies that provide competence to future teachers so that they can build their own proposals with a focus on ESD.**

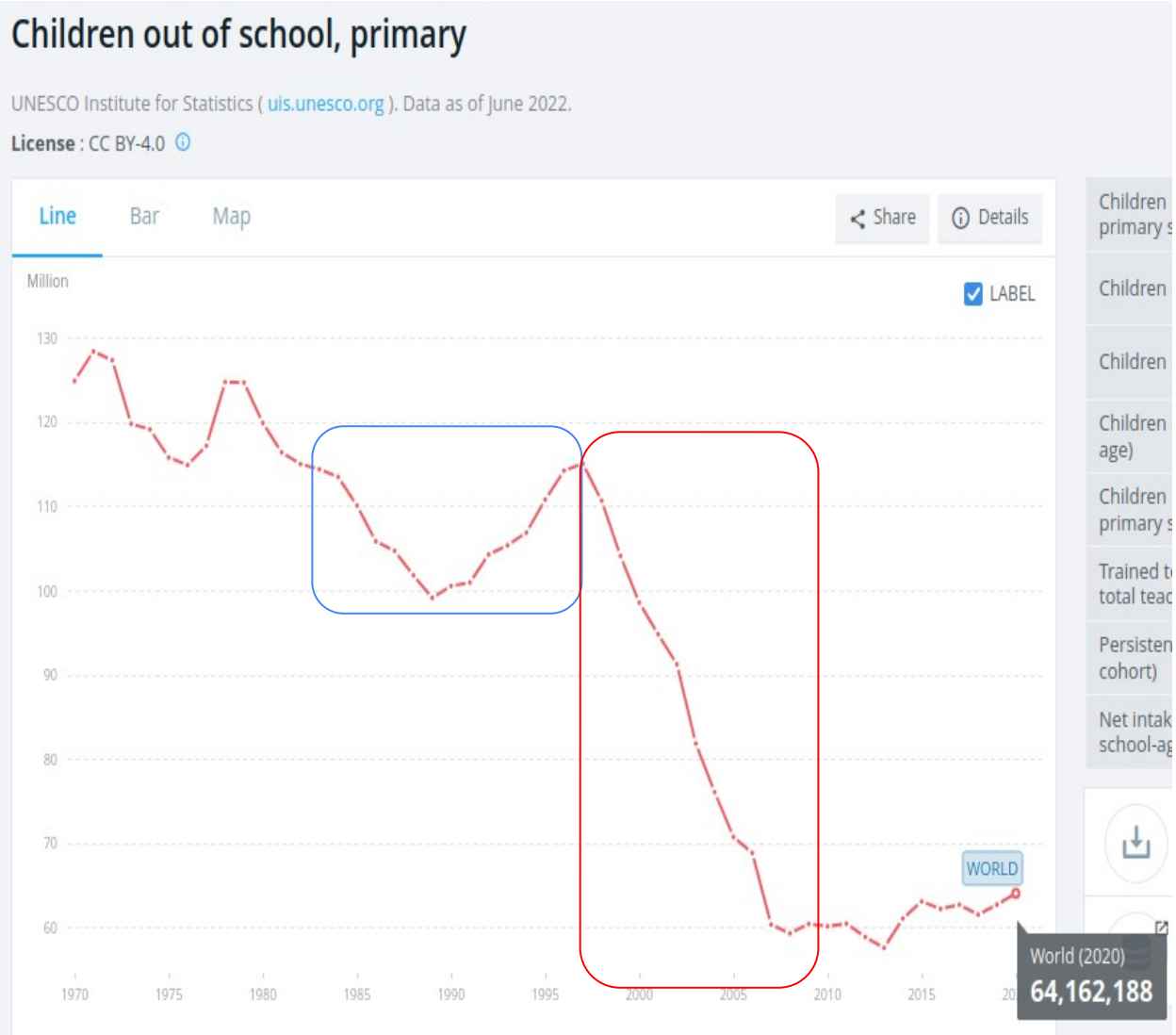
**Step 0: Basic training in SDG**

**Step 1: Students are required to develop a mathematics classroom proposal with a focus on ESD.**

**Step 2: Presentation of a mathematics project focused on ESD, contextualised in SDG-4 (Quality Education), which addresses the problem of early school leaving in the world and the possible causes and consequences.**

**Step 3: Review of proposals done in step 1**

https://data.worldbank.org/indicator/SE.PRM.UNER




TM 2. Which time intervals do you observe significant changes in behaviour?

TM 3. What functional behaviour do you identify in the selected intervals?
Build a predictive model for each period so that we can appreciate the real change in trend produced (Desmos1).

TM 4. Compare the rates of increase and decrease in each period.

TM 5. Use the predictive models for each period to measure the impact of the measures (Desmos2).

TM 6. Build a predictive model for the whole time series [1970, 2020] (Desmos3).


TS 5. Which historical events do you think had a relevant influence on these two periods [1979, 1997] and [1997, 2007]?

TS 6. Which initiative marks the largest decline in history?

TM 6. If we had followed the trend of reduction halted in 2007, in which year would the target of 2% of out-of-school children have been achieved?

1. https://en.wikipedia.org/wiki/Lists_of_wars
   https://en.wikipedia.org/wiki/List_of_wars:_1990%E2%80%932002
2. https://es.wikipedia.org/wiki/Objetivos_de_Desarrollo_del_Milenio
   https://www.aecid.es/EN/FCAS/Paginas/Que-es/Transp/objetivos-milenio.aspx

# Conclusions + Warnings:

- **Incorporate workshops** that demonstrate **project-based learning strategies** with a **focus on ESD** and through **mathematical learning** show good results.
- Promote c**onnecting mathematics with other disciplines** and with other mathematical contents, and where the context is the common thread.
- The **SDGs are a global urgency**
- **Teachers** are **"key players"** in **ESD development**.
- **Initial training** of future **teacher of mathematics** must **address the keys of ESD** and its relation to **mathematics.**

# 2. Our actions

## c) Degree in Mathematics: Three projects on the subject Modelisation (4th course)

- Subject: Modelisation (6 ECTS)
- Schedule: 2nd semester – 4th course – Last mandatory subject
- Profile of students:
  - *Same profile than master students.*
  - *Very tired and stressed students.*
  - *Mostly with high delay on finish (average of 6 years to finish).*
  - *Very low enthusiasm on new activities.*

**Our proposal: Project Based Learning approach**

- *17 groups (4 students)*
- *One SDG assigned to each group along all the course*
- *Two projects related with the assigned SDG*
- *One final project on SDG #3 Good Health & Well Being*

# Project 1: Composite Indicators



The Organisation for Economic Co-operation and Development (OECD) has among its main objectives to promote policies that improve the economic and social well-being of people and countries.

