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SPIDAS

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INDEX

1. CURRICULUM OVERVIEW OF PRIMARY AND SECONDARY EDUCATION IN CATALONIA (SPAIN)

The main objective of this section is to give a general outlook of the Catalan (Spain) curriculum in relation to data analytics.

Firstly, we synthesise the main contents and learning competences included in the curriculum in relation to data analytics.

Secondly, we present an overview of how these contents are developed in the three schools that participate in SPIDAS throughout the different levels of the educational system. This presentation is displayed in a table that contains the next seven aspects: a) the key data analysis content; b) the learning objectives/competences that students have to acquire or develop; c) the subject in which this content and competences are taught; d) students age; e) the teaching methods used; f) the technology tools employed to support students' learning and g) the approximate time used to teach each content.

Thirdly, we expose the main conclusions that can be drawn from the curriculum overview. These conclusions will lead the educative design SPIDAS projects.

1.1. GENERAL ASPECTS AND CONTENT STRUCTURE

The Catalan curriculum emphasises that the role of mathematical education in the obligatory stages is to develop key knowledge and a series of competences that enable students to understand and think thoroughly about different realities and problems, reason critically about them, and take decisions and actions accordingly.

For that reason, the curriculum highlights that mathematics education has to be developed attending three main proposes: mathematics have to be formative by themselves, applicable to real contexts, and be an instrument to promote a robust learning in other subjects.

Taking these three objectives of mathematics in education, the Catalan curriculum is organised round two axes: contents and competences. The mathematical contents of primary and secondary education are structured in five blocks: Numbering and calculation; Relations and changes; Space and shape; Measurement; Statistics and probability. SPIDAS project will contribute to develop good practices in the last block of contents: Statistics and probability. Specifically, in this block of contents related with data analysis the Catalan curriculum establishes four main groups of contents: Sense of statistics; Data, tables and statistics graphs; Methods; and sense and probability measure.

In Figure 1 is present the two axes in which the curriculum is organised: contents of the Statistics and probability block and competences.

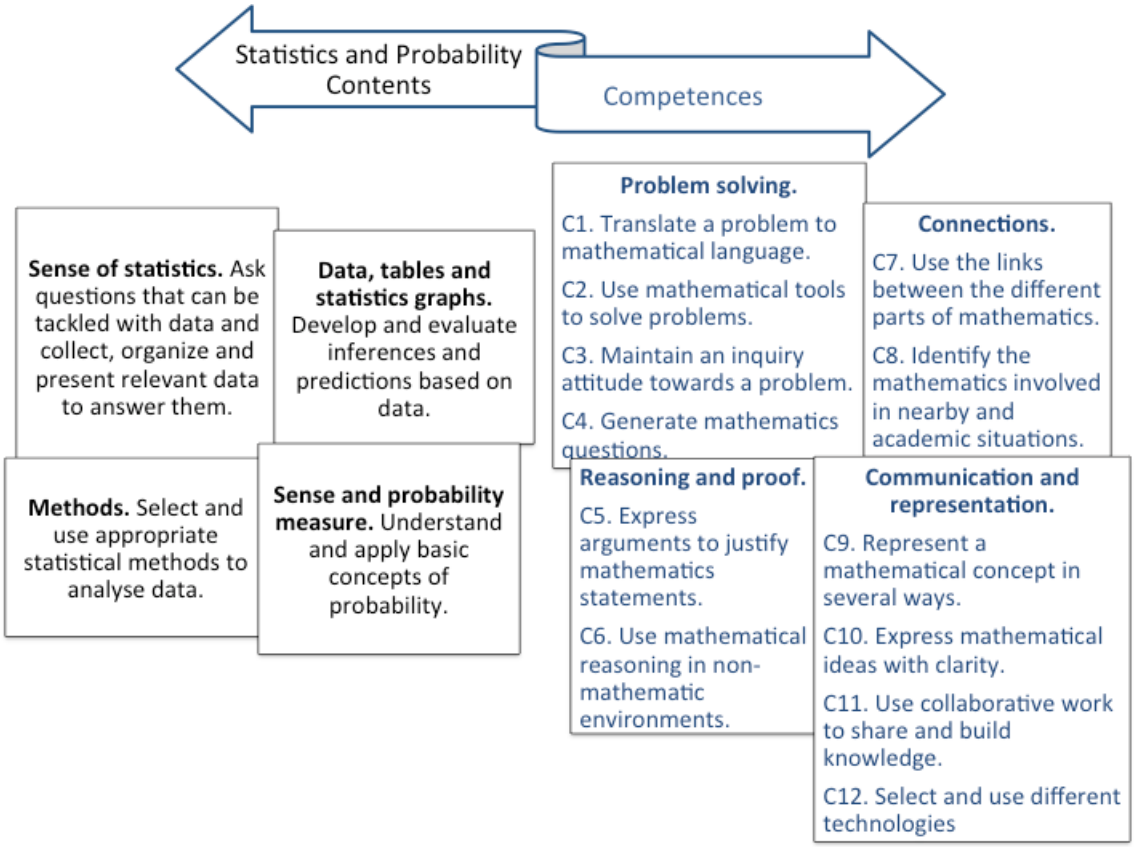


Figure 1: Statistics and probability contents and competences

In the next section it is presented a summary of the curriculum in relation to data analysis contents in Primary, Secondary and Baccalaureate education. This summary has been done taking into consideration the main contents and competences represented in Figure 1, and specifically, in the summary there are presented the key DA contents taught, the learning objectives, the inter-relations with other subjects, the teaching methods used, the technology tools employed, the amount of teaching hours employed, and the age of students.

1.2 CURRICULUM OVERVIES

1.2.1. Curriculum overview of Primary Education – Catalonia (Spain)

Key content	Learning objectives/Competencies	Subject	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
14. Data, tables and statistics graphs Graph construction	Interpreting and building graphs (pictograms, bar graphs) with quotidian and known data from different subjects.	Maths	6-7	Drill and Practice Problem base solving Lecture		
13. Sense of statistics Data handling (collecting, organising)	Creating questions about closed topics and collecting the given answers.	Maths	6-7	Research Problem base solving		
13. Sense of statistics	Simple planification of data collection with small samples up to 30. Reading the absolute frequency.			Research		

Data handling	Organising and representing data from counting and ordering experiences, through specific objects, drawings and graphs.	Maths	6-7	Problem base solving		
	Using specific and basic vocabulary to describe the attributes and classify according to specific standards.			Lecture		
15. Methods Data analysis	Quantitative comparison of numerical data.	Maths	6-7	Drill and Practice		
	To choose the most appropriate graph type for representation.			Problem Resolution Drill and Practice Lecture Research		
16. Sense and probability measure Random	To use expressions such as: ‘possible’, ‘impossible’, to answer related questions to explain known experiences or self-experiences.	Maths	6-7	Problem Solving (PB) Problem Resolution (PR) Problem base solving		
	Recognising random through experiments with different items			PB, Project base learning		

	(colourful markers, throwing a dice, roulettes, …).			(Interdisciplinary: PB, PR, Drill and Practice Lecture: expositive class Research		
13. Sense of statistics Formulation of questions	Formulation of questions based on close events and own interests	Maths	8-9	Drill and Practice Problem base solving Lecture		
13. Sense of statistics Data handling (gathering, organization, and data display)	Data collection through observation, enquiries and experiments of a max set of 50. Interpretation of the absolute frequency.	Maths	8-9 9-10	Research Problem base solving	Spreadsheet	2h

13. Sense of statistics Data handling (interpretation and data display)	Reading, interpreting, and using varied forms of data display, mainly graphs (pictograms, bar graphs…) in traditional or digital sources. To use numeration and spatial concepts to gather, describe, and interpret data.	Maths	8-9	Drill and Practice Problem Resolution Lecture	Paper	2h
15. Methods Data analysis	To know and see the difference between qualitative and quantitative representation of data.	Maths	8-9	Problem base solving Lecture		
	Reading and interpreting statistics data and graphs from newspapers, books, internet, and other sources.	Maths	8-9	Lecture Problem Resolution		
	Describing the form and the main characteristics of a data set.			Drill and Practice Problem Resolution Lecture		
	Analysing the characteristics of a			Problem Resolution		

	set of quantitative data.			Drill and Practice Lecture		
15. Methods Mode and median	Identify and understand the concepts of mode and median. Applying it for problems solving.	Maths	8-9	Problem Solving Problem Resolution Lecture Drill and Practice		
	Introduction to the concept of arithmetic mean.			Problem base solving Project-based learning (Interdisciplinary Problem Solving Problem Resolution Drill and Practice Lecture: expositive class Research		

