

**A Robust Approach to Statistics Education in Your School:  
Considering Sociocultural Contexts, Involving all Teachers,  
Accessing Data, and Using Technology**

A Brief produced at the Park City International Seminar  
Park City Mathematics Institute July 5-9, 2016

Quantitative information is everywhere, and statistics are increasingly presented as a way to add credibility to advertisements, arguments, or advice. Being able to properly evaluate evidence (data) and claims based on data is an important skill that all students should learn as part of their educational programs. The study of statistics provides tools that informed citizens need in order to react intelligently to quantitative information in the world around them. Yet many research studies indicate that adults in mainstream society cannot think statistically about important issues that affect their lives.

Ben-Zvi & Garfield (2004)

In the Americas many social, cultural, environmental and scientific considerations are very important in promoting national development. Schools are one possible place where such issues can be confronted and studied in constructive ways that help societies form the kinds of citizens they need for the 21<sup>st</sup> Century. Conscientious identification of problems, data collection and data analysis can be a key element in addressing these important issues.

Moore (1998, p. 1254) insisted that statistics “is an independent discipline with its own core ideas rather than, for example, a branch of mathematics”. At the secondary level, some countries require a specific statistics course or courses(s) while other countries locate statistics within their mathematics courses. Even in those countries with specific statistics courses, they are usually taught by mathematics teachers. But, to address problems related to social, cultural, scientific and environmental issues, teachers from all disciplines should collaborate to ensure that statistical experiences take advantage of multiple perspectives.

*Guidelines for Assessment and Instruction in Statistics Education*, often referred to as the GAISE Report, (Franklin, et al., 2007), suggested that statistical problem solving is an investigative process that involves four components (and the curriculum frameworks of many countries reflect similar components). For each component we have suggested sociocultural considerations that might be considered and present relevant examples.

I. Formulate Questions

→ clarify the problem at hand

How is the problem relevant to your school, your community, your country or other context? For example,

How can the collection and analysis of data help you understand issues related to garbage in your school and community?

What percentage of children in your community are in school?

How does gasoline consumption impact the national economy?

How does inflation influence family budgets?

Are there special socio/cultural conditions that will make a difference in how a particular problem is approached? For example,

Does the local culture permit children to actually collect garbage?

Is there access to appropriate data sets?

→ formulate one (or more) questions that can be answered with data

## II. Collect Data

→ design a plan to collect appropriate data

If the plan involves interviews, are there some individuals or groups that require special consideration. For example,

Are there situations in which certain groups of one gender or subculture must be interviewed by individuals from the same group?

Are some questions so sensitive that accurate answers will not be forthcoming?

Does a social studies teacher at your school have special insight into these issues?

→ employ the plan to collect the data

## III. Analyze Data

→ select appropriate graphical and numerical methods

Here special emphasis needs to be placed on the intended audience for the results. For example,

How can data be presented in ways that those who are not literate or not statistically literate can understand the information?

→ use these methods to analyze the data

## IV. Interpret Results

→ interpret the analysis

Are the results of a sensitive nature that makes it difficult to actually report them? For example,

Be aware when results might offend one or more groups (e. g. a university study that shows drastic economic differences between students in different departments).

→ relate the interpretation to the original question

Below we suggest some areas that might be interesting for data collection and analysis. We are not presenting specific activities that address all four of the GAISE components. Instead, for each example, we are presenting considerations of the following four dimensions:

### 1. Socio-cultural contexts/constraints

In all data collection activities in which the ideas, religion, ways of living, experiences, values of people are involved, it is important to keep in mind that those aspects are going to influence the responses. Therefore, those who are collecting the data should have the information and sensibility to orient in the best way possible what they need to know.

## **2. Possible roles for teachers in various disciplines**

Teachers from various disciplines may be able to carry out data collection and analysis projects related to their own disciplines or collaborate with other teachers on cross-disciplinary projects. They may also be able to provide specific expertise to other teachers and students. One way to encourage a schoolwide emphasis on data collection and analysis might be to have schoolwide teacher meetings to discuss the roles of all in statistics education.

## **3. Access to data sets**

The Internet offers access to thousands of sites that present data. However, it is often a challenge to find appropriate and reliable data sets that can be easily downloaded in usable formats.

## **4. Possible use of technology**

As a cultural tool, different technologies should be used to develop statistical projects at secondary schools. Even though many schools may not be well provided with digital resources, nowadays, it is likely that at least one cell phone could be used to collect, organize and share data on the Internet. Activities can be structured that allow students to compare their data and results with what students have obtained in projects realized in another location.