To this end, it commissions us, as mathematicians, to develop a prototype Composite Indicator for a specific SDG, using real data and allowing pilot designs for country or regional rankings.

We are free to choose the indicators, countries or regions that we consider, and what interests them in this assignment is that we present an indicator proposal to see if in subsequent developments they are useful for broader studies.

The OECD is known for the large number of studies it publishes, with a huge battery of indicators that allow us to analyse and compare the situation of communities (countries, regions, etc.). In this link you can see many of them:

https://www.oecd.org/statistics/indicadores-clave.htm

There are many manuals on Composite Indicator design published by the OECD and the EU's Joint Research Centre (JCR).

# Example

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**MATHEMATICS**
**FOR ACTION**
Supporting Science-Based Decision-Making

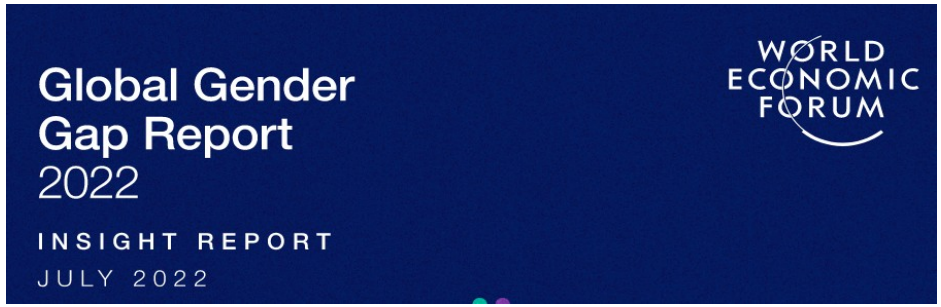
## MEASURING COMPLEX PHENOMENA

Composite indicators mathematically aggregate a set of individual indicators, usually with no common unit of measurement, into a single summary indicator. Ideally, composite indicators are based on a statistical and mathematical framework that selects, combines, and weights the individual indicators to best reflect the dimensions or structure of the measured phenomena.

## KEY MESSAGES

- ☑ Composite indicators are a mathematical aggregation of a set of individual indicators that measure multi-dimensional concepts, but usually have no common unit of measurement, They're increasingly used by global institutions to enhance public debate, benchmark performance, and analyze policies.
- ☑ Multiple composite indicators are used to measure and track the legal, economic, social, and cultural drivers of the gender gap.
- ☑ The proliferation of composite indicators for decision- and policymaking raises issues about accuracy, robustness, and reliability. Poor composite indicators can lead to poor decisions and ineffective policies.
- ☑ Mathematical approaches provide robust means to analyze the sensitivity of composite indicators and uncover which dimensions contribute most to closing the gender gap, providing the means to measure the gender gap in more accurate and reliable ways.

**The Global Gender Gap Index (GGGI)** — The World Economic Forum first introduced the GGGI in 2006 as a framework for capturing gender-based disparities and tracking their progress over time. The GGGI benchmarks national gender gaps on economic, education, health, and political criteria and provides country rankings that allow for comparisons across regions and income groups.




https://www.weforum.org/reports/global-gender-gap-report-2022/

**GGGI** measures **four equally-weighted dimensions**:

- *Economic participation & opportunity,*
- *educational attainment,*
- *health & survival, and*
- *political empowerment.*

**Country rankings and index scores vary considerably depending on the choice of dimensional weights.**

World Economic Forum statisticians chose to weight these dimensions equally, but with a different choice of weights, the indicator scores would be quite different.

| Country | Algeria | Angola |
|---|---|---|
| Economics | 0.456 | 0.646 |
| Education | 0.966 | 0.759 |
| Health | 0.958 | 0.979 |
| Political | 0.151 | 0.245 |
| Equally-weighted Average | 0.633 | **0.657** |
| Weighted to Education (50%), Health (30%), Others (10%) | **0.831** | 0.762 |
| Weighted to Economic Participation (50%), Health (30%), Others (10%) | 0.627 | **0.717** |

# Objetives (outcomes)

- **Construct a Composite Indicator** with the selected data.
- Compile basic information on the construction of Composite Indicators for similar work.
- Identification of the mathematical tools necessary for the design of the Composite Indicator.
- Design of a solution in Dashboard format that allows to make proofs of concept (test) with the data, modify variables, handle new data, etc, in order to have a flexible tool adaptable to tests and changes.
- ...and all the added value provided by each group.

# Project 2: Mini-PBL design

Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura

Educación 2030

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MATHEMATICS FOR ACTION
Supporting Science-Based Decision-Making

Education is the top priority of the United Nations Educational, Scientific and Cultural Organization (UNESCO) because it is an essential human right and the foundation for building peace and fostering sustainable development. UNESCO is the United Nations specialised agency for education and its Education Sector provides global and regional leadership in education, strengthens national education systems and responds to the global challenges of our time through education, with a special focus on gender equality and Africa.

UNESCO has been tasked with leading and coordinating the Education 2030 Agenda. This agenda is part of a global movement to eradicate poverty by achieving 17 Sustainable Development Goals by 2030.

Part of this commission is the publication "MATHEMATICS FOR ACTION: Supporting Science-Based Decision-Making "1 which, through activity sheets, presents applications of mathematics to address the SDGs and the UN 2030 Agenda.

**UNESCO asks us to develop proposed classroom activities focusing on data fitting using functions and ODEs. The data should be related to the SDGs, and the classroom proposal should illustrate the usefulness of elementary functions as well as ODEs, and their use in answering SDG questions.**



1 https://unesdoc.unesco.org/ark:/48223/pf0000380883.locale=en

# Example: Logistic ODE adjustment

Consider the growth of a population of yeast. Yeast are single-celled organisms used for a variety of purposes, including alcohol production and baking. Researchers collected the data in Table 1 from a yeast population grown in liquid culture, measuring the population size (in number of individuals per mL of culture) at different points in time (in hours).[1] Figure 1 is a scatter plot of these data.

