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## A COLLABORATIVE INTER-GRADES STATISTICAL INQUIRY: DESIGN AND FIRST STEPS

### INTRODUCTION: INQUIRY AND STATISTICS

We present the design and first implementation steps of an inquiry proposal for the teaching of statistics at secondary school level. The importance of inquiry in statistical education is commonly accepted, it being related to statistical thinking (Pfannkuch & Wild, 2004), statistical investigations (Watson, 2009) or statistical problem-solving, as in the GAISE PreK-12 Report (Bargagliotti et al., 2020):

The statistical problem-solving process typically starts with a statistical investigative question, followed by a study designed to collect data that aligns with answering the question. Analysis of the data is also guided by questioning. Constant questioning and interrogation of the data throughout the statistical problem-solving process can lead to the posing of new statistical investigative questions. (p. 9)

Let us notice the importance given to the "investigative questions" that generate the inquiry process (Leavy et al., (2016), Frischemeier et al., (2020)), and the fact that they are not always given, but arrive after a problematisation process in which students can also take part:

In most instances, the investigative question starts from a wide-ranging or vague general question and then develops into a precise question. (Arnold et al., 2021, p. 124).

Our instructional proposal takes this problematisation process into account by organising a collaborative inquiry among different school levels.

### THEORETICAL FRAMEWORK: ATD AND SPRs

The theoretical framework used for the design and implementation of the instructional proposal is the Anthropological Theory of the Didactic (ATD, Chevallard, 2015), and its instructional model called *study and research paths* (SRP). An SRP starts with a generating question  $Q_0$  that leads the inquiry and can be identified with the investigative question aforementioned.  $Q_0$  is brought to class by the teacher or an external organisation. The students, then, need to elaborate their own answer  $A^\heartsuit$  to  $Q_0$ , not only to the teacher, but also to this external entity. In the process of elaborating  $A^\heartsuit$ , new subquestions  $Q_i$  arise. The students, guided by the teacher, follow the path these subquestions lead and answer them by providing some partial answers  $A_i^\heartsuit$ . In the process, some new pieces of knowledge or information in the form of external "already available answers"  $A_j^\diamond$  are found. This path made by the subquestions and subanswers will end up answering the main generating question  $Q_0$ .

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## AN INTER-GRADE SRP IN STATISTICS

### Context and infrastructure

This SRP as a whole is composed by three complementary inquiry-based instructional proposals in statistics about air pollution. It is being implemented in years 7, 9 and 11 by the first author in 2023-24 at the Nelson Mandela School, a diverse and inclusive international bilingual state school in Berlin. In all classes, students work in teams of three or four. One Google Classroom associated to the project is set for all the students and teachers taking part in it. It progressively includes the external answers or works  $A_j^\diamond$ , the provisional subanswers  $A_i^\heartsuit$ , and the empirical data, whenever they are found or needed along the implementation of the SRP. The final outcome  $A^\heartsuit$  will be a written report and a Google Site that will contain all the results and will be published online.

### Design and planning

The core idea is the interweaving of three proposals developed in grades 7 (SRP7), 9 (SRP9) and 11 (SRP11), and a collective final answer elaborated from the three proposals (Fig. 1):

- (1) The external organisation raising the generating question varies depending on the year that is developing the SRP. In SRP11, it is KlimaLink, a company whose aim is to provide a platform that calculates the CO<sub>2</sub>e emissions of travel components, in order to support the travel industry on its way to more climate protection. In SRP9 and SRP7, the external organisation is the group of older students (year 11 and year 9, respectively).
- (2) The global inquiry generating question  $Q_0$  is stated by KlimaLink: How does our school community contribute to air pollution? Derived questions emerging from  $Q_0$ , for which Year 11 students are responsible, become the generating questions of SRP9 who are in charge of collecting data and analysing it, and of SRP7 who are in charge of analysing part of the data collected in SRP9. Thus, the final answer  $A^\heartsuit$  will have, as partial answers, the final answers  $A^\heartsuit$  from SRP7 and SRP9. In the problematisation process, year 11 students carry out the process of formulating good investigative questions, whereas the investigative questions for the subsequent SRP9 and SRP7 appear as derived questions of the first ones.
- (3) For SRP11, the whole proposal is carried out in one group since October until June, one lesson a week. SRP9 is implemented in two groups for six weeks in December and January, four lessons a week. SRP7 is implemented in one group for three weeks in January, four lessons a week. All lessons are 45 minutes long and the teacher is the first author of the communication.

