Chapter 3
A Conceptual Framework for Civic Statistics and Its Educational Applications

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Abstract This chapter presents a comprehensive conceptual framework of 11 *facets and tools* which together describe the knowledge, skills and dispositions that (young) adults need in order to comprehend, critically evaluate, communicate about, and engage with Civic Statistics regarding 'burning' societal issues, and that may enhance citizen empowerment. The framework is organized around three key dimensions involving engagement & action, knowledge, and enabling processes. It identifies knowledge-bases covering meaning for society and policy and critical evaluation and reflection; selected statistical and mathematical constructs and skills; core literacy and mathematical skills; understanding models and modelling, multivariate ideas and textual and rich visual representations; knowledge of research and data production methods and extensions related to official statistics and risk on the societal level; and it emphasises the importance of appropriate dispositions, critical stance, and habits of mind. We offer examples and curriculum tasks that illustrate each of the 11 facets and their interconnectedness. We also describe the use of a 'radar plot' tool to support the analysis of how balanced are prospective class activities or test items in terms of covering the 11 facets and tools. The chapter ends with a brief discussion of the implications of the conceptual model and its 11 facets for planning curricula, instruction, and assessments that can promote teaching and learning about Civic Statistics within mathematics education, statistics and data science education, and related disciplines.

Keywords Conceptual framework · Critical statistical literacy · Dispositions and attitudes · Media and data literacy · Citizenship skills · Cognitive task demands

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3.1 Introduction

This chapter builds on Chap. 2 (Engel & Ridgway, this volume), which sketched the history and discussed the importance of Civic Statistics, and included more details about the goals, products, and educational resources of the ProCivicStat project (see ProCivicStat Partners, 2018). Chapter 2 also sketched the many *areas* which Civic Statistics encompass (e.g., climate change, employment and income, social justice, equality, diversity and inclusion, crime, education, sustainability, and many more) and described in detail *12 key features of Civic Statistics* that pertain to all these areas. The 12 features of Civic Statistics, which are summarised in Table 3.1, characterise the nature of the statistical and quantitative messages, texts and evidence related to Civic Statistics which citizens read, see or hear in the news media (e.g., magazines and newspaper articles, TV and radio broadcasts), press releases by statistics producers, blog entries, social networks, etc. Chapter 2 argued that these 12 features require sophisticated statistical reasoning, but are hardly addressed in introductory statistics courses. Hence, in line with earlier positions (Engel et al., 2016) Chap. 2 argued that teaching about Civic Statistics is both essential and urgent, if future citizens are to engage effectively with the media they encounter.

Table 3.1 Twelve features of Civic Statistics

Twelve Features of Civic Statistics *What citizens see/read/hear*
I. Contexts and interpretations
1. Societal context is the focus
2. Statistics are embedded in rich texts
3. Causality is often attributed
4. Conclusions, implications, and consequences for society are discussed
II. The nature of the statistics
5. Phenomena are often multivariate
6. Decisions have been made about measures and operationalization
7. Data are often aggregated
8. Indicator systems are common
9. Dynamic data, spanning times and locations is common
III. Unfamiliar methods and representations
10. Novel data sources and analysis techniques are common
11. Varied data collection methods are used
12. Innovative visualisations have been invented

This chapter focuses on the following key question:

What *facets and tools* are needed (by students, and citizens in general) so that they can critically understand the statistical information that they see/read/hear, and engage with the underlying societal or economic issues?

To answer this question, this chapter maps out a conceptual framework describing 11 facets and tools, i.e., knowledge bases, skills, enabling processes, and dispositions and attitudes that together are needed if we expect learners to critically understand and engage with Civic Statistics and all their underlying features. These 11 facets and tools, which are listed in Fig. 3.1, are all *learnable*, i.e., can be acquired or be 'improved' in the classroom. Thus, they are the basis for the development of teaching methods and curriculum materials that can help teaching/learning processes focused on Civic Statistics, and are the basis for the many examples in the other chapters in the book.