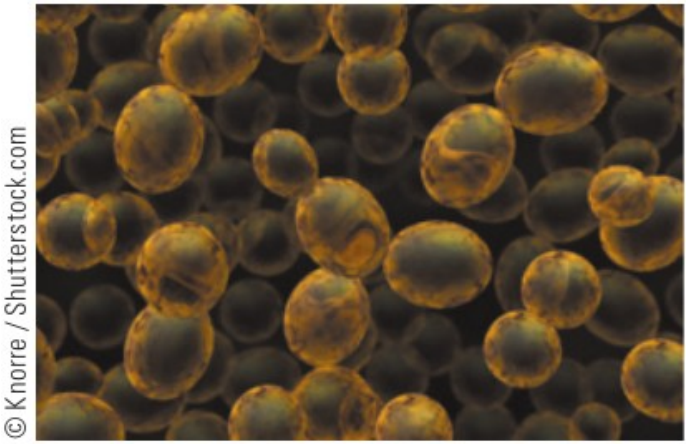



**Table 1**

| Time (h) | Pop. size ($\times 10^6$/mL) | Time (h) | Pop. size ($\times 10^6$/mL) |
|---|---|---|---|
| 0 | 0.200 | 19 | 209 |
| 1 | 0.330 | 20 | 190 |
| 2 | 0.500 | 21 | 210 |
| 3 | 1.10 | 22 | 200 |
| 4 | 1.40 | 23 | 215 |
| 5 | 3.10 | 24 | 220 |
| 6 | 3.50 | 25 | 200 |
| 7 | 9.00 | 26 | 180 |
| 8 | 10.0 | 27 | 213 |
| 9 | 25.4 | 28 | 210 |
| 10 | 27.0 | 29 | 210 |
| 11 | 55.0 | 30 | 220 |
| 12 | 76.0 | 31 | 213 |
| 13 | 115 | 32 | 200 |
| 14 | 160 | 33 | 211 |
| 15 | 162 | 34 | 200 |
| 16 | 190 | 35 | 208 |
| 17 | 193 | 36 | 230 |
| 18 | 190 | | |

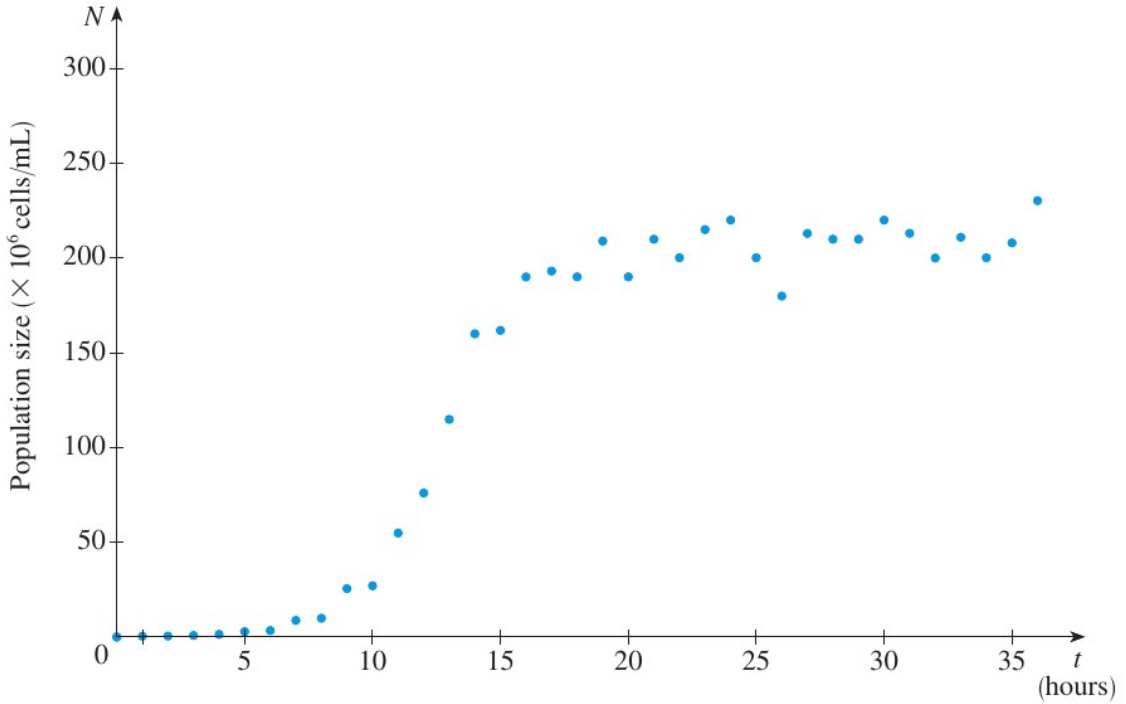
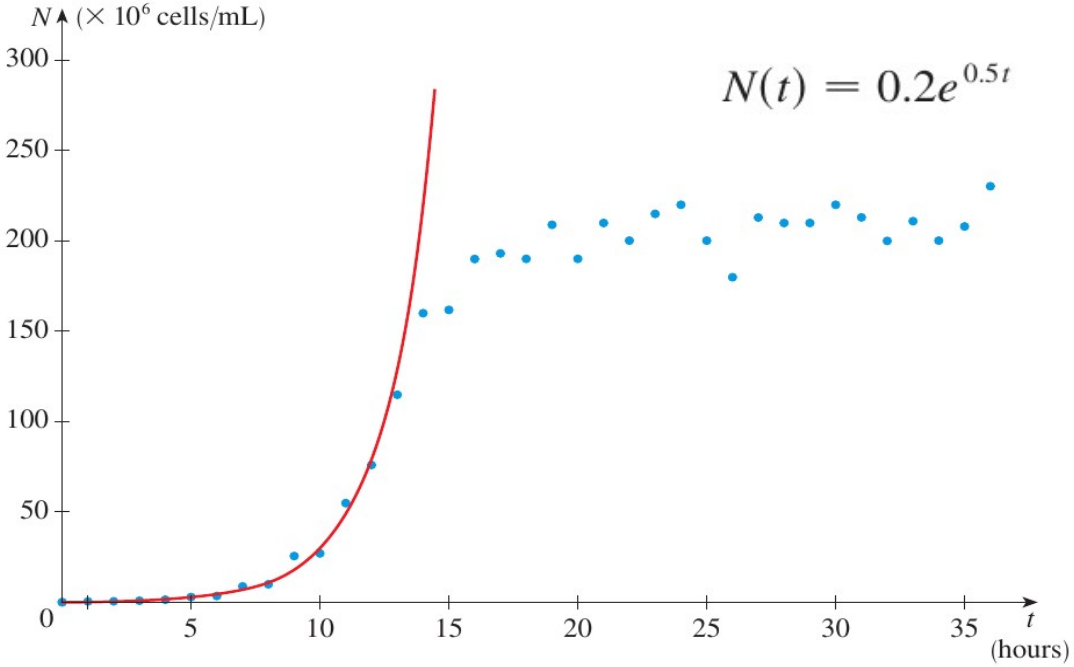
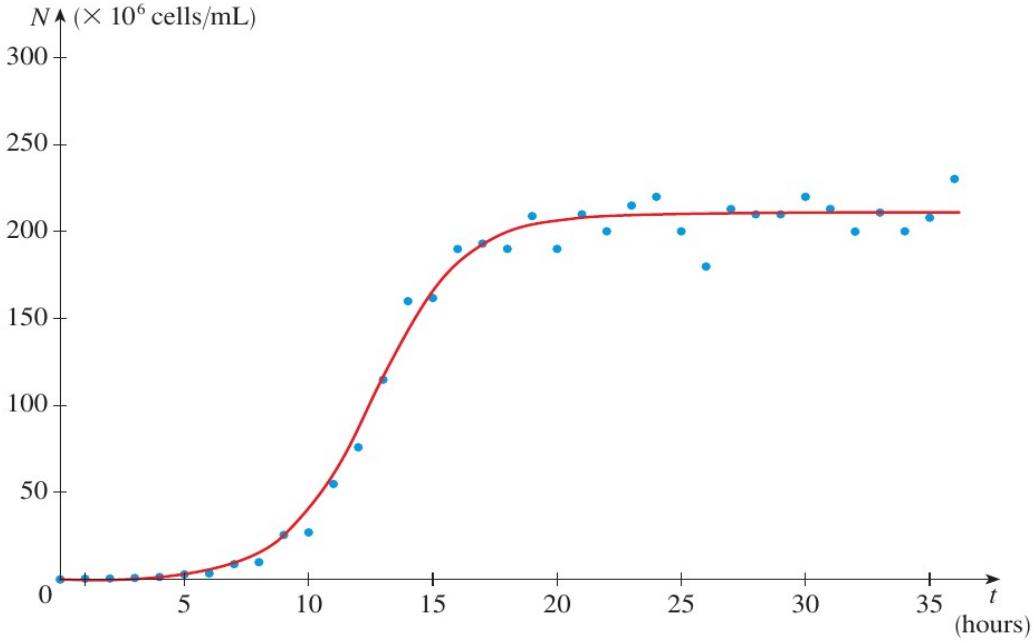