In the following four themes we develop ideas on how to use those four dimensions to enrich statistical projects so students will better understand our world and consider possibilities to improve it.

## **Quantity of water we use for personal hygiene**

### **1. Socio-cultural contexts/constraints**

Conserving water is crucial in many regions. The amount of water we use in our personal hygiene has to do with intimate aspects of individuals. Therefore, it is important to know who can and wants to participate in such a study, and who does not want to participate. Also, for this activity the purpose of the data collection and how the obtained information will be used should be clearly communicated.

### **2. Possible roles for teachers in various disciplines**

Environmental Education and Natural Science Teachers

Determining the quantity of drinking water used in personal hygiene and how this valuable resource can be used more efficiently

Social Studies Teachers

Analyzing the hydrological sources of the water that is used.  
Analyzing the difficulties in obtaining better access to drinking water in certain regions of the country,  
Emphasizing that water, an indispensable element in maintaining life, has always been necessary for the viability and development of all civilization.  
Analyzing the amount of fresh water available on the planet that can be used for human consumption.

**Economics Teachers**

Analyzing the effect on the economy in relation to the demand, possible shortages, and prices of drinking water.

**Language Teachers (local language)**

Writing reports and questionnaires

Elaborating scripts for explanatory videos

(Language teachers can fulfill this same role with any project theme.)

**Foreign Language Teachers**

Translating information from sources that are in foreign languages.

(Language teachers can fulfill this same role with any project theme.)

**Technology Teachers**

Using technological media to design and carry out an awareness campaign

Using technological media to develop videos that explain the activities that will be carried out in such a way that individuals collaborating with a group of students in data collection can understand the work that is being done.

Preparing online surveys.

**Ethics teachers**

Promoting personal actions that care for this vital element in the environment in which we and other beings live

**3. Access to data sets**

The World Health Organization (WHO) has a website in Spanish

([http://www.who.int/water\\_sanitation\\_health/database/es/](http://www.who.int/water_sanitation_health/database/es/)) with data sets related to

water, sanitation and health. AQUASTAT is Food and Agriculture Organization's (FAO) global water information system, developed by the Land and Water Division.

It is the most quoted source on global water statistics. AQUASTAT collects, analyzes and disseminates data and information by country on water resources, water uses, and agricultural water management

(<http://www.fao.org/nr/water/aquastat/main/index.stm>). Data sets are available from many countries in their national languages that can easily be copied into spreadsheets.

**4. Possible use of technology**

Students could describe a process for collecting data for the variables related to their problem they have chosen to analyze. Students could also design a video to provide advice about how to obtain data from other people interested in participating in their project. This media resource could be disseminated by common social media used by students. Data could be gathered using an online shared spreadsheet. In this way, students could collect data, not only from their immediate context but also from

people living in different situations to add more depth to understanding problems related to water.

## Noise pollution

### 1. Socio-cultural contexts/constraints

Noise pollution has been something that we have had to adapt to as part of the growth of our cities, and, although it may not seem natural to us, it is important to know what level of harm is being caused in living beings (humans and other animals) in order to make decisions with respect to its control. The study could be affected by social or individual interests. Some sources of noise pollution can be controlled and others not easily (airplanes, heavy transportation, factories and construction). Again, the reason for the data collection should be clearly explained.

### 2. Possible roles for teachers in various disciplines

Biology Teachers

Determining how noise pollution affects people's lives.

Physics Teachers

Analyzing the propagation of sound waves and how the environment can be improved by controlling offensive noises that are produced on the streets.

Measuring certain street noises.

Measuring the noises in seating areas in restaurant centers in shopping malls.

Measuring noises created by planes and other means of transportation.

Ethics teachers

Promoting a student consciousness that recognizes we contribute to noise pollution by having the students themselves create a list of sources of noise pollution and use this list for a survey to help determine issues related to the creation of noise pollution.

### 3. Access to data sets

A link for monitoring noise levels in Córdoba, Argentina, is available at <http://ruidocba.webs.fcm.unc.edu.ar>. Students in Córdoba add data to the site, and the site can serve as a model for other cities and regions. The developer of the data set for Córdoba suggests that <https://github.com> can be very useful in developing similar data sets.