The conceptual framework in Fig. 3.1 argues that the ability to engage with Civic Statistics involves eleven separate but related facets and tools, organised in three groups:

- **Engagement & Action:** This group involves three facets (Meaning for society and policy; Critical evaluation and reflection; and Dispositions), and relates to the motivations for generating Civic Statistics, engaging with them, and investing in their critical evaluation.
- **Knowledge:** This group involves five facets (Statistics and risk; Models, patterns and representations; Methodology and enquiry processes; Extensions in official statistics; and Contextual civic knowledge). Together, these encompass the diverse knowledge bases and skills that pertain directly to the statistical

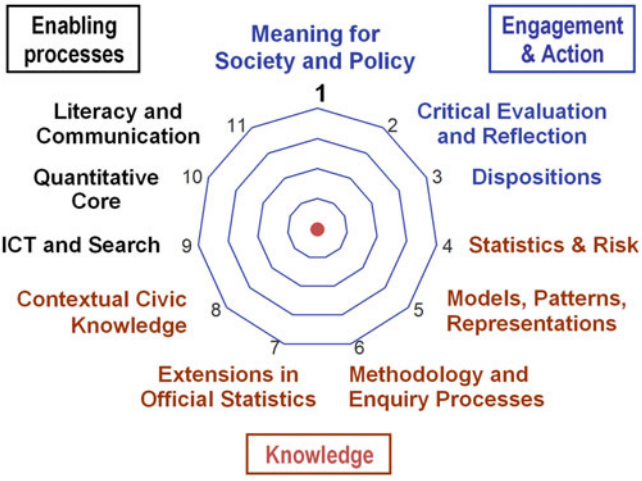

Fig. 3.1 A conceptual model for Civic Statistics

information which may be contained in messages about Civic Statistics. Note that this involves the understanding of the *context* (i.e., the social and economic settings) from which data are generated and to which the statistics refer.

- **Enabling Processes:** This group involves three facets (ICT and search; Quantitative core; and Literacy and communication)—these are general skills, not unique to the area of statistics and probability, but essential for finding, accessing and comprehending messages (textual and quantitative) with or about Civic Statistics.

The remainder of this chapter is organised in four sections. First, in order to help grasp the need for, and to better understand, the conceptual framework sketched in Fig. 3.1, Sect. 3.2 presents examples to illustrate how the 11 facets and tools in the conceptual framework are needed to understand messages about Civic Statistics. Section 3.3 sketches the theoretical background used to develop the conceptual framework. Section 3.4, which is the heart of this chapter, discusses in detail each of the 11 facets and tools, with illustrative examples. Finally, Sect. 3.5 points to some implications for teaching, and describes a simple "radar plot" tool that teachers can use to analyse how the content of instructional tasks or assessment items they may want to use relates to the 11 facets and tools.

Please note that the present chapter should be seen in the context of the whole book: Chap. 4 (Gal, Ridgway, Nicholson, & Engel, this volume), which follows, discusses more ideas, examples, and implications related to instruction, curriculum planning and assessment, based on the ideas here and in Chap. 2. The many other chapters in this book all have additional examples related to or based upon the conceptual framework in Fig. 3.1.

3.2 Opening Examples: The Facets and Tools in Action

This section presents two short examples to illustrate some of the facets and tools listed in Fig. 3.1 and show their relevance to different areas and features included in Civic Statistics. These examples are 'thinking tasks'—so please reflect about each one before moving further on.

Example 1 relates to Civic Statistics about public health, and it has two parts, first a small excerpt from one article and then a title from another article about the spread of the Coronavirus (COVID-19), both published by the USA-based news network CNN. These were just two of thousands of articles and news broadcasts that appeared around the world during the pandemic which engulfed the world in 2020. Example 2 relates to the gender pay gap (i.e., a gap between men and women in terms of wages or salaries), a thorny issue which has been getting much public attention for years and relates to social equality and employment markets.