**FIGURE 1** A scatter plot of the data in Table 1

1. B. K. Mable et al., "Masking and Purging Mutations following EMS Treatment in Haploid, Diploid, and Tetraploid Yeast (*Saccharomyces cerevisiae*)," *Genetical Research* 77 (2001): 9–26.

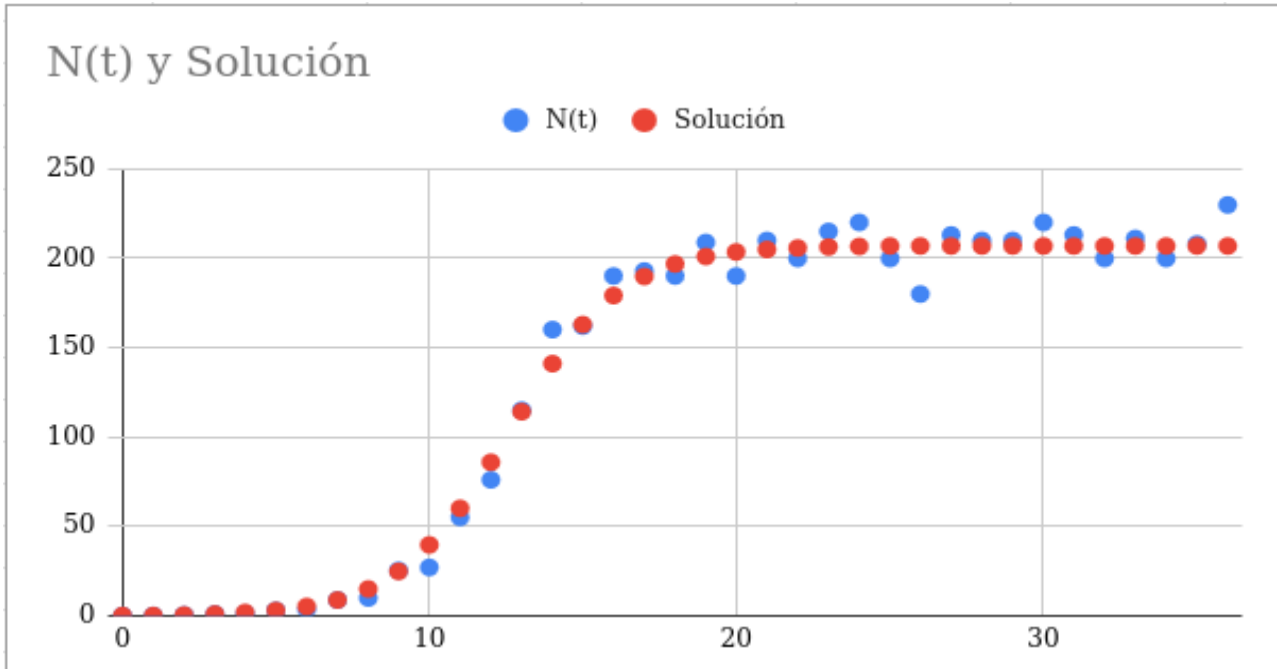



$$N(t) = 0.2e^{0.5t}$$




$$N(t) = \frac{207 \cdot 0,2}{0,2 + (207 - 0,2)e^{-0,55t}}$$

TASK 1: Perform two similar fits (ODEs exponential, logistic, linear,...) with indicators of the assigned ODS (any related data table will be valid).