The European Regional Office of the World Health Organization (WHO) offers information related to defining noise pollution with various suggestions concerning related data (<http://www.euro.who.int/en/health-topics/environment-and-health/noise/data-and-statistics>). One data set of the noise (sound level) generated by over 1700 occupational, recreational, and military noise sources is available in Excel format from

<https://www.researchgate.net/file.PostFileLoader.html?id=550153a7d4c11828248b45ed&assetKey=AS%3A273731476230144%401442274077304>. An article explaining its use can be downloaded from

<http://multimedia.3m.com/mws/media/888553O/noise-navigator-sound-level-hearing-protection-database.pdf>.

#### 4. Possible use of technology

Some cell phones come with integrated tools like GPS and sound meters. Both could be used to obtain a collection of data related to sound level and its location. Using data displayed in a map, students could analyze the distribution of information, present hypotheses, propose some answers and suggest practical solutions.

### Garbage/Waste

#### 1. Socio-cultural contexts/constraints

Garbage is part of our culture. We need to know how to manage garbage, how we might take advantage of it (methane gas, for instance), and how to dispose of it. We need information about possible levels. When studying garbage/waste, it is important to recognize that the quantity of waste can generate much harm but also that waste has possible uses.

#### 2. Possible roles for teachers in various disciplines

Environmental Education and Natural Science Teachers

Emphasizing that the quantity of garbage and waste is an environmental problem in our societies.

The following suggestions for areas of study appear in

[http://www.magrama.gob.es/es/ceneam/articulos-de-opinion/2001-03manzanal\\_tcm7-141799.pdf](http://www.magrama.gob.es/es/ceneam/articulos-de-opinion/2001-03manzanal_tcm7-141799.pdf)

Use of raw materials to obtain products, and the resulting economic and ecological costs.

Daily consumption and its relation to waste production.

Natural decomposition of waste and its relation to waste management.

The existence of actions to reduce the production of waste: the three Rs (reduction, reuse and recycling).

Social Studies Teachers

Analyzing the impact of garbage that is inappropriately disposed of.

The following suggestion for an area of study appears in

[http://www.magrama.gob.es/es/ceneam/articulos-de-opinion/2001-03manzanal\\_tcm7-141799.pdf](http://www.magrama.gob.es/es/ceneam/articulos-de-opinion/2001-03manzanal_tcm7-141799.pdf)

The importance of keeping in mind the resources and raw materials that are used in the production of the products that we use.

Economics Teachers

Analyzing how the quantity of garbage affects a country's economy, a family's budget or a school's budget.

Health Science teachers

Studying how, by consuming fresh food and non-bottled juices, we not only improve our diets but eliminate much waste.

Ethics teachers

Promoting respect for others by producing less garbage and recycling what is possible.

#### 3. Access to data sets

Eurostat, the statistical office of the European Union, maintains a website in Spanish with access to data sets on waste statistics ([http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste\\_statistics/es](http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics/es)). Here is one example of the kinds of spreadsheet data it provides:

File: Waste generation by economic activities and households, 2012 (thousand tonnes)

	Total	Mining and quarrying	Manufacturing	Energy	Construction and demolition	Other economic activities	Households
<b>EU-28</b>	<b>2 515 110</b>	<b>733 980</b>	<b>269 690</b>	<b>96 480</b>	<b>821 160</b>	<b>380 390</b>	<b>213 410</b>
Belgium	67 630	115	17 736	1 314	24 570	18 891	5 004
Bulgaria	161 252	141 083	3 009	9 533	1 033	3 841	2 755
Czech Republic	23 171	167	4 376	1 063	8 593	5 739	3 233
Denmark	16 332	18	1 610	893	3 867	6 216	3 727
Germany	368 022	8 625	56 596	8 050	197 528	60 752	36 472
Estonia	21 992	9 355	4 121	6 258	657	1 165	436
Ireland	13 421	2 025	4 599	396	366	4 379	1 657
Greece	72 328	47 832	4 183	12 259	813	2 383	4 859
Spain	118 562	22 509	14 594	5 772	26 129	28 333	21 224
France	344 732	2 477	21 431	2 100	246 702	42 024	29 996
Croatia	3 379	5	425	108	682	968	1 191
Italy	162 765	720	34 142	3 616	52 966	41 708	29 613
Cyprus	2 086	218	98	2	965	353	451
Latvia	2 310	2	396	133	8	558	1 213
Lithuania	5 679	26	2 551	29	419	1 477	1 177
Luxembourg	8 397	131	509	2	7 079	426	249
Hungary	16 310	91	2 991	2 872	4 038	3 638	2 681
Malta	1 452	45	9	2	1 041	201	155
Netherlands	123 613	179	14 115	1 342	81 354	17 758	8 864
Austria	34 047	51	3 636	622	19 471	6 247	4 020
Poland	163 378	68 035	31 135	20 706	15 368	18 809	9 324
Portugal	14 184	243	3 188	422	928	4 672	4 731
Romania	266 976	223 293	6 029	9 043	1 325	22 638	4 647
Slovenia	4 547	14	1 345	1 069	535	941	641
Slovakia	8 425	311	2 516	1 046	806	2 090	1 657
Finland	91 824	52 880	14 531	1 011	16 034	5 635	1 734
Sweden	156 367	129 481	6 218	1 852	7 656	6 967	4 193
United Kingdom	241 922	24 044	13 596	4 965	100 230	71 580	27 506
Iceland	529	0	93	2	11	191	233
Liechtenstein	467	29	12	0	107	2	316
Norway	10 721	470	2 639	89	1 881	3 205	2 438
Montenegro	386	1	33	351	0	0	0
FYR of Macedonia	8 472	802	1 304	6	0	6 360	0
Serbia	55 003	47 896	760	5 744	364	238	0
Turkey	1 013 226	950 587	13 141	18 424	0	289	30 785
Bosnia and Herzegovina	4 457	72	1 213	3 171	0	0	0
Kosovo	1 167	177	80	151	0	268	490