14. Data, tables and statistics graphs Oral interpretation of data	Oral description of a situation from a data analysis.	Maths	8-9	Problem Solving Problem Resolution Drill and Practice		
16. Sense and probability measure Basic concepts of random	First introduction to the concepts of probability: ‘100% sure’, ‘possible’ or ‘impossible’.	Maths	8-9	Problem Resolution Drill and Practice Lecture		
	Predicting the probability. Basic experiments and results contrasting.			Problem Resolution Drill and Practice Lecture		
	Exploring probability through experiments and games with few results.			Problem Resolution Drill and Practice Lecture		
16. Sense	Problem solving with random	Maths	8-9	Problem Resolution		

and probability measure Random concepts application.	factors. To use random to reinforce numerical concepts.			Drill and Practice Lecture		
13. Sense of statistics Data handling	To formulate research questions that require data collection, design experiments or surveys to collect data, and compare results between the same population. To use numeration and geometry to collect, describe, and understand data.	Maths	10-11	Problem based learning Problem Solving Drill and Practice Lecture Research	Excel	2
	To use data collected by others or generated from simulations such as internet, written press, etc. To obtain the absolute frequency of a sample data inferior to 50.			Problem base solving Problem Solving Research Drill and practice	Excel	4

				Lecture Research		
15. Methods	To compare related data sets.	Maths	10-11	Problem Resolution Drill and Practice Lecture	Excel	2
Statistics methods	To use calculators and other digital sources to create frequency tables, to calculate the median, the arithmetic mean and the mode. To use all for problem solving.			Problem base solving Project base learning Problem Resolution Drill and Practice Lecture	Excel	4
914. Data, tables and statistics graphs	To observe, make conjectures and propose new questions based in the differences between two data sets.			Problem base solving Problem Solving Problem Resolution Research		1

To draw conclusions and to make predictions	Usage of line graphs to analyse the relationship between two characteristics in different populations. To use it for problem solving.	Maths	10-11	Problem base solving Problem Resolution Drill and Practice Research	Excel	2
	To understand the different ways to quantify truth in the results.			Problem Resolution Drill and Practice.		1
	To describe orally and written a situation from data analysis.			Problem base solving Problem Resolution Research		2
16. Sense and probability measure	Understanding and usage of the correct probabilistic terms to describe complementary and exclusive events.			Drill and Practice Lecture Research		1
Understanding	To use statistics and random to support your decisions regarding	Maths	10-11	Problem base solving Problem Resolution	Excel	2

and application of basic concepts of random.	everyday subjects.			Research		
	To make predictions and discuss if results are tallied or not with these predictions.			Problem base solving Problem Resolution.		1
	To use digital sources to work with bigger samples. Use it for problem solving.	Maths		Problem Resolution Drill and Practice Research	Excel Access	1

1.2.2. Curriculum overview of Secondary Education – Catalonia (Spain)

Key content	Learning objectives / Competencies	Subjects	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
13. Sense of statistics (Using statistics as a tool)	1, 4, 5, 6	Biology Maths Chemical Physics Economy statistics History	12 - 15	Problem solving collaborative work	Excel Calculator	12 h/year
	Research design		12 - 13	Problem solving collaborative work	Excel Calculator	
	Data collection		12 - 13	Problem solving collaborative work		
	Concepts: Qualitative and		12	Problem solving		

	quantitative data			collaborative work		
	Concepts: population, individual and sample		13 - 14	Problem solving collaborative work		
	To represent data with frequency tables (one-way tables),		13	Problem solving collaborative work		
	Concepts: variables (measurement scales)		14	Problem solving collaborative work		
	Interval (measurement scales)		14	Problem solving collaborative work		
	Concepts: design, sample and aleatory answers		15	Problem solving collaborative work		
	Concepts:		15	Problem solving		

	unidimensional and bidimensional data			collaborative work		
14. Data, tables and statistics graphs (tools)	7, 9, 10, 12	Maths, technology, biology science (in general) History Biology		lecture drill and practice	Excel Calculator	18 h/year
	To display data in basic charts (bar code, pie chart, etc…)		12 - 13	Lecture. Drill & practice	Excel Calculator	
	Characteristics and classification of data		12	Lecture		
	Spreadsheets		12 - 13	Drill & practice. Problem		

				solving. Brainstorming. PBL		
	Histograms and hanging bar histograms		14	Drill & practice		
	Box plots, scatterplots		15	Drill & practice		
15. Data analysis methods	2, 3, 8, 11, 12	Maths Statistics		Drill & practice. Problem solving. Brainstorming. PBL	Calculator	4 h/year
	Spreadsheets		12	Drill & practice. Problem solving. Brainstorming. PBL	Calculator	
	To calculate and interpret the arithmetic mean, median and mode of a data set		12 – 13 – 14 – 15	Drill & practice. Problem solving. Brainstorming. PBL		

	To calculate and interpret the measures of central tendency an spread of data		13 – 14 – 15	Drill & practice. Problem solving. Brainstorming. PBL		
	To calculate and interpret de IQR of a data set and the median		14 – 15	Drill & practice. Problem solving. Brainstorming. PBL		
	Dispersion measures: rank and deviation		14 – 15	Drill & practice. Problem solving. Brainstorming. PBL		
	Spreadsheets		14 – 15	Drill & practice. Problem solving. Brainstorming. PBL		
	Other digital resources for statistics		15	Drill & practice. Problem solving. Brainstorming. PBL		
	Inference and		15	Lecture. Drill & practice		

	prediction					
16. Sense and probability measure	1, 4, 5, 6, 8, 10, 11	Maths Biology (Mendel)			Calculator	4 h/year
	Probability rank		12	Lecture. Drill & practice		
	Concepts: “more likely”, “equally likely”, “less likely”.		12 13 - 14	Lecture		
	To determine possible outcomes of an event		12 - 13	Lecture. Drill & practice		
	Checking predictions		12	Drill & practice		
	To determine possible outcomes of an event		12	Drill & practice		
	Digital simulations to		12	Drill & practice		

	calculate probability		13 14 - 15			
	Occurrence and sample		14	Drill & practice		
	Compound events probability		14 - 15	Drill & practice		
	Conditional probability Independent Events		15	Drill & practice		
	Combination		15	Drill & practice		

1.2.3. Curriculum overview of Baccalaureat & Vocational Studies – Catalonia (Spain)

Key content	Learning objectives/Competencies	Subject	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
Elements of a statistical study: variable, population and sample.	**1.** Conducting research using the method of investigation. **2.** Treatment and interpretation of experimental data.	Biology CTMA Physical Chemical Maths Metrology and rehearsals Economy Geography	16 - 17	Research using the problem solving method. Problem-based learning Reading, analysing and interpreting Data, graphic interpreting and analysis	Excel Curve expert Geogebra The statistical lab	5 h/subject all the key content in class but students spend more time. 2 h/subject all the key content in class but students spend more time

Unidimensional distributions.	**1** & **2**	Biology CTMA Physical Chemical Maths Metrology and rehearsals Business Economy Geography	16 - 17 - 18	Research using the problem solving method. Data, graphic interpreting and analysis	Excel Curve expert Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time 2 h/subject all the key content in class but students spend more time
Calculation of median and mode and typical variation deviation in unidimensional distributions.	**1** & **2** **3.** Determination of the data centralization degree of the data for further comparison and conclusion.	Biology CTMA Physical Chemical Maths	16 - 17	Research using the problem solving method.	Excel Curve expert Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time

	4. To Know the degree of imprecision of a measure.	Metrology and rehearsals				
Calculation of different measures of dispersion: Range of the data, variance and standard deviation	**5.** Determine the degree of dispersion of the data in order to compare them and come to conclusions.	Biology CTMA Physical Chemical Maths Metrology and rehearsals				
Bidimensional Distributions	**1** & **2**	Biology CTMA Physical Chemical Maths	16 - 17	Research using the problem solving method.	Excel Curve expert Tracker Multilab Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time

Construction of simple tables and double entry tables to organise the values of bidimensional distributions.	**1** & **2** **6.** To Know how to collect and represent with graphics the experimental data adequately.	Biology CTMA Physical Chemical Maths Economy Business Economy	16 - 17	Research using the problem solving method	Excel Curve expert Tracker Multilab Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time
Adequate graphic Representation to interpret the data.	**1** & **2**	Biology CTMA Physical Chemical Maths Economy Geography	16 - 17	Research using the problem solving method.	Excel Curve expert Tracker Multilab Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time
Coefficient correlation	**1** & **2** **7.** To know the	Biology	16 - 17	Research using the problem	Excel	5 h/subject all the key content

calculation.	degree of correlation between two variables **8.** To adjust the experimental data to a polynomic lineal function	CTMA Physical Chemical Maths		solving method.	Curve expert Tracker Multilab Geogebre The statistical lab	in class but students spend more time at home as homework
Regression Lines	**1, 2, 7** & **8**	Biology CTMA Physical Chemical Maths	16 - 17	Research using the problem solving method.	Excel Curve expert Tracker Multilab Geogebre The statistical lab	5 h/subject all the key content in class but students spend more time at home as homework
Differentiation between lineal and non-lineal correlation .	**1, 2, 7** & **8**	Biology CTMA Physical Chemical			Excel Curve expert Tracker Multilab	5 h/subject all the key content in class but students spend more time at home as

