CIVIC STATISTICS AND INTERDISCIPLINARITY IN THE CHILEAN SCHOOL CURRICULA

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Civic statistics aims to promote work with statistics on social phenomena in educational contexts. We asked ourselves how viable civic statistics would be in the Chilean educational context. For this purpose, we analysed the curricular bases of the subjects Science for Citizenship, Citizenship Education and Mathematics for the last two years of compulsory schooling (16-18 years old). Through a content analysis, using the eleven facets that make up the civic statistics knowledge and skills framework, we characterise the learning objectives of these three subjects. We observe that the facets related to the engagement and action dimension have a high presence in the subject of Citizenship Education and Science for Citizenship, while the facets related to knowledge models, patterns and representation and statistics and risk have a high presence in the subject of mathematics. Based on the results, we consider that the articulation of these three subjects would allow the development of knowledge and skills from an interdisciplinary perspective, which could result in the design of teaching modules that promote the development of civic statistics competences.

INTRODUCTION

For some years now, various organisations have been calling for action on social issues to improve the lives of people and the planet (United Nations [UN], n.d.). However, *doing something* about different social issues involves an understanding of these issues, which are often present in the media through the use of statistics. Weiland and Sundrani (2022) argued that statistics is present in various spheres of society, so it is necessary to promote the development of critical statistical literacy. Engel (2017) notes that statistics education at secondary and tertiary levels should address the understanding of multivariate phenomena and foster thinking with complex data, as these are often present in describing and understanding social issues. However, Ridway (2022) states that:

> Paradoxically, academic cultures themselves can present barriers to the development of empowered citizens. In high schools, few social science teachers or humanities teachers have skills in communicating statistical ideas. In the sciences and mathematics, teachers may stay within their comfort zone by emphasising statistical techniques and subject-specific methods and theories, as opposed to using statistics and mathematics as part of reasoning about broader social issues. (p.2)

Following this idea, the GAISE II document (Bargagliotti et al., 2020) incorporates the need to address the complexity of data describing social issues in the classroom. Along with this, it promotes work with first- and second-order data, which implies that students develop activities that allow them to collect their data and analyse data that come from an external source. Recently, the book Statistics for Empowerment and Social Engagement: Teaching Civic Statistics to Develop Informed Citizens (Ridway, 2022) presents different experiences in teaching civic statistics in various educational contexts. Engel et al. (2022) highlight the interdisciplinary nature of statistics, and that despite the fragmentation of the curriculum in compulsory education, the materials developed by ProCivicStat (PCS) can be adapted to different school subjects.

If we consider the Chilean context, the complex situation of the educational system during the COVID-19 pandemic led the Ministry of Education (MINEDUC) to make available to schools a document called Curricular prioritisation for the comprehensive reactivation of learning (MINEDUC, 2023). The validity of these guidelines is planned, at least, until 2025, and one of its objectives is "to promote the integration of learning within a subject and/or between two or more subjects" (MINEDUC, 2023, p.3). Therefore, this leads us to ask what skills and knowledge the different subjects of the Chilean national curriculum promote for the development of empowered citizens, and how statistics is present

In: EM Jones (Ed.), *Fostering Learning of Statistics and Data Science*
Proceedings of the Satellite conference of the International Association for Statistical Education (IASE),
July 2023, Toronto, Canada. https://iase-web.org

in these subjects and how civic statistics could be a discipline that allows interdisciplinary work in Chilean classrooms.

Thus, this paper aims to identify the potential for the development of civic statistics competencies in three subjects of the Chilean school curriculum by characterising the learning objectives stated in the curriculum documents. The characterization of these documents from the framework of civic statistics would allow us to identify characteristic elements of each subject and their possible complementarity for the design of classroom activities from an interdisciplinary perspective.