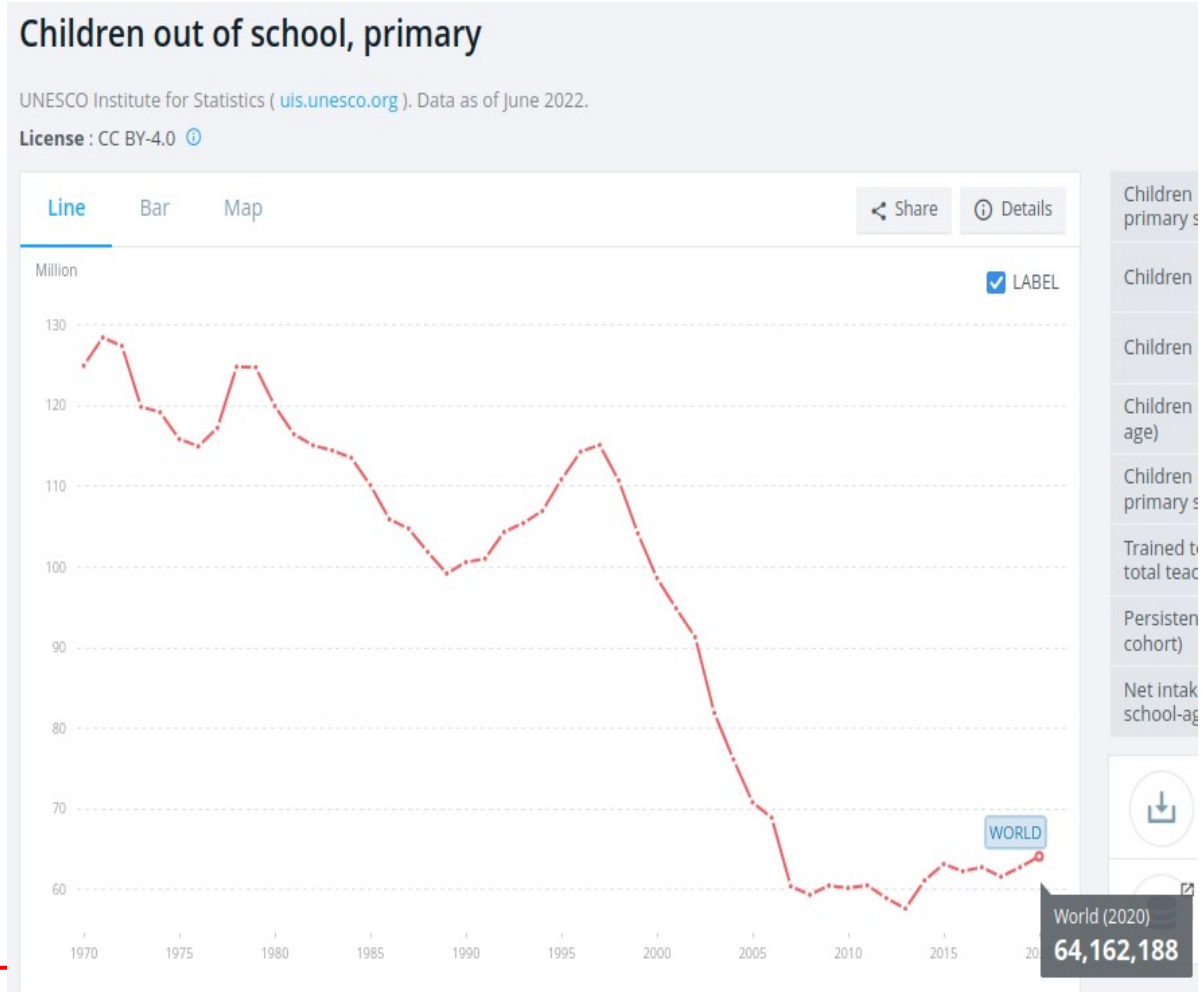


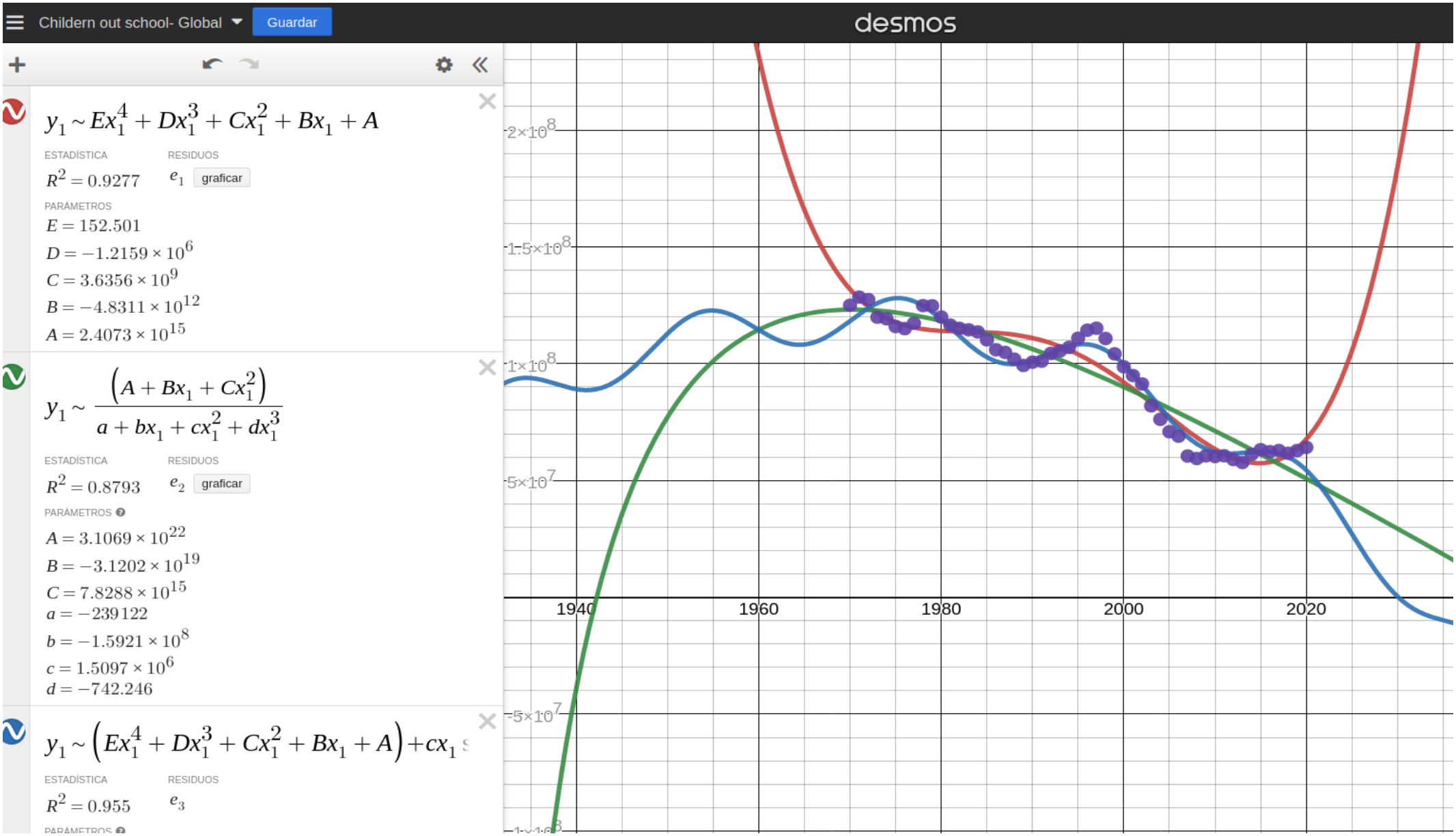
# Access to basic education: Almost 60 million children in primary school age are not in school

The world has made a lot of progress in recent generations, but millions of children are still not in school.