		Maths			Geogebre The statistical lab	homework
Hypothesis contrasts	**1** & **2**	Biology & CTMA Research Essay	16 - 17	Research using the problem solving method.	Excel	5 h/subject all the key content in class but students spend more time at home as homework
Khi Frame	**1** & **2**	Biology & CTMA Research Essay	16 - 17	Research using the problem solving method..	Excel	5 h/subject all the key content in class but students spend more time at home as homework
Calculator Use in order to stablish statistical calculus	**1, 2, 3, 4, 5, 6, 7** & **8**	Biology & CTMA Research Essay	16 - 17	Research using the problem solving method.	Excel Calculadora	5 h/subject all the key content in class but students spend more time at home as

						homework
Assessment and oral exposition	**1, 2, 3, 4, 5, 6, 7** & **8**	Geography			PREZZI POWERPOINT KAHOOT	
Interpretation of data and verification of data and hypothesis	**2**	Social Sciences Geography	14 - 15 16 - 17	Read and analyse and interpret data in different formats, graphics, statistics, thematic maps, etc.	Text Processor	1 h/subject all the key content in class 2 h/subject all the key content in class

1.3. CONCLUSIONS OF THE CURRICULUM OVERVIEW

Next, the main conclusions that can be drawn from the curriculum overview in relation aspects are presented: a) the escalation of the contents related with statistics and probability throughout the different stages; b) the time used to develop statistics and probability competences; c) the teaching methods developed; d) the type of technology employed; and e) the inter-relations between other subjects.

a) The escalation of the DA contents throughout the different stages

The curriculum in primary and secondary education is organised attending the same structure: five blocks of contents, namely: Numbering and calculation; Relations and changes; Space and shape; Measurement; Statistics and probability; and 12 competences grouped in four dimensions, namely: Problem solving, Reasoning and testing, Connections and communication, and Representation. This common structure of the curriculum ensures that DA contents are developed throughout aIn ll the stages of the educational system. Besides, students deal with contents related to Sense of statistics; Data, tables and statistics graphs; Methods; and Sense and probability measure.

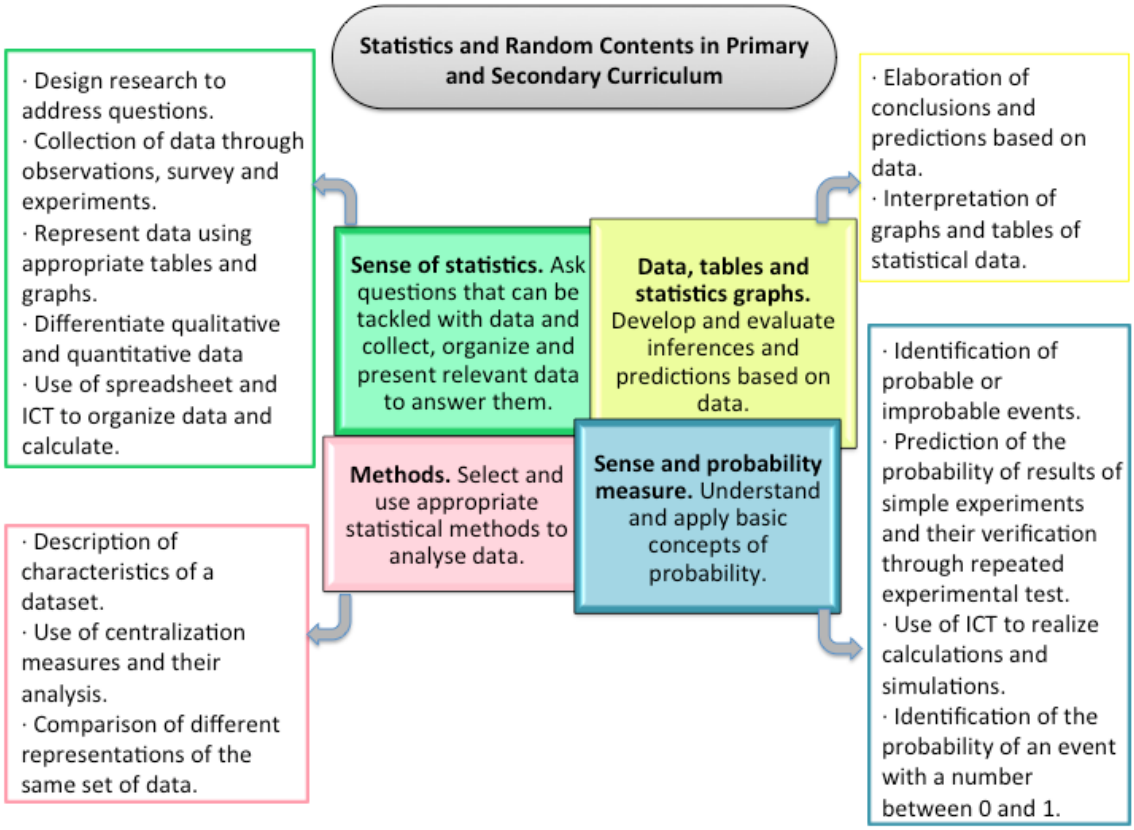


Figure 2: Statistics and Random Contents in Primary and Secondary Curriculum

Figure 2 displays a summary of the data analysis contents that are included in maths primary and secondary education.

b) Time invested in teaching DA contents

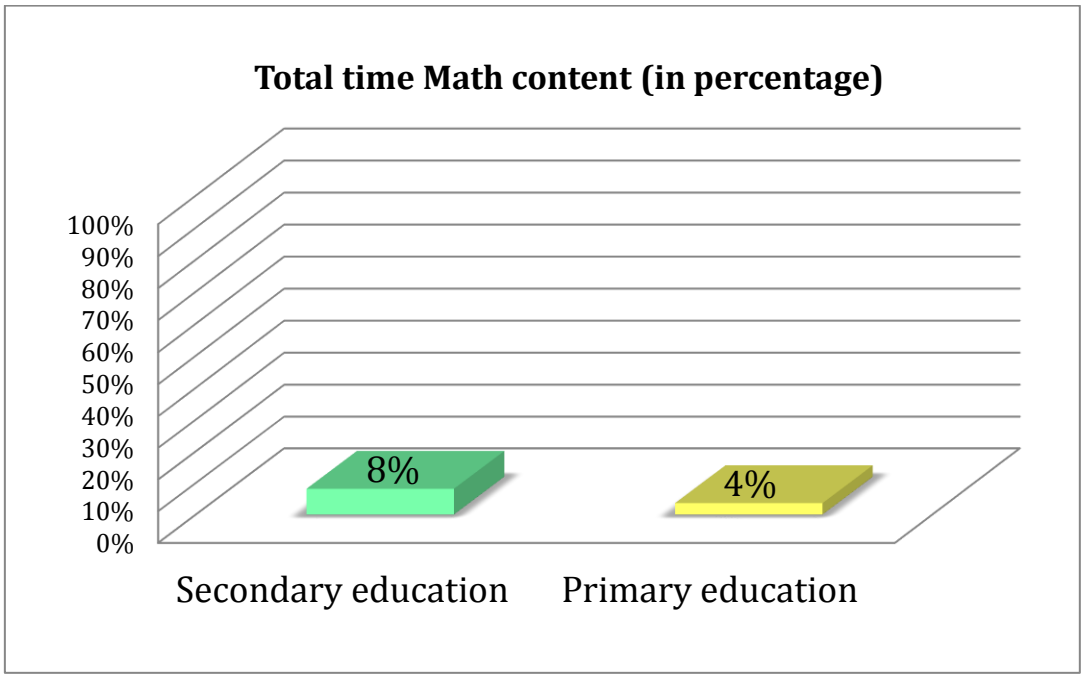


Figure 3: Total time Math content -in percentage-

The time invested to teach the block of statistics and probability contents increases progressively in the educational system. This is due to the higher number of subjects in which this content is involved. For example, in primary education this content is learnt in Mathematics lesson, whereas in secondary and baccalaureate education this content is also taught in biology, chemistry, economy, and history lessons.