CIVIC STATISTICS

Civic statistics emerges from the intersection of statistics, education and politics, and social science (ProCivicStat, 2018). Civic statistics focuses on understanding statistical information about society provided by the media, statistical institutes, and other agencies, by critically evaluating and reflecting on the data (Engel et al., 2021). Regarding the role of students in developing activities in the context of civic statistics, students do not learn a collection of statistical techniques and procedures, but rather, develop and use statistical techniques and procedures to discuss and communicate ideas about social phenomena (Ridway, 2022). Gal et al. (2022) proposes a conceptual framework for civic statistics, where eleven facets compose the knowledge and skills framework of this discipline. These eleven facets are distributed in three dimensions: Engagement and action, Knowledge, and Enabling Processes, where in Table 1 we can observe the facets corresponding to each of them, as well as their characteristics.

Table 1. Characteristics of the facets describing the civic statistics knowledge and skills framework

Dimensions	Facets	Characteristics
Engagement and action	Meaning for social policy	Form an opinion on what could and should be done to address policy issues, based on evidence.
	Critical evaluation & reflection	Develop and use habits of mind on a routine basis that allow you to question the veracity of statistical information.
	Dispositions	Monitor emotional responses associated with evidence-based arguments. These responses correspond to a complex network of motivations, beliefs, and attitudes.
Knowledge	Statistics & Risk	Understand the key ideas of statistics (Burrill and Biehler, 2011), the idea of risk from probability and conditional probability, and Big Data.
	Models, patterns, and representations	Understand that qualitatively different models can be used to model the same complex social phenomenon and critique novel representations.
	Methodology & enquiry processes	Be familiar with different methods of data collection, both qualitative and quantitative. Understand the ethical issues associated with the production of data and the use of various research methods.
	Extensions in official statistics	Understand the structure and functioning of official statistics.
	Contextual civic knowledge	Understand contextual civic knowledge including data such as the size of populations, size of GDP, national debt and resources; demographics; history and geography; regional and geographical politics.
Enabling Processes	ICT & search	Understand appropriate analytical techniques for accessing and analysing large volumes of unstructured data.
	Quantitative core	Understand and use quantitative resources such as number sense, proportion, percentages, rates, and fractions.

	Literacy and communication	Communicating, understanding, and deconstructing the messages conveyed in these new forms of communication.

Nicholson et al. (2018) argue that this conceptual framework can be used as a tool for the analysis of curriculum documents and tasks, to identify which of the knowledge and skills these documents promote. Thus, considering the objective of this research, we present below the methodology associated with this research, which justifies the choice of the documents to be analysed, as well as their characteristics.

METHODOLOGY

We developed a content analysis (Cohen et al., 2007) of the curricular bases of three subjects of the General Education Programme for the third and fourth secondary educational levels (16-18 years) of the Chilean curriculum (MINEDUC, 2019). The Chilean curriculum for the last two levels of compulsory education is divided into a General Formation Plan (GFP), which contains common subjects for all students, and a Differentiated Formation Plan (DFP), which can be Humanistic-Scientific, Technical-Professional or Artistic depending on the student's choice. Since we are interested in subjects that are part of the common and compulsory curriculum and are also in line with civic statistics, we have chosen the subjects Science for Citizenship, Citizenship Education and Mathematics which are part of the PFG. Table 2 shows the curricular organisation of the three subjects and in brackets the number of corresponding Learning Objectives (LOs).

Table 2. Summary of the curricular organisation of the subjects Citizenship Science, Citizenship Education and Mathematics (MINEDUC, 2019)

Subject	Skills	Knowledge and understanding	Total LOs
Science for Citizenship (Mineduc, 2019, p. 42-49).	- Plan and conduct research (2) - Analyse and interpret data (2) - Construct explanations and design solutions (3) - Evaluate (2)	Approach of the LOs according to thematic modules: - Well-being and health (3) - Safety, prevention and self-care (3) - Environment and sustainability (3) - Technology and society (3)	21
Citizenship Education (Mineduc, 2019, p. 54-59).	- Research (1) - Critical thinking (5) - Communication (1)	Approach to objectives according to level: - Third grade (8) - Fourth grade (8)	23
Mathematics (Mineduc, 2019, p. 102-107).	- Representing (2) - Modelling (2) - Problem solving (2) - Arguing and communicating (2) - Digital skills (4)	Approach to objectives according to level: - Third grade (4) - Fourth grade (4)	20