Example 1: Media Excerpts About the Coronavirus (COVID-19) Pandemic

(CNN, 21 March 2020). Does Russia have Coronavirus under control? According to information released by Russian officials, Putin's strategy seems to have worked. The number of confirmed Russian coronavirus cases is surprisingly low, despite Russia sharing a lengthy border with China. The numbers are picking up, but Russia—a country of 146 million people—has fewer confirmed cases than Luxembourg, with just 253 people infected, and no deaths. Luxembourg, by contrast, has a population of just 628,000 . . . and by Saturday had reported 670 coronavirus cases with eight deaths . . .

Source: https://edition.cnn.com/2020/03/21/europe/putin-coronavirus-russia-intl/index.html (note: the original article had much more text)

(CNN, 31 March 2020) Coronavirus death rate is lower than previously reported, study says, but it's still deadlier than seasonal flu.

Source: https://edition.cnn.com/2020/03/30/health/coronavirus-lower-death-rate/index.html

Reader—your task: before continuing, please read carefully the two excerpts in Example 1 (Note: The original articles are longer), and then reflect on this question:

What do you need to know or activate (think of the 11 facets and tools listed in Fig. 3.1*) so that you can critically understand the information you encountered in the articles and engage the underlying civic issues*?

Please write a list of your ideas. Only then, continue to read.

Finished? Now continue to Example 2. After doing it, you will see a short summary with a partial answer to the questions in Examples 1 and 2.

Example 2: Wage (Salary) Inequality

Assume that you want to sensitise your students to how statistics are used or reported in the real world, and decide to let them tackle statistics about the equality of income between men and women. This is a hotly debated topic; perhaps the most well-known indicator in this regard is the *Gender Pay Gap*. So, to make life easier for you and your students, you could check Wikipedia. The text there is quite detailed—so below we show only an excerpt, along with a single graph from the explanation about this concept. (Note: Wikipedia entries are edited from time to time, so when you read this book, what is listed below may not be exactly what you will actually find in Wikipedia).

Wikipedia Definition: *Gender Pay Gap*—English *(excerpt)*

(note: The Wikipedia entry also includes the graph shown in Fig. 3.2)

The **gender pay gap** or **gender wage gap** is the average difference between the remuneration (pay/compensation) for men and women who are working. Women are generally considered to be paid less than men.

There are two distinct numbers regarding the pay gap: *non-adjusted* versus *adjusted* pay gap. The latter typically takes into account differences in hours worked, occupations chosen, education and job experience. In the United States, for example, the ***non-adjusted*** average female's annual salary is 79% of the average male salary, compared to 95% for the ***adjusted*** average salary. The reasons link to legal, social and economic factors, and extend beyond 'equal pay for equal work'. The gender pay gap can be a problem from a public policy perspective because it reduces economic output and means that women are more likely to be dependent upon welfare payments, especially in old age . . . (More text follows)

Source: https://en.wikipedia.org/wiki/Gender_pay_gap (Retrieved June 1, 2021)

***Reader—your task*:** As before, please read Example 2 carefully, including the text and the graph. Then, reflect on the same question:

What do you need to know or activate (think of the 11 facets and tools listed in Fig. 3.1*) so that you can critically understand the information you encountered (i.e., text + graphical display) and engage with the underlying civic issues*?