However, it is worth to be noted the reduced hours dedicated to this content. Figure 3 presents approximately the time dedicated to teach DA contents in primary and secondary education. We have calculated the time invested in teaching DA contents as follows: In primary education there are 125h Math class yearly. So, within the 6 courses of this stage, there is a total of 750h. From this total, 27h are designated to the teaching of statistical content. As to secondary education, during the first year, there are 93h of Math class yearly, and in the 3 subsequent years, there are 125h per year. The total of hours in the four secondary courses is 468h, of which 38h are meant to teach DA contents.

We can conclude that although one block of mathematics contents out of five is devoted to statistics and probability, in practice, teachers dedicate less time to teach statistics than the other four block of mathematic contents (namely: Numbering and calculation; Relations and changes; Space and shape; Measurement). In our view, this finding may show that primary and secondary teachers may not feel the importance of data analysis in promoting students' statistical literacy which it will help citizens to be freedom and responsible data consumers because statistical literacy will aid citizens to take critical decisions accordingly to specific data. SPIDAS project will contribute to shift this situation

by designing, implementing and communicating good data analysis teaching practices.

c) Teaching methods

In primary and secondary education, the most used teaching method is drill and practice, where students put in practice DA content to solve well-defined problems, with non-contextualized data, and where the data sets are provided by the teacher. Research has already claim that this type of methodology does not help students to understand the contents and develop the competences to apply them to solve problems and make decisions in everyday life (Jimenez, Suñé & Alonso, 2012; Zamora, Aciego, Martín-Adrián & Ramos, 2017). Therefore, there is a need to develop good teaching practices in Catalonia in primary and secondary education so as to teach DA contents in more significant ways.

In Figure 4 is represented the teaching methods used by teachers when teaching DA contents. The methods are presented depending on the frequency in which each method is used at each stage of the educational system. It is worth to highlight that teachers have already started to develop other methodologies, such as problem-solving or project-based learning, to teach DA contents. SPIDAS intends to contribute with this line of work.

Collaborative work has only started being used in secondary education by means of project-based learning. Educational research has already backed the positive impact of collaboration on students' learning (Brindley, Blaschke & Walti, 2009; Revelo-Sánchez, Collazos-Ordóñez & Jiménez-Toledo, 2018).

In baccalaureate education as DA contents are related to other subjects where teachers use a research or inquiry-based methodology.

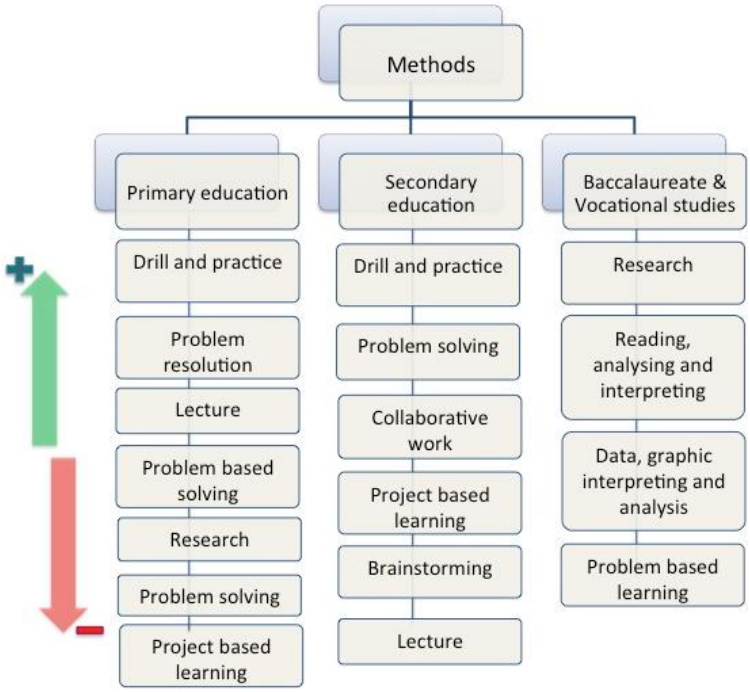


Figure 4: Pedagogical methods

d) Technology and Mathematics

In Figure 4 is represented the technology employed by teachers to teach DA contents. The technological tools are presented depending on the frequency in which each technology is used at each stage of the educational system. As it can be seen, spreadsheets (Excel) and calculators are the most used technologies in all the different stages. In secondary education, there is not any other technology used.

Other technologies are used in baccalaureate education, which are related to contents of other subjects, such as Biology and Chemistry, where DA contents are more contextualized and applied to practical and significant activities.

As a conclusion of the curriculum overview about ICT tools used for teaching DA conctents, we can claim that there is a need to increase the contextualization of the DA contents with practical and everyday life activities, as well as increase and diverse the technologies that can mediate and promote students' learning.

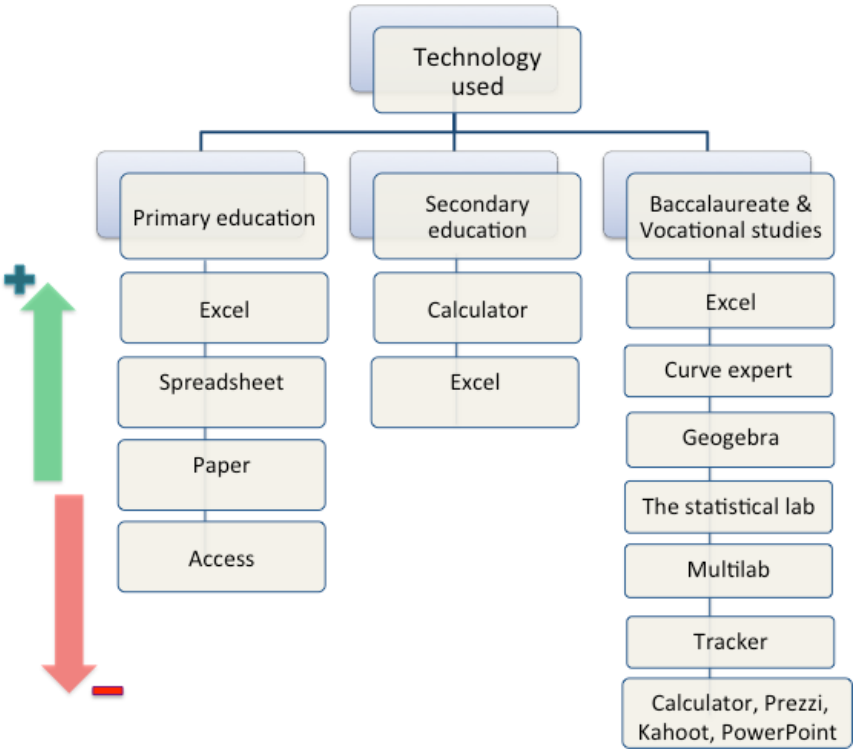


Figure 4: Technology used

Educational research has already shown the affordances of technology in promoting better mathematics learning. For example, Konold and Kazak (2008) suggested that TinkerPlots allows students to manipulate interactively and dynamically graphical data and this increased students' visual reasoning. In the same line of research, Huscroft-D'Angelo et al. (2017), Ersoy & Akbulut (2014), Eyyam & Yaratan (2014) i de Pierce & Stacy (2004) [cited in Higgins, Huscroft-D'Angelo & Crawford, 2017] showed how technology had a positive impact on students mathematical attitude, better mathematical knowledge understanding and in turn, better learning.

e) Inter-subjects teaching of DA contents

In the secondary education curriculum, we can see more often that the measuring and statistical contents are the ones with more connections with other disciplines, and the ones that offer more real contexts. In 1st grade of ESO, the following subjects appeared related to Mathematics: **Natural Sciences** (mass, volume, density, measuring tools, map reading and interpretation), **Social Sciences** (interpretation of climographs, historical time line, and other statistical tables and graphs), **Music** (harmony and rhythm), and **Technology** (scales and benchmarking).

In 2nd grade of ESO, the following subject are related: **Natural Sciences** (climate and temperature, scales), **Social Sciences** (historical time lines, statistical tables and graphs, population pyramids, other statistical sources), **Physical Education** (heart rate and effort/work measurements), **Visual Education and Visual Arts** (3D models/shapes construction), and **Technology** (shapes, Ohm law, food labelling analysis).

In 3rd grade of ESO, the mathematical contents are related to: **Natural Sciences** (chemical reactions, dietary calculation), **Social Sciences** (economy, taxation, percentages), **Visual Education and Visual Arts** (image creation), **Physical Education** (heart rate and eating habits), **Music** (reading and writing of musical notation), and **Technology** (housing design, industrial process, energy saving strategies).

In 4th grade of ESO, the mathematical contents are related to: **Natural Sciences** (measurement scales, genetic inheritance laws, forces and movements), **Social Sciences** (economy), **Visual Education and Visual Arts** (shapes and 2D representations), **Physical Education** (rating systems), **Music** (auditory analysis), and **Technology** (technological problems, basic trading documents).