Only upper secondary out-of-school rates are projected to continue their downward trend until 2030, when one-quarter of all adolescents are still expected to be out of school. Primary and lower secondary out-of-school rates are projected to remain at nearly the same levels as today.

TASK 2: Perform fitting with elementary functions with indicators of the assigned ODS (DESMOS, Python, etc).
Find the combination of functions (polynomial, rational, trigonometric, exponential,...) and generate at least three different examples.




Childern out school- Global
Guardar
desmos
$y_1 \sim Ex_1^4 + Dx_1^3 + Cx_1^2 + Bx_1 + A$
ESTADÍSTICA
RESIDUOS
$R^2 = 0.9277$
$e_1$
graficar
PARÁMETROS
$E = 152.501$
$D = -1.2159 \times 10^6$
$C = 3.6356 \times 10^9$
$B = -4.8311 \times 10^{12}$
$A = 2.4073 \times 10^{15}$
$y_1 \sim \frac{\left(A + Bx_1 + Cx_1^2\right)}{a + bx_1 + cx_1^2 + dx_1^3}$
ESTADÍSTICA
RESIDUOS
$R^2 = 0.8793$
$e_2$
graficar
PARÁMETROS
$A = 3.1069 \times 10^{22}$
$B = -3.1202 \times 10^{19}$
$C = 7.8288 \times 10^{15}$
$a = -239122$
$b = -1.5921 \times 10^8$
$c = 1.5097 \times 10^6$
$d = -742.246$
$y_1 \sim \left(Ex_1^4 + Dx_1^3 + Cx_1^2 + Bx_1 + A\right) + cx_1$
ESTADÍSTICA
RESIDUOS
$R^2 = 0.955$
$e_3$
PARÁMETROS
$2\times10^8$
$1.5\times10^8$
$1\times10^8$
$5\times10^7$
$-5\times10^7$
1940
1960
1980
2000
2020

# Outcome in Pythagoras' mini-PBL format

| Mini-PBL project | |
|---|---|
| **Teacher data sheet: Teaching Guide** | |
| **Title** | The Title declares most of the project and is probably the first spark to wake the interest of students.<br>It must be direct, clear, motivating and descriptive of the real-life issue which it addresses. |
| **SDG attended** | Using this UN graphics, we mark such SDG which this project works.<br>  |
| **Content units** | The project may cover **2 or 3 content units**, as minimum. As the course advances, more units can be considered, but we may take care not to design a too long activity.<br>The key concept to attend is the spiral curriculum strategy, focusing the review processes to recover students on risk to fail, and remark the connection between the content units of the course. |
| **Sessions** | Here we advance the number of sessions in the classroom we dedicate to work on this project. However, the students may know in advance that, in general, all the projects will require autonomous work, following the ECTS metric. |
| **Hours of autonomous work** | Here we may pay special attention and be careful not to generate an overtasking project. This is relevant since if you don't measure this autonomous part, the students' attitude and performance will be seriously affected. The exceed of work out of classroom affects to another subjects, impact negatively on the next mini-PBL proposed and, more disheartening for us, the goals of the mini-PBL will be displaced by the urgencies and rush (deep reflections, careful writing, checking results by different ways, discuss with classmates, etc).<br>The worst consequence of an overtaking proposal is the cheating between students. You can introduce ways to avoid or reduce this bad practices, but regular teaching generates a high stressing workflow for both students and professors, if you have to manage additional control of the students' ethics performance. |
| **Competences to be developed** | Your subject has a list of competencies to be achieved by your students. Here is the place where those related with this project should be listed.<br>Recall always the sense of competences, don't mix with contents to be |

# Project 3: ODS#3 – Epidemic diseases

World Health Organization

Organización Mundial de la Salud

Organización Panamericana de la Salud

World Health Organization
REGIONAL OFFICE FOR Africa

The goal of the World Health Organization (WHO/WHO) is to build a better and healthier future for people everywhere. WHO staff, working with 194 Member States spread across six regions and from more than 150 offices, are united under a common commitment: to improve the health of everyone around the world.

Together they strive to fight diseases, whether they are infectious, such as influenza and HIV infection, or non-communicable, such as cancer and heart disease.

The list1 of infectious diseases is enormous, and epidemiological models are central to their care. The past global crisis generated by COVID-19 has brought to light the importance of these epidemiological models, with a massive investment of resources as never before made for any other infectious disease.

For this reason, models for other diseases need to be made available and provide tools for the study of possible future outbreaks.

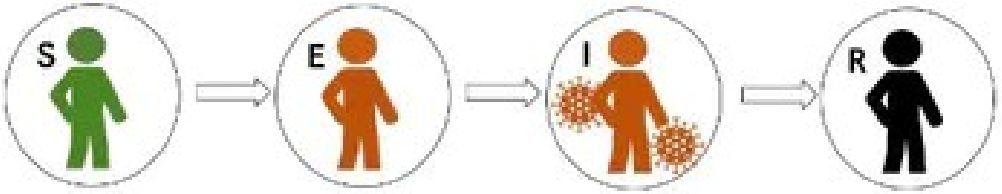
**The WHO/WHO is asking us to develop control panels for variants of the SIR model (SIS, SEIR, SIRD, SIRV,...) based on published scientific results, and linked to infectious diseases (non-COVID19), so as to visualise the behaviour of the agents involved according to the models (susceptible, infected, vectors,...) and to allow simple manipulation of the values of the fundamental parameters.**