As for the analysis process, an Excel sheet was generated where the LOs of the three subjects were copied and pasted. The units of analysis correspond to the learning objectives stated in each of the documents. Two of the three authors of this paper separately analysed each LO by assigning one of the eleven facets of the curriculum document analysis tool of the civic statistics framework (ProCivicStat, 2018). In this process, the authors assigned separately, one predominant and one secondary facet for each LO. After this process, the three authors of this paper met to discuss the classification and came to an agreement on the characterisation of each LO. From this discussion, we noticed that some LOs

attributed to more than one facet so that some LOs have one facet identified in each dimension (i.e., a maximum of three facets are associated with one LO). Table 3 shows an example of the characterisation of an LO according to facets.

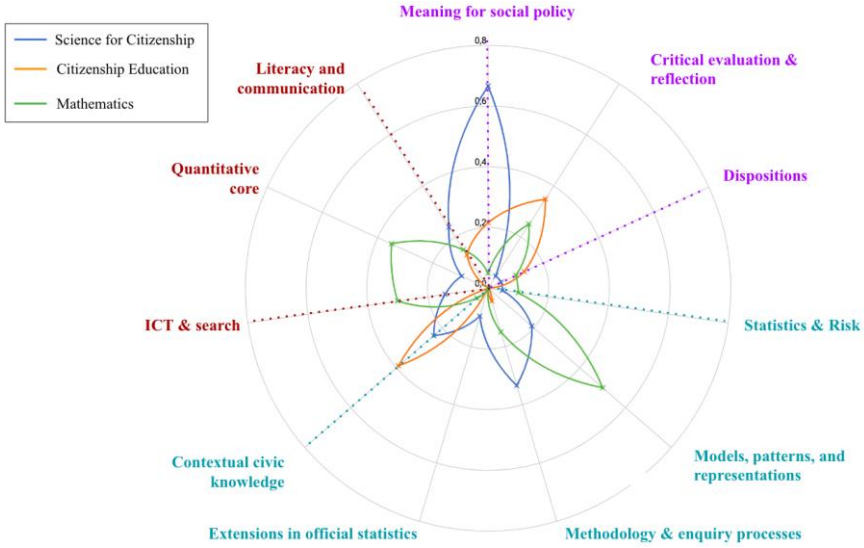
Table 3. Example of characterisation of learning objectives

Subject	Learning objective and characterisation according to facet
Science for Citizenship	Skills - *Construct explanations and design solutions: Develop and use evidence-based models to predict and explain natural mechanisms and phenomena* (Meaning for social policy and Models, patterns, and representations).
Citizenship Education	Skills - Critical thinking: *Developing interpretations and arguments, based on varied and relevant sources, making ethical use of information* (Critical evaluation & reflection and Literacy and communication).
Mathematics	Digital skills: *Develop online collaborative work for discussion and resolution of mathematical tasks, using electronic productivity tools, virtual environments, and social networks* (Dispositions and ICT & search).

RESULTS

After characterising the learning objectives of the three curricular frameworks through the eleven facets of civic statistics, we obtained the representation shown in Figure 1. This figure shows the percentage of LOs that contribute to each facet. In purple are the facets related to Engagement and action, in blue are the facets related to Knowledge and in red are the facets related to Enabling Processes.