Generally speaking, all along the secondary education stage, students work with the mathematical contents in subjects such as Natural Sciences, Social Sciences, and Technology. Other subjects, that work with mathematical contents in three out of the four grades of secondary school and are worth to be noticed, are Music (1st, 3rd, 4th), Visual Education and Visual Arts (2nd, 3rd, 4th), and Physical Education (2nd, 3rd, 4th).

2. SPANISH AND INTERNATIONAL WEBSITES WITH INTERESTING INFORMATION ABOUT STATISTICS

The objective of this section is to report on valuable Spanish and international websites about statistics. We have also searched other European projects that have worked with data analysis. The information found in these websites might help teachers to clarify statistical concepts and be good resources to design learning activities, and we hope to use these resources in SPIDAS project. In most of the websites, Statistics basic concepts are explained.

a) L'Institut Nacional d'Estadística [http://www.ine.es/explica/explica.htm]

This is an informative portal where accessible contents are explained, targeting laymen audience. They spread information through simple activities, videos, games, and user-friendly apps.

After a brief introduction about what is Statistics, they explain concepts like randomness and probability by providing some examples. In another section, they explain descriptive Statistics (absolute and relative frequency, central tendency measures, and spreading measures) and the statistical inference (parametric and non-parametric inference, dependence of variables, predictive models, hypotheses contrast). At the end of both sections, there is a brief quiz and with closed questions about the previously explained contents. There is also an explanation of how to gather data and how to present the results of a survey. The section *"Statistical bits"* contains short videos explaining statistic main concepts. Finally, there is another section for official statistics where they explain how do they come up with such statistics.

Displaying a more modern layout, there is the informative website about Statistics of l'Escola Andalusa de Salut Pública (Divestadística) [http://www.divestadistica.es/es/index.html]. This is a quite clear website that separates Statistics theory *("Learn")* from Statistics related with everyday life *("Statistics around you")* and from news in the subject *("What's new?")*.

In the "*Learn*" section, there are informative articles that go over methods, techniques, and concepts to understand Statistics better - for example: *La investigación por muestreo y las encuestas; Eligiendo el método de muestreo más apropiado; Los errores de las pruebas diagnósticas; Probabilidad-la medida de la incertidumbre*. In this section, the theoretical content is divided in two subsections: elementary and advanced.

In *"Statistics around you"*, there are four subsections: [1] informative articles (*Se puede ganar a la ruleta usando la estadística; Música estocástica; La estadística mide la audiencia de TV; Estadístico en la luna*); [2]Statistics cinema (documentaries and feature films that have integrated Statistics as part of their plot); [3] Statistics on the net (Google Fusion Tables, Eurostat -estadístics de la UE-); [4] Projects *"I+D+i"* that have employed Statistics as their main axis (e.g. an statistical model to detect ovarian cancer; differences in the use of public health services among native and foreign population)

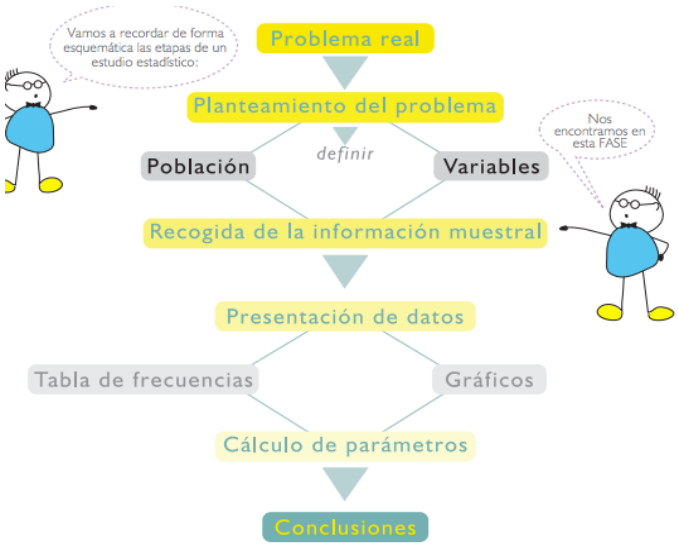
In the *"What's new?"* section, there is some information about the conferences and congresses, as well as other activities related to Statistics that are being carried out internationally, or updates or

innovations in the matter (e.g. information about worldwide sanitary statistics or population census).

Finally, there is a section for a specific dictionary of Statistics.

b) L'Institut Canari d'Estadística
[http://www3.gobiernodecanarias.org/istac/webescolar/index.php]

This website provides information for the teaching community. It has lots of ready-to-use class materials, both for primary and secondary school. There activities to do in class and printable PDF worksheets for students (graded by specific levels: primary, 3rd and 4th grade of obligatory secondary school -ESO-). Some of the topics intended to work with at ESO are: *ICT use, physical activity made during free time, recycling, active population surveying*.



The website also provides teaching guides for the suggested projects with the specific activities to be carried out - it explains the objectives and the recommendations to be done in the classroom for each stage (see previous image).

There is a section containing several closed question quizzes to assess students' statistical knowledge (the quizzes are graded accordingly to the school levels: primary school, ESO and non-obligatory high school).

c) L'Institut d'Estadística de les Illes Balears
[http://www.caib.es/sacmicrofront/contenido.do?idsite=1365&cont=29875&lang=es]

This website has as its main objective to get high school students familiarized with the subject. There is a more theoretical section, where they briefly explain what is Statistics, what is it used for, where to retrieve data, and how to do a statistical study. Another section is dedicated to different exercises divided into the four courses of ESO. One example can be an activity for 1st grade of ESO, where it is necessary to analyse some data about unemployment (6 short questions must be answered, e.g. *"Do you think it is possible to state without any room for doubts that unemployment is growing?"; "What calculations have been done on the third column?"*). All of these are short activities about different topics (many of which use charts from the newspapers: *unemployment, weather, nationalities of students in Mallorca, schooling level, truism,*

immigration, forest fires, rain, calls to emergency number 112, daylight hours, etc.)

On the Idescat website [http://aprenestadistica.idescat.cat/] they explain what is Statistics and there is a series of activities for primary and secondary school. - It' won't be that useful, otherwise it'll be a chaos.

d) On the Xtec website, CREAMAT [http://srvcnpbs.xtec.cat/creamat/joomla/index.php/estadistica],

This webside proposes different activities to go over Statistics at both primary and secondary school. Here are some examples of the projects they have carried out:

- Higher courses of primary school - School Els Estanys de Platja d'Aro: *Which is the impact of the school day schedule on our environment?*

  They have calculated the daily average of kilometres that students do every day to go to school. Knowing the kilometres done, they have calculated the petrol/ diesel consumption.

- Higher courses of primary school - School Pit-roig de Barcelona: *When and where there is more noise in our school?*

  Students built up a thermometer to measure acoustic pollution. They used Ecodad, a software that allows to see through charts the noise levels in certain space.

- Higher courses of primary school - MATHEMATIC CLUB GOOGOLPLEX (Institut Lluís Domènech i Montaner, Escola Misericòrdia, Escola Turó del Drac, Col·legi Yglesias, Escola el Pi Gros: *What if all students in Catalonia attended to the same school?*

  Students have looked up the total number of students in Catalonia, from 1st grade at primary school till 4th grade of ESO. Then, they have calculated how many classes there would be for each grade, how many paper sheets would be needed if everyone was to take the same exam, and how much space would be needed if everyone should fit in the same classroom and under which conditions.

- 2nd of ESO - INS Les Vinyes de Cubelles: *What is the volume of human blood in the world?*

  Students have looked up the world's population sorted by ages, the average weight by age groups, and the amount of blood that there is per kilogram.

- 3rd of ESO - Oak House School /Casa del Roure de Barcelona: *Are libraries being more visited since the crisis?*

  Scatter plot: yearly number of registrations for a twelve years period. The first year of crisis, library registrations increased considerably.

- 4th of ESO - INS Arnau Cadell de Sant Cugat del Vallès: *What is the increase of public transportation fees?*

  Students looked up the public transportation prices of the last years and calculated the increase percentage.

- 4th of ESO - INS Castell d'Estela d'Amer: *What square surface would all people in the world do?*

  They have calculated how many people would fit in a square meter.

- 1st of non-obligatory high school (baccalaureate) - School Immaculada Concepció Horta de Barcelona: *Can we analyse creativity?*

  A statistical study about creativity perception. Students have shown four drawings to participants, who had to rate which the one that seemed more creative. from their answers, students have done some charts comparing gender, age, etc.