Source: Eurostat (online data code: env\_wasgen)

#### 4. Possible use of technology

Students could use Google Maps to zoom over different garbage landfills in their community, capture the images obtained, insert them into GeoGebra and measure their areas. With this information at hand students could design a statistical project to study the impact on local inhabitants' health.

### School data

#### 1. Socio-cultural contexts/constraints

Making decisions in any school system should be done with the use of relevant quantitative data. If a culture of data collection does not exist, one should be developed (number of students, teachers and schools; dropout, repetition and achievement rates). The intention to collect data and how it will be used should always be transparent to the public, and the data should be publically available, including the data used in preparing final reports.

#### 2. Possible roles for teachers in various disciplines

Economics Teachers

Analyzing the different socio-economic situations of the country's students in different regions and schools.

Health Science Teachers

Analyzing how nutrition affects student learning.

Language Teachers (local language) and Foreign Language Teachers

In addition to their roles in assisting students with writing and translations, language teachers might contribute ideas concerning variables of concern to their discipline (achievement levels, participation and success in foreign language learning, literacy programs, etc.)

### **3. Access to data sets**

Many Ministries of Education offer access to data sets with various kinds of information about schools in their country. As one example, the Ministry of Education (Secretaría de Educación) of Honduras, has a web page, <http://sace.se.gob.hn/reportes/sace/matricula/>, that provides easy access to school enrollment data. As another example, data and maps concerning education in Paraguay can be found at <http://datos.mec.gov.py/>.

The CensusAtSchool International Project based in Great Britain aims to;

- Encourage children to get involved with data handling and learn statistical skills;
- Provide real data for data handling activities;
- Increase awareness of what national censuses are and what they are for;
- Show how Information and Communication Technology (ICT) can be used effectively to enhance teaching and learning especially in the area of data handling.

CensusAtSchool is presently running in the UK, Ireland, South Africa, Canada, New Zealand, Australia, USA, Japan and Korea but allows access to teachers from around the world and would apparently very much like to increase its international reach.

Another easily accessible source to obtain data on other countries is the CIA World Factbook (<https://www.cia.gov/library/publications/the-world-factbook/>).

### **4. Possible use of technology**

The students can design a webpage that can be used to store data they collect relative to school issues of interest to them. They can use this data to compare their situation to that of students in other contexts.

## **Conclusions**

Statistics should become a tool used in making informed decisions in an appropriate and intelligent manner. For this reason, information obtained concerning any theme of personal, community, national or international interest should always be as accurate as possible, particularly if the data are used to make decisions that affect individuals, policies or actions. But the data will only be useful if the social, political and economic factors that define the culture of our countries are taken into account.

Statistics should be understood as a cultural project that involves people, not only in the design of projects, but also as participants. As stated above, in schools, statistical projects should be

interdisciplinary in their essence. The cultural and disciplinary perspective of each participating teacher helps to confer a clear understanding of the phenomena that are studied.

We have presented a series of examples analyzed from four related dimensions: sociocultural aspects, the role of teachers from distinct disciplines, the possibility to access data sets and the use of technology. We hope that those examples serve as motivation to encourage teachers to look closely at their environment, and considering their specific culture, work with their students to develop a better understanding of the issues facing our different societies.

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