Figure 1. Relative frequency, with respect to the total number of LOs for each subject, associated with the facets of civic statistics



For the Engagement and action dimension, more than 60% of the Science for citizenship LOs promote aspects related to meaning for social policy, while less than 30% and 40% of the Mathematics and Citizenship education objectives, respectively, promote critical evaluation and reflection. Along with this, we observe that less than 20% of the mathematics and citizenship education AOs present some theme related to dispositions. Regarding the Knowledge dimension, the mathematics curriculum presents a high percentage of models, patterns, and representations, while the science for citizenship subject has around 30% of LOs that promote methodological aspects and the enquiry process. On the other hand, in the subject of citizenship education, 40% of its LOs contribute to contextual civic knowledge. Finally, in terms of the Enabling Processes dimension, the mathematics subject presents

some characteristics of the use of technology and information search, as well as quantitative core, even so, it corresponds to less than 40% of its learning objectives.

Looking at Figure 1, we can see that in general terms, Science for Citizenship, from the framework of civic statistics, aims for students to form an opinion on what could and should be done to address policy issues, based on evidence, using an appropriate methodology. As for the subject of Citizenship Education, from the framework of civic statistics, it aims for students to understand contextual civic knowledge, as well as to promote habits of mind that enable them to question the veracity of statistical information. Finally, the subject of mathematics, from the framework of civic statistics, seeks to make students understand that different models can be used to model the same complex social phenomenon and to promote the use of number sense.

Considering the three subjects, we observe little, or no presence of aspects related to the use and understanding of official statistics, provisions, statistics and risk, and literacy and communications.

DISCUSSION AND CONCLUSIONS

Due to recent work in civic statistics, this research would show the applicability of this discipline in the school context and to establish a basis for articulating different subjects or areas of knowledge in other school contexts. Along with this, we note that statistics is part of all three curricula, however, it is expressed and used in different ways, with differentiating characteristics for each discipline, as discussed by Ridway (2022). On the one hand, given the structure of the Science for Citizenship subject (Table 2), we note that knowledge is organised around teaching modules classified according to social issues that can be addressed through science. This organisation could explain the high presence of learning objectives related to the meaning for social policy strand. In addition, the skills that this subject aims to address focus on the methodological process according to the discipline, where statistics can be used as a tool. In the case of Citizenship Education, the skills declared in the curriculum include critical thinking, which is in line with a marked presence in the facets of critical evaluation and reflection, as well as learning objectives that seek the use of contextual civic knowledge, which is typical of this subject. Finally, in the case of mathematics, we observe characteristics of civic statistics related to models, patterns, and representations, which are related to the skills stated in the curriculum, such as representing and modelling. In addition, we note that aspects related to contextual civic knowledge or critical evaluation of information are not present in the subject of mathematics.

Thus, in the case of the Chilean context, we observed that the subjects of mathematics, science for citizenship and citizenship education, which are part of the compulsory curriculum during the last two years of schooling, could be a scenario for interdisciplinary work in the school context, with civic statistics being a referential framework for such an organisation as outlined by Engel et al. (2022). After this work, we managed to identify the presence (or non-presence) of different facets of the framework of civic statistics which could be taken into consideration for a future design of activities that want to promote the teaching of statistics through socially relevant contexts and to address those aspects that are deficient in each area of knowledge. This curriculum analysis has allowed us to identify learning objectives of the three subjects that could generate interdisciplinary work, which would be in line with the Chilean curriculum prioritisation (MINEDUC, 2023). Finally, this paper invites teachers of science, mathematics, and social sciences to discuss the importance and role of statistics in each of these disciplines and how relevant interdisciplinary work to promote critical citizenship among secondary school students could be.

ACKNOWLEDGEMENTS

This research was carried out thanks to funding from ANID-Chile grants: FONDECYT 3220122, FOVI 220056, the Basal Funding for centres of excellence (CMM) FB210005, Millenium Scientific Initiative NCS2021_014 and as part of a research and teaching innovation project financed by the School of Education of the Universidad de O'Higgins (FID Fund).

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