There is also the following information:

- Apps to draw statistical graphics and charts:
  - http://nlvm.usu.edu/es/nav/topic_t_5.html (bar graphs, histograms)
  - http://eduteka.icesi.edu.co/MI/ (math activities - statistics)
  - http://illuminations.nctm.org/ (mean, linear regression problems...)
  - http://illuminations.nctm.org/Activity.aspx?id=4098 (fill out a table that can be automatically converted into bar chart, sector chart or pictograms)
  - http://illuminations.nctm.org/Activity.aspx?id=3476 (graphics: histograms, point cloud, bubble cloud...)

- Statistical graphics in 3D:
  - Make charts from creating a customized dice for each student and stack them for example, depending on whether they are an only child or by the number of siblings.
  - Another example is to make a human graph with the students: histogram of heights.

Institut Gallec d'Estadística [http://www.ige.eu/estatico/educacion/index.htm] They have created an educational website aimed to spread out this topic. It has a section where they explain different concepts of Statistics combinig theory and practical examples (percentages, taxes, probability, descriptive statistics, regression, time series, etc.) There is another section for graphical representations. It will not be useful to us because it is not an updated website and it is only available in Gallego.

2.1. OTHER INTERESTING WEBSITES AND PROJECTS TO DESIGN THE PILOTS

It is worth to mention the two previous Erasmus+ projects that involve the educational promotion of data analytics in schools and comprise previous work upon which we can build on our project.

The first project is *Promoting civic engagement via explorations of evidence* [http://community.dur.ac.uk/procivic.stat/]. The aim of this project was to develop new methods for Statistics instruction for high schools and universities in order to help students to understand quantitative evidence about key social phenomena that influence civic life. They wanted young people to be aware of the importance of Statistics in understanding evidence. In the following link of the project some examples of classroom activities can be found: [http://community.dur.ac.uk/procivic.stat/index.php/teaching-materials/]

The other project is *I use statistics in education* [http://www.i-use.eu/]. The aim of this one is to promote and expand the use of updated statistics in education for both students and teachers. In the next link of the project some worksheets can be found:

[http://www.i-use.eu/resources/worksheets.html]

2.2. TABLE THAT SYNTHESISES THE WEBSITES

Name of network	Website (Contact)
National Institute of Statistics. http://www.ine.es/explica/explica.htm	The contents are accessible to a non-expert audience through simple activities, videos, games and easy to understand applications.
Divestadística is a scientific dissemination project of the Andalusian School of Public Health. http://www.divestadistica.es/es/index.html	Its objective is to disseminate statistical knowledge in a comprehensible manner for the entire population, including professionals from other areas of scientific knowledge who are not specialists in Statistics. Since 2012, Divestadistica is part of the International Statistical Literacy Project (ISLP), an international project whose objective is to promote statistical culture around the world. The contents of Divestadística are periodically renewed and all of them are prepared by professionals with training in Mathematics or Statistics who develop their teaching and research

	activity in this field.
Canary Institute of Statistics. http://www3.gobiernodecanarias.org/istac/webescolar/index.php	This space has been developed to offer the educational community resources and specific information of statistical content that can contribute to the improvement of the statistical culture of the students (primary and secondary education), and to collect different aspects about the treatment of the information. *Examples of statistics through projects (for primary and secondary education):*[*http://www3.gobiernodecanarias.org/istac/webescolar/secundaria.php*]
Statistical Institute of Catalonia - IDESCAT. http://aprenestadistica.idescat.cat/	Primary and secondary education. Explain what statistics are and what it is for. There is a set of activities to apply the statistics using real data. Statistical concepts and how to interpret the data in a clear and understandable way with the definitions and animations that are collected in the glossaries of each web.
Institute of Statistics of the Balearic Islands. http://www.caib.es/sacmicrofront/contenido.do?idsite=1365&cont=29875&lang=es	Secondary education. *Activities for each course of secondary education* [*http://www.caib.es/sacmicrofront/contenido.do?mkey=M101026113557155281 06&lang=ES&cont=29542*]
Galician Institute of Statistics. http://www.ige.eu/estatico/educacion/index.htm	Definitions of theoretical concepts and activities.
Resource center for teaching and learning mathematics (CREAMAT). http://srvcnpbs.xtec.cat/creamat/joomla/index.php/estadistica	The purpose of Creamat is to provide resources to schools and faculty of the different non-university educational stages to achieve a better achievement and development of the competences of students in the mathematical field.
TIBCO Statistica http://www.statsoft.com/Textbook/Elemen	Information about statistics concepts.

tary-Statistics-Concepts/button/1	
Mobile learning in statistics education. https://www.mittag-statistik.de/app/index.html	This statistics app contains a set of interactive learning objects to be used in statistics education at universities or secondary schools. The app enables the user to “try out“ statistical concepts or to interactively visualize interesting data sets. The app operates on desktops and as well on smartphones or tablets. - Descriptive statistics - Probability distributions - Parameter estimation and testing - Visualization of data sets

3. EXISTING RESEARCH ABOUT DATA ANALYTICS TEACHING AND LEARNING IN SPANISH EDUCATION: A REVIEW OF SPANISH TEACHING OF MATHEMATICS JOURNALS

The objective of this section is to identify effective and relevant practices in the arena of data analytics that have been already carried out and reported in didactical journals. The analysis of this literature will shade light about key educational variables to be taken into account in order to design the pedagogy of SPIDAS project.

Next, we will present the literature research process we followed in order to select the papers and the main findings we encountered.

3.1. LITERATURE RESEARCH PROCESS

A thorough literature review was carried out to identify relevant papers on data analytics in primary, secondary, and high school education in Spanish language. The papers developed at university level were not considered for this review.

We selected the articles from three data-bases: Scopus, ERIC and the Spanish data-be: in-recs. Additonally, we selected some articles from the websites of the following pedagogical journals: *Revista de investigación en educación*, *Revista de Investigación Educativa*, *Enseñanza de las ciencias, Revista de investigación y experiencias didácticas, Educación XXI, Aula de Secundaria, Números, Revista de Didáctica de las Matemáticas, SUMA, Revista para la enseñanza y el aprendizaje de las matemáticas, Unión, Revista Iberoamericana de Educación matemática y Uno, Revista de didáctica de las matemáticas.*

We have searched upon the following key words: statistic*, math*, creative*, project-based learning.

After this process, seven articles related with the teaching and learning of data analysis were found.

3.2. FINDINGS

The literature review has revealed that the school interest for statistics has increased during the last years. In one of the highest ranked mathematics didactic journal in Spain, named UNO, a special issue entitled: *Managing data, extending the citizenship*. It came out in October 2017. This special issue reflects about the necessity to promote in schools the statistical literacy as a means to encourage critical citizens capable to take decisions in their everyday life. Besides, this special issue presents real-classroom experiences that have been successful in reaching this objective and invite other teachers to follow this path.

We also have reviewed two other articles appeared in another high standard didactic journal named *NUMEROS* in which data analysis competences are promoted in real-classrooms activities.

Although, there is an increased interest on promoting statistical literacy and data analysis competences in real-classrooms, we can claim that this has not yet reached the desirable acceptance and dispersion because of the reduced number of articles found (7 articles). This fact emphasises the need to follow up the research in this area and the necessity to develop good teaching practices that could help more teachers to think about the importance of developing statistical literacy in our students and be inspired to design data analysis lessons. The SPIDAS project is set indeed in the right direction.

Next, we present a synthesis of the seven didactic papers about statistics and data analysis found in this review. The revised didactical papers draw the next seven educative and didactical conclusions.

3.2.1. The need of promoting statistical literacy throughout all the educational levels

The papers revised claim that data analysis competences should be promoted at primary and secondary education. However, it is taught primarily at secondary education levels. However, an interesting work developed by Arteaga, Díaz-Levicoy & Cervilla (2017) promoted statistical literacy in pre-school education. In this work, 5-year-olds had to put their name on a panel above the fruit they had eaten (or not), obtaining a chart of the class' favourite fruit. Data representation allowed 5-year-old children to identify and comprehend key information about their behaviours related to eating fruits, for example: special days when the majority had eaten no fruit, such as birthdays, as they had had cake instead, the favorite fruit, etc. Students and teacher could reflect and take decisions about how the class community behaviors could change in order to take the best out of eating fruits.

3.2.2. Proposing authentic and challenging problems

The reviewed papers emphasise the need of engaging students in solving authentic, real, and complex problems. Students should not address mere pre-structured and fragmented problems according to subject-domain, but they must carry out inquires by themselves, and be engaged in real problems related to statistical contents. Authentic problems give students the opportunity to be motivated by meaningful maths in new ways. Furthermore, this type of problems can support the development of new forms of math enquiry skills. For instance, Rodríguez-Moldes (2017) describes how students participated in a multi-data analysis about how climate is changing and how students could provide data-based explanations about this scientific phenomena.