[1] https://www.ecdc.europa.eu/en/all-topics

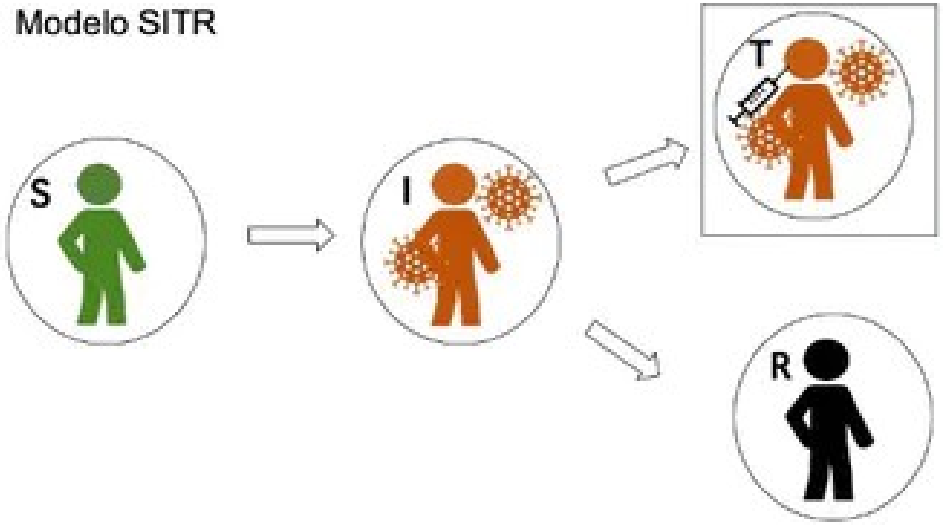
# Different SIR models...

a) Modelo SIR

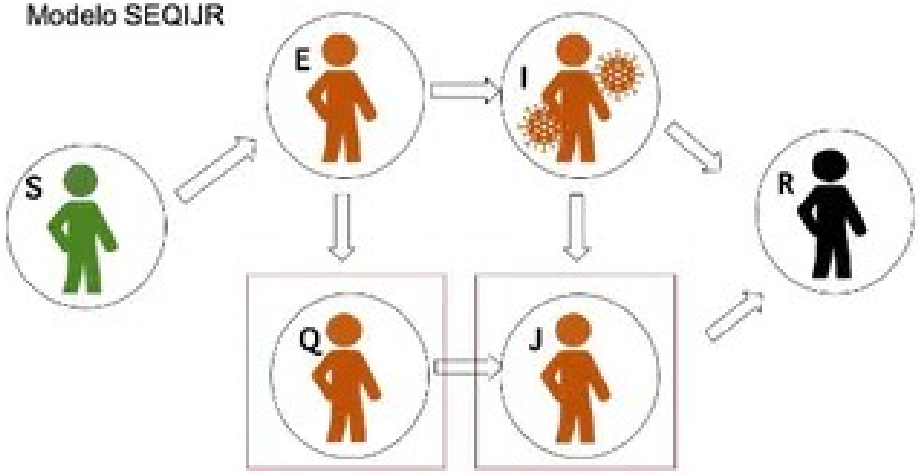

b) Modelo SEIR



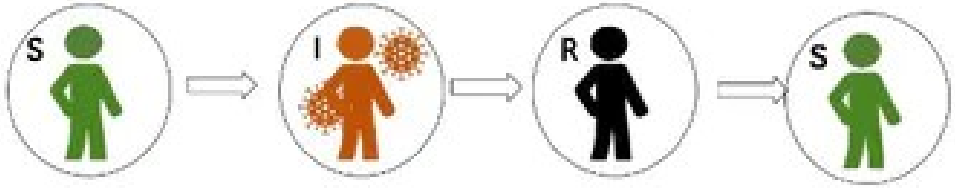

c) Modelo SITR




d) Modelo SEQIJR




e) Modelo SIRS

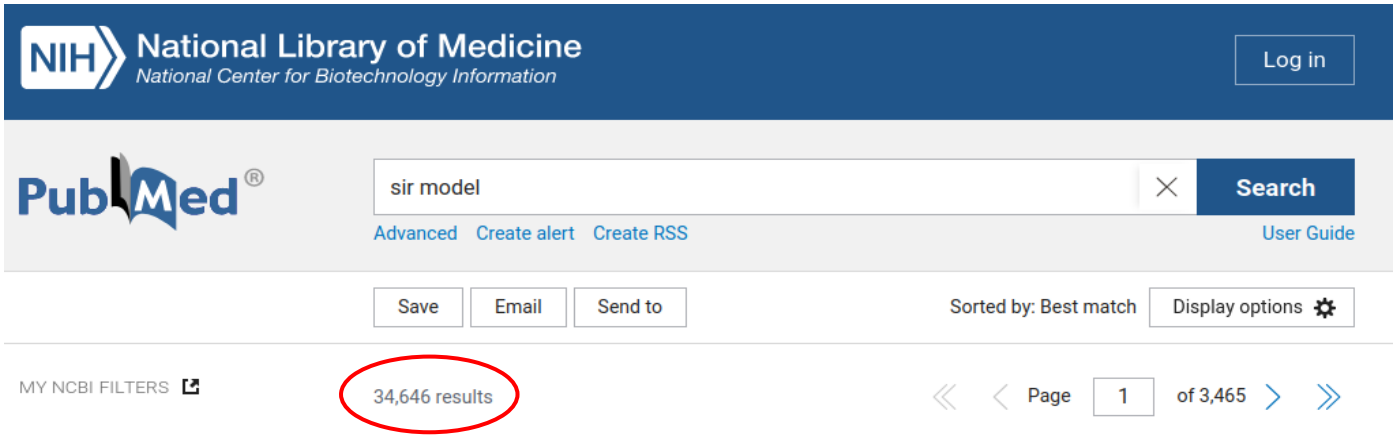



**...with vector, travels, vaccines,.....**

# Task 1:

TASK 1: Search for a scientific article with SIR variant model applied to an infectious disease (non-COVID19)
(4 hours)

https://pubmed.ncbi.nlm.nih.gov/




- We have thousands of articles related to the SIR model. Each group should review and choose one for development.
- It should contain a system of differential equations that models one infectious disease, or a generic model applicable to many at once.
- We have discarded specific models for COVID19 as there are already more than enough resources for its study. We are interested in lesser-understood diseases.
- The selected article must be previously reviewed and approved by the teacher to be used in subsequent tasks (to avoid duplication).

**A**

Acquired immunodeficiency syndrome (AIDS)
Alkhurma haemorrhagic fever
Anaplasmosis
Anthrax
Arenavirus
Avian influenza in humans

**B**

Babesiosis
Bordetella (pertussis)
Borreliosis
Botulism
Brucellosis

**C**

Campylobacteriosis
Chickenpox (varicella)
Chikungunya virus disease
Chlamydia infection
Cholera
Ciguatera fish poisoning (CFP)
Clostridium difficile infection
Congenital rubella
Congenital syphilis
Coronavirus
COVID-19
Cowpox
Coxsackievirus
Creutzfeldt-Jakob disease
Crimean-Congo haemorrhagic fever
Cryptosporidiosis
Cutaneous warts

...