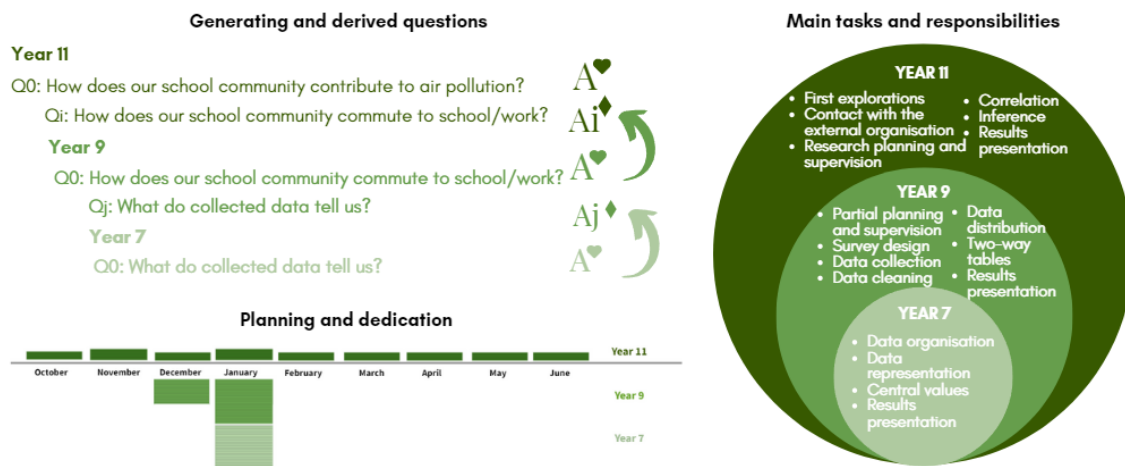


Figure 1. Design and planning

### Assessment criteria

In all SRPs, each team of students is required to hand out a final report, edit their part of the Google Site and present the results to the rest of the class, the teachers and their corresponding external organisation. Additionally, a written test will be taken by each student individually to check if they have learnt the core ideas the SRP covers. This test will contain questions set in different contexts, to check the students' capacity to transfer their learnings.

### A COLLABORATIVE INFRASTRUCTURE: FIRST STEPS

The collaborative inquiry started with SRP11. Its first six sessions were devoted to determining the lines of study and the subquestions, the students considered worth studying (to be proposed to year 9). It had five steps: first explorations; first questions; questions classification; are the questions statistically "studiable"?; and investigative questions. Therefore, year 11 students were responsible for the problematisation process of SRP9.

Once the generating questions for SRP9 were decided, year 11 students proposed them to year 9 students. In the presentation, they explained KlimaLink's request, their first explorations, the investigative questions and what year 9 students were expected to do: design and test a survey, collect, clean and organise the data, graphical representation, central values, distribution, conclusions and results presentation. Part of this analysis, though, data organisation, representation, and central values, will be carried out by year 7 students. The procedure will be similar: year 9 students will prepare a presentation with the work done, the collected data and the tasks they expect from year 7, who will carry out this part and present the results to year 9, who will supervise and incorporate them in their study.

Year 11 students will supervise all this work and complement it afterwards

with a correlation analysis between variables and a comparison with the results obtained from the data collected in a school in South Africa.

With these complementary proposals, we expect the students from different grades, not only to learn the statistics required by the curricula with a real project with real data, but also to feel part of a community with a common goal. Moreover, in the three SRPs, the goal is external from their typical learning process at school, creating appropriate conditions for the teacher to act as a guide and not being the main validator of the final answer. The proposal, initially organised by the first author and a teacher of grade 11, progressively involved two more teachers of year 7 and another of year 9, thus extending the collaborative infrastructure beyond the students' work.

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