However, in other papers more simple and well-structured problems are used to promote statistic literacy. For example, Romarís, Somoza & Blanco (2017) posed to the students the problem to design and throw several models of paper airplanes to see which one travels a longer distance. They calculated the probability that each type of plane would have to fly a longer distance. Then, students calculated the maximum distance that each plane could achieve. Finally, they calculated the mean, the arithmetic median, and the mode. They represented the mean on a number line, and finally, they created a bar chart on the board. As a conclusion, students could argue which airplane model was the most successful.

3.2.3. The design of student-centred activities: hands-on activities in a problem-based approach

In all the didactic proposals revised, students had a central role in solving the statistical problem and were engaged in a shared inquiry in which they went through a complete inquiry cycle including steps such as: defining a problem, collecting data, representing data, interpreting data using meaningfully statistical concepts, and taking critical decisions.

For example, Braso (2017) designed a simulation of a lottery with rice, and students were engaged in a hands-on activity in which they worked meaningfully the concepts of probability. Students counted 100.000 seeds of rice and painted some seeds simulating the prizes. Then, students designed their simulations to contrast their hypothesis about the probability to win the prize. Besides, Braso (2017) extends this work upon the reflexion about social behaviours and beliefs around lottery, such as: luck, chances to win depending on the amount of money you spend: the more you invest the better to win a prize. The teacher is then encouraging students to develop data-based arguments and critical thinking.

3.2.4. Collaborative learning

Group work is used in all the didactic papers revised. Students work in small groups and a group solution is proposed. However, in the papers revised, it is not included specific collaborative pedagogy.

3.2.5. Promotion of creativity

Creativity is also a common variable in all the didactical proposals. Creativity took place in proposals of creative problems and challenges which invited students to think differently and creatively to eventually put into practice their statistical competences. For example, the work of Conejo and Muñoz (2017) design the workshop "Creative Fridays" in which every Friday proposed to the students to solve a statistical challenge.

Sol and Vilella (2017) invite students to consult, handle and interpret different resources (historical, weather conditions…) in order to calculate the number of German soldiers that were involved during the invasion to Russia in the Second World War.

Bonet, Font and Manrique (2017) compile creative resources to work probability concepts in a creative and manipulative way. In this work, authors show how to use dices, boxes, glasses, among other objects, to design creative activities to work with probability meaningfully.

3.2.6. Engage and motivate students

One of the most mentioned reasons why pushing teachers to explore new methodologies to teach Maths in general, and statistics in particular, is students' demotivation towards this subject.

Teachers' main objective is to motivate students to learn Maths by relating the academic contents to everyday life aspects and with the reality surrounding them. In the didactical papers revised, teachers employ the following three strategies:

a) Letting students to choose the topic and whom they want to work with. For example, Conejo and Muñoz (2017) in *Creative Fridays*, proposed every day different problems and each group of students chose the one which they preferred most.

b) Contextualising the problems in real-life topics such as climate change. Students can handle information from different resources; e.g. from the news.

c) Encouraging students to be the ones to collect the information - for example, in the article *Statistics to train free citizens* (Moldes, 2017), students had to interview elderly people by themselves. It stands out the importance of statistics

as a way of learning that can foster reasoning and better decision-making [stated by the director of the journal *"Revista Uno" (Tomàs Queralt Llopis, núm. 76, abril 2017)*, without any specific context, nor an activity example].

3.2.7. Statistical contents and competences

The papers focus on three concepts: probability, descriptive statistics (frequency, mean, median, and mode) and data representation (bars diagrams).

Furthermore, the papers focus on statistical competences and critical thinking. All the papers revised emphasised the role of using meaningfully the statistical concepts to take a decision/action or to construct an argument. Therefore, the papers highlight that the ultimate aim of teaching statistics is to develop a statistical literacy capable to foster more autonomous and free citizens in a global society that deals with big and global data.

In order to reach this ambitious objective, in the revised papers, all the problems, challenges, and activities proposed to the students involved students to reason the mathematical solutions and argue the decisions they took accordingly.

3.3. SUMMARY OF THE PAPERS REVIEWED

Conejo, I., & Muñoz, J. L. (2017). Los viernes creativos [Creative Fridays]. *NÚMEROS, 95,* 93-106.	
Education level	Third grade of secondary education (15 years old)
Participants	90
Research method (if applicable)	-
Activities/Projects (*about daily life?*)	Every Friday in the math class, students chose which subject they wanted to work and the classmates whom they preferred to carry out the activity with. The stages of the process students had to follow were: approach, aims, development, and evaluation. There were 2 teachers in the classroom. *Example of an activity:* Statement

	A very orderly pirate captain with mathematical vocation had the cannon bullets of his ship stacked forming a pyramid, like the oranges at the market. He didn't always form square-based pyramids though. After a great storm, the bullets got wet and he ordered to spread them to let them dry. After placing the last one, he observed that they formed a perfect square. There were more than four bullets, of course, as in every top notch pirate ship. Could you investigate how many bullets were there? How was the base of the pyramid like? How many floors did it have? 
Properties of data used (Data type, data set size, real life data etc)	-
Pedagogy (theoretical perspective)	This work follows Bloom's Taxonomy to design the activities: 1. Know and understand 2. Apply 3. Analyse 4. Create 5. Evaluate
Technology	One computer for each student; digital board.
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	-

Results	These projects promote the interest and motivation of the students, so that they lose the anxiety caused by this subject. The students develop statistical competences.

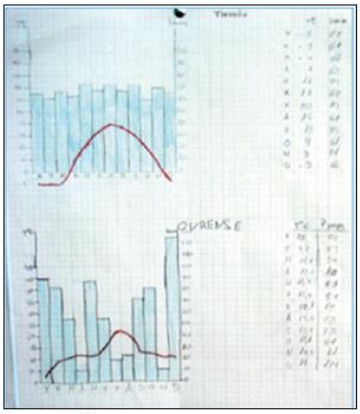
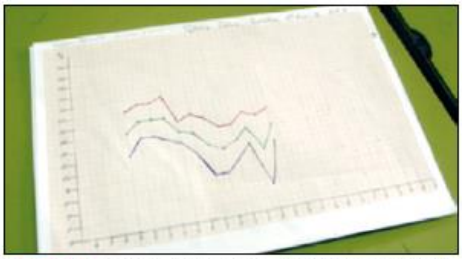
Romarís, A. G., Somoza, M. S., & Blanco, M. T. F. (2017). La probabilidad y la estadística por el aire: Una práctica con adolescentes en riesgo de exclusión social [*Probability and statistics by air: A practice with adolescents at risk of social exclusion]*. *Uno: Revista de didáctica de las matematicas*, (78), 35-41.	
Education level	Teenagers between 12 and 14 years old.
Participants	9
Research method (if applicable)	-
Activities/Projects (*about daily life?*)	They proposed to work mathematics using everyday life problems. Students threw several models of paper airplanes to see which one travelled more distance. They calculated the probability that each type of plane had to be fly the longest. Then, students calculated the maximum distance that each plane could reached. Finally, they calculated the mean, arithmetic median, and mode.
Properties of data used (Data type, data set size, real life data etc)	-
Pedagogy (theoretical perspective)	Students learn by doing, so that they become the protagonists of the teaching-learning process (Chamorro, 2005).
Technology	-
How students analyse data	First, they calculated the mean, arithmetic median and mode. Then, they represented the mean on a number line. Finally, they created a bar chart on the board.
Data collection instruments (attitude test, achievement test etc)	-

Results	The authors consider that they provided an effective teaching practice around probability and statistics.

Arteaga, P., Díaz-Levicoy, D. & Cervila, C. (2017). Gráficos estadísticos en los primeros cursos de primaria [*Statistical graphics in the first years of primary school]. Uno: Revista de didáctica de las matematicas*, (78), 7-11.	
Education level	5 and 6-year-olds. First grade of primary school and last grade of preschool.
Participants	-
Research method (if applicable)	-
Activities/Projects (*about daily life?*)	They work solving real problems: they started from a question they must work out by collecting and analysing data. Question: Which fruits we prefer in this class? During three days, the students had to put their names in a panel indicating the fruit they had eaten or under the category of "no fruit" if they had not eaten any. 
Properties of data used (Data type, data set size, real life data etc)	-
Pedagogy (theoretical perspective)	Problem based learning
Technology	-
How students analyse data	Observation of the different bar charts.

Data collection instruments (attitude test, achievement test etc)	-
Results	Analysing the differences between their graphics, children observed that there were some special days in which they barely had eaten any fruit (like birthdays, because almost always they had eaten cake) and they also made an hypothesis about the class' preferred fruits.