**T**

Tetanus
Tick-borne diseases
Tick-borne encephalitis (TBE)
Tick-borne relapsing fever
Toscana virus infection
Toxoplasmosis, congenital
Trench fever
Trichinellosis
Tuberculosis (TB)
Tularaemia
Typhoid and paratyphoid fever

**V**

Vaccine-preventable diseases
Variant Creutzfeldt-Jakob disease (vCJD)
Varicella
Viral haemorrhagic fever
Viral hepatitis

**W**

West Nile virus infection
Whooping cough (pertussis)

**Y**

Yellow fever
Yersiniosis

**Z**

Zika virus disease
Zoonosis

[1] Listado enfermedades infecciosas

# Task 2:

**TASK 2:** Construction of the dashboard where the model is solved numerically, allows to change the initial data and parameters, and contains the representations of the curves of the groups involved in the study (humans, vectors,...).
(6 hours)

$$(1)\quad \frac{dS(t)}{dt} = -\beta \cdot S(t) \cdot I(t)$$

$$(2)\quad \frac{dI(t)}{dt} = \beta \cdot S(t) \cdot I(t) - \gamma \cdot I(t)$$

$$(3)\quad \frac{dR(t)}{dt} = \gamma \cdot I(t)$$

Initial conditions:

$$S(0) \in (0, 1]$$

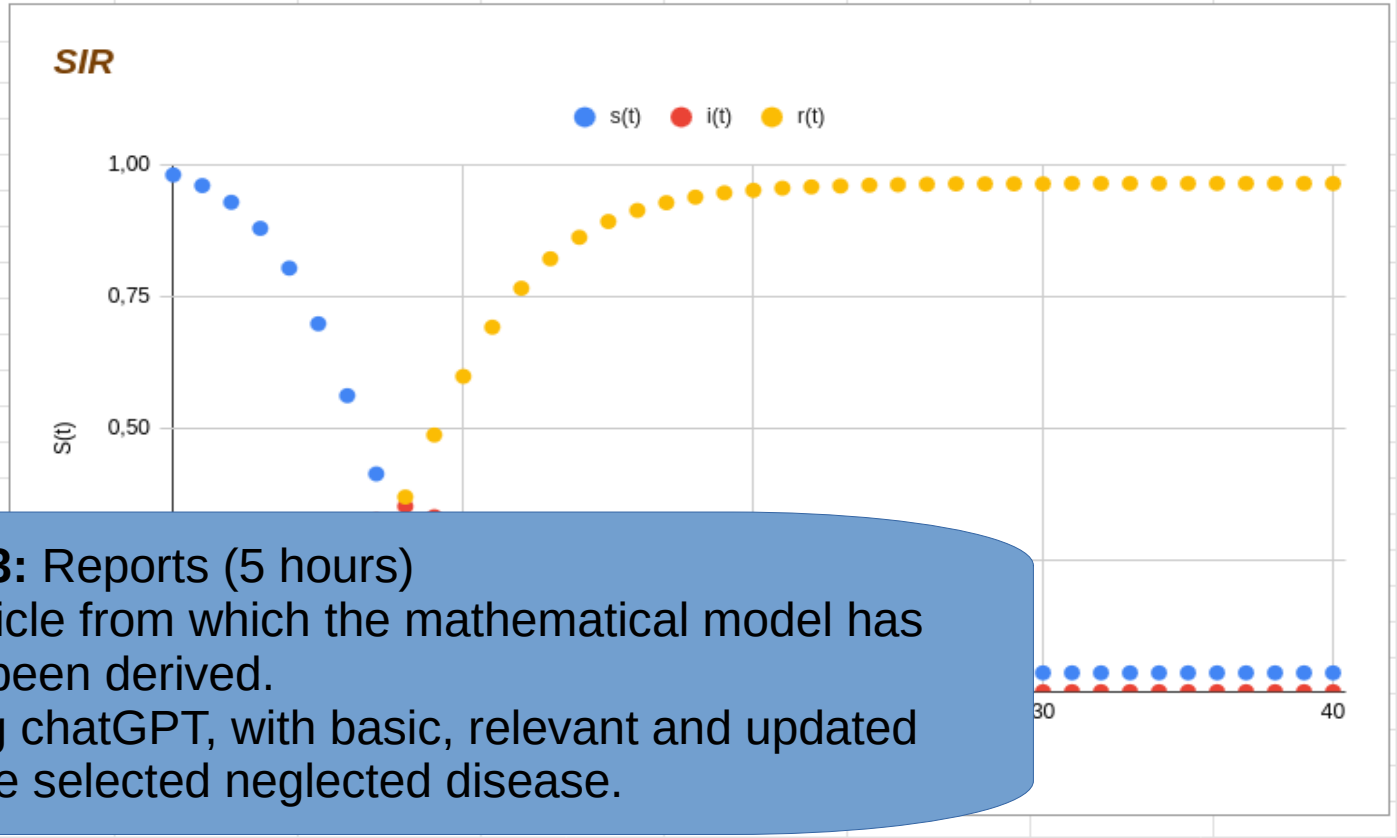
$$I(0) \in (0, 1]$$

$$R(0) = 0$$

$$S(0) + I(0) = 1$$

| | |
|---|---|
| ***S(0)=*** | 0,98 |
| ***I(0)=*** | 0,02 |
| ***R(0)=*** | 0 |

| ***Paso temporal:*** | 1 | | |
|---|---|---|---|
| t | s(t) | i(t) | r(t) |
| 0 | 0,98 | 0,02 | 0 |
| 1 | 0,960 | 0,033 | 0,007 |
| 2 | 0,929 | 0,054 | 0,018 |
| 3 | 0,879 | 0,085 | 0,036 |
| 4 | 0,804 | 0,132 | 0,064 |
| 5 | 0,698 | 0,194 | 0,108 |
| 6 | 0,562 | 0,265 | 0,173 |
| 7 | 0,413 | 0,326 | 0,261 |
| 8 | 0,279 | 0,352 | 0,370 |
| 9 | 0,181 | 0,332 | 0,487 |
| 10 | 0,121 | 0,282 | 0,598 |
| 11 | 0,087 | 0,222 | 0,692 |




**TASK 3:** Reports (5 hours)
3.1. Write a summary of the article from which the mathematical model has been derived.
3.2. Prepare a fact sheet, using chatGPT, with basic, relevant and updated information on the selected neglected disease.

# Conclusions

- SDG is a excellent vehicle to present mathematical contents related with real world and critical problems.
- ESD empower the role of the professor, the value of teaching and the focus on skills more than contents.
- It is possible to design activities in the framework of ESD for any level.
- The role of the students is enlarged by promoting their protagonism and creativity, while their social and global awareness is enhanced.
- …..

*Thanks for your attention!*