Moldes, C. R. (2017). Estadística para formar ciudadanos libres [*Statistics to train free citizens*]. *Uno: Revista de didáctica de las matematicas*, (76), 16-27.	
Education level	First and second of secondary education courses.
Participants	-
Research method (if applicable)	-
Activities/Projects (*about daily life?*)	The name of the project is "The climate is changing" (interdisciplinary project: maths, social and natural sciences). The students collected diverse information: meteorological information, the maximum and minimum temperatures of representative geographical areas around the world (Ecuador, North and South Hemispheres), as well as in Galicia and Spain in general. They made climatic maps. They also attended to expert talks on climate change and its possible consequences, analysed information from the media, and collected opinions from the elderly (about how they perceived the climate when they were young).
Properties of data used (Data type, data set size, real life data etc)	-
Pedagogy (theoretical perspective)	Interdisciplinary project (Math, Social and Natural Sciences)
Technology	-

How students analyse data	From the analysis they obtained data such as that the differences between the maximum and minimum temperatures of Las Palmas, that were lower than in Madrid, or which are the coldest places in Spain.  Imagen 1. Climogramas  Imagen 2. Gráfica de temperaturas diarias en un lugar
Data collection instruments (attitude test, achievement test etc)	Climogram Graph of daily temperatures
Results	-

Sol, M. & Vilella, X. (2017). Más allá de los parámetros [*Beyond parameters*]. *Uno: Revista de didáctica de las matematicas*, (76), 32-38.	
Education level	First and fourth grade of secondary school.
Participants	
Research method (if applicable)	
Activities/Projects (*about daily life?*)	-First course: <u>description and interpretation of data</u>. Based on some graphs, students had to answer some questions, such as *how many soldiers had participated and how many had survived the Second World War and the Punic Wars? What percentage of soldiers from the army of Anibal had crossed Catalonia?* -Fourth course: <u>interrelation of two variables</u>. Students must search the relationship between the lenght of some fossil bones.
Properties of data used (Data type, data set size, real	

life data etc)	
Pedagogy (theoretical perspective)	
Technology	GeoGebra (correlation; 4th of secondary education)
How students analyse data	They interpreted the linear regression.
Data collection instruments (attitude test, achievement test etc)	
Results	-

Brasó, E. (2017). Las loterías, un impuesto voluntario [*Lotteries, a voluntary tax*]. *Uno: Revista de didáctica de las matematicas*, (76), 28-31.	
Education level	-
Participants	-
Research method (if applicable)	Solving a real problem.
Activities/Projects (*about daily life?*)	This teacher proposed the following question: "Why do we play the lottery?" He intended to compare the Christmas lottery with rice grains. Steps followed: 1. A handful of rice was given to each student so that he or she counted the number of grains containing. 2. The counted grains were added and, gathering the rice again, and weighted. 3. Carrying out the corresponding proportion, they calculated approximately the weight of 100.000 rice grains. The result, which depended on the type of rice, was between 2.5 and 3 kg. 4. They coloures a grain of rice which would be "El Gordo" (the “fat” prize). 5. They mixed it inside the container. 6. The draw consisted of paying €200 to blind catch a grain.

Properties of data used (Data type, data set size, real life data etc)	
Pedagogy (theoretical perspective)	
Technology	-
How students analyse data	
Data collection instruments (attitude test, achievement test etc)	
Results	Rice simulation clashes with the intuitive assessment of the probability of winning.

Bonet, G., Font, I., Manrique, A. & Grupo MatGI (2017). Materiales para trabajar la probabilidad [*Materials to teach probability*]. *Uno: Revista de didáctica de las matematicas*, (76), 39-42.	
Education level	All the levels (adapting the difficulty).
Participants	-
Research method (if applicable)	Experimental
Activities/Projects (*about daily life?*)	The authors propose to work probability experimentally, through the following activities: 1. They presented to the students 22 boxes with «prizes» that ranged between € 0.01 and € 250,000. The game consisted in picking a box of which the content is unknown, and choosing, also blindly, five more boxes whose content was later displayed. The challenge then was to decide whether to go for the five boxes shown or keep the initial one. They asked participants to look for a winning strategy. In order to do so, students played and analysed the results in small groups. In this activity they were able to work from basic concepts of probability, to the more complex concept

	of mathematical hope. 2. They presented three glasses facing down, one of which contained a coin inside it. A student chose a glass at random and separated it from the others. Then the teacher lifted one of the remaining glasses (which did not contain the coin) and offered the student the possibility to change glass or to stick with the one originally chosen. They were able predict the result probability of a game of chance and verify whether these intuitive predictions were erroneous by repeating the experimental test and the theoretical calculation.
Properties of data used (Data type, data set size, real life data etc)	
Pedagogy (theoretical perspective)	Learning through manipulative materials and in-class experiments
Technology	-
How students analyse data	
Data collection instruments (attitude test, achievement test etc)	
Results	-

4. STUDENTS' INTEREST

A focus group technique was developed in order to know students' knowledge and interests about weather, climate and climate change.

The focus group lasted one hour and the procedure we followed was the following:

1. Students watched the video *Climate Change 1*

2. Individually, they were asked to write down in a piece of paper ideas about:

What / who is responsible for extreme climate episodes?

What actions/ who / how could we mitigate these extreme climate episodes?

Students had around 5-10 minutes to answer (depending on the age).

3. We grouped students in groups of 4-5 students and gave them a big paper (an A2 paper sheet) to be placed in the middle of the group's table in which we had written the aforementioned two questions. Then we asked students to share, discuss ideas, and write their common ideas down on the paper.

What / who is responsible for extreme climate episodes?	What actions / who / how could we mitigate these extreme climate episodes?

4. After round 20 minutes, we gave to each of the student groups another big paper with these questions to be discussed.

How do weather and climate change affect our life?	Which of these affections would you like to study and know more about? Why?

In order to enrich students' discussion, after 10 minutes of group work, they watched the video *Climate Change 2*, and then, they followed up their discussion.

We collected both the individual notes and the group notes.

4.1. PARTICIPANTS

63 students aged between 12 and 16 years old participated in the focus groups (1st, 3rd and 4th grade of ESO).

4.2. DATA COLLECTION

Individual answers and group answers written in a common A2 paper.

The answers were transcribed and grouped up depending on their similarities.

4.3. FINDINGS AND DISCUSSION

4.3.1. Individual answers

Except 3 students, everyone else reckoned that human actions are responsible for climate change. They mentioned pollution and associated it to car use, factories, industries, use of fans and air conditioning. Furthermore, many students highlighted the use of plastic as a human action responsible for pollution and climate change.

"The climate change is a natural consequence but humans change it with factories that produce CO2 to the atmosphere."

To reduce the extreme climate episodes, the most frequent answers were: to recycle, to produce more electrical cars, and to use renewable energy. Only five students proposed actions explicitly linked with their daily life, four students proposed controlling the use of water, and one mentioned turning off the lights.

Some commented that we should stop climate change with our actions, but did not pose any solution or alternative.

Regarding how climate change affect us, the answers tended towards human health, they mentioned respiratory diseases and allergies; as well as to the lack of consumable products and foods, due to draughts destroying crops. Only 4 students spoke about animal suffering due to heat – attributing water and food shortage to it.

4.3.2. Group answers

All 15 groups considered that humans are responsible for the extreme climate episodes. 13 of them blame car use, and 7 of them pointed factories too. Another answer repeated in several groups, although just a few, was the fact that we do not recycle.

Referring the answers to reduce the extreme climate episodes, most of the groups mentioned that we should use the least cars, and 9 groups agreed that we should promote the use of electrical cars. 11 groups recommended recycling. 2 of these remarkably proposed a change in the legislative framework (creating more restrictive laws).

Regarding how climate change affects our everyday life, 8 groups wrote about the health problems that it causes, 6 about food shortage, 4 mentioned it affects our state of mind, and only 1 group said it affects animals.

4.4. DISCUSSION AND CONCLUSIONS

Humans are mentioned as a key responsible actor for climate change. Therefore, students are aware that certain human actions are causing extreme climate episodes

Students associate climate change to: use of cars, too many industries, excess in the use of air conditioning and plastics. It seems that students' answers are strongly by the media. For example, currently in Catalonia, there is an observable media encouragement to buy electrical cars, which is being reflected in students' answers.

However, students have a poor knowledge about the actions that could be taken to mitigate climate change and how it affects our everyday life. The actions mentioned by the students to reduce climate change are situated in a global scale (fewer industries, less use of plastics, use of electric cars…) but not in the individual scale, in which students could be involved. Therefore, the people involved to address these actions are organizations or governments, for example, using less cars and factories; yet they do not mention any action that could be carried out individually or within communities close to them (the city council, the neighbour community, their school…), like consuming less water at a particular level.

This conclusion is also applicable to students' thinking about the consequences of climate change in our everyday lives. Students mention global changes: melting poles, fewer polar bears, but not any change that affects them personally.

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