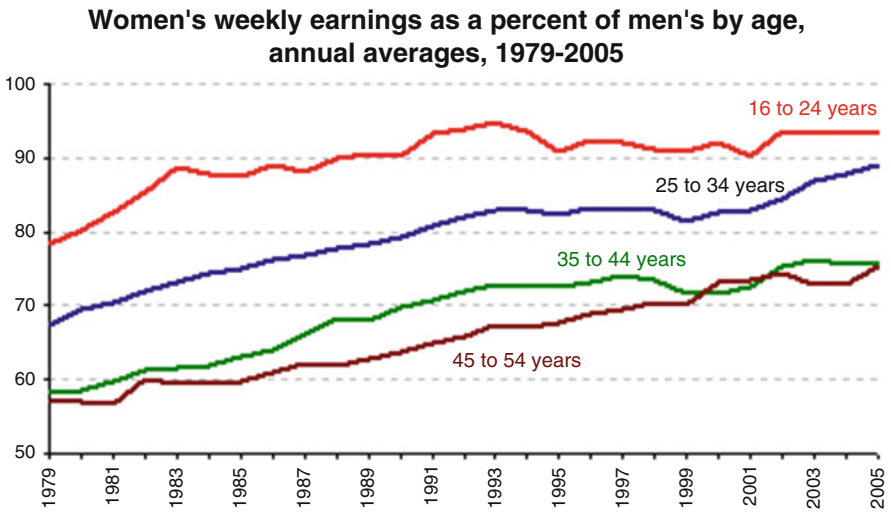

Fig. 3.2 Women's weekly earnings as a percentage of men's in the U.S. by age, 1979–2005

Please write a list of your ideas. Only then, continue to read.

Analysis of Examples 1 and 2. The two examples may not have touched on all 11 facets and tools shown in Fig. 3.1, because only short excerpts from longer sources were presented, and after all, any single example is limited. Yet, although short, even these two examples illustrated the richness of the demands on citizens when they encounter Civic Statistics. It is important to emphasise that the 11 facets and tools, which are explained in detail in Sect. 3.4, are not independent (i.e., there may be some overlap between them) and they interact together in any single task or activity. Interpreting and reacting to a media article or digital text on any important social issue, such as *health* in Example 1, or *equality* in Example 2, is likely to require the joint activation of many facets and tools.

Both examples require activation of enabling skills we have called 'literacy and communication' and 'quantitative core'. They entail knowledge about 'models, patterns and representations' (e.g., the way *gender pay gap* is calculated is one of several ways to model this phenomenon), and understanding of 'methodology and enquiry processes' or how official statistics are calculated and communication (e.g., see the 'adjusted' and 'unadjusted' rates in Example 2). The examples require a critical perspective (e.g., are the reported statistics credible enough, as in Example 1? how up to date are the graphed data, as in Example 2?). Then, 'contextual civic knowledge', 'critical evaluation' and 'meaning for society and policy' are involved, in order to link with the civic reality, and to think what might be done (if anything), in terms of policy implications. What do you think? Are other facets and tools needed or invoked in these examples?

3.3 The Conceptual Framework: Overview of the 11 Facets and Tools Needed for Understanding and Engaging with Civic Statistics

This section sketches the background of the conceptual framework of 11 facets and tools illustrated in Examples 1 and 2. This framework, which is elaborated in Sect. 3.4, was conceived by the ProCivicStat partners (2018) (see also Ridgway et al., 2018) through a multi-stage process, sketched below.

In the first stage, academic literature and conceptual frameworks related to key constructs or domains relevant to the understanding of Civic Statistics were consulted. Table 3.2 lists sample key references which were part of the literature review. The constructs and domains listed in Table 3.2 fall into two general families. Some are relatively broad and reflect generic expectations regarding general outcomes of schooling, while others are more specific to the area of statistics and probability. All of these constructs have undergone conceptual developments over the last few decades, but they have not all been integrated into a single schema, hence were the focus of much work by the ProCivicStat partners. Of course, there is

Table 3.2 Key constructs related to Civic Statistics, and sample key references

Constructs and domains	References (partial list)
Models related to adult numeracy and mathematical literacy	Geiger et al. (2015), Kilpatrick (2001), Gal et al. (2005), PIAAC Numeracy Expert Group (2009), Tout and Gal (2015)
Models related to broad quantitative reasoning (QR) competencies	Boersma et al. (2011), Madison (2014)
Heuristics related to critical reading of quantitative statements and other aspects of critical thinking	Gal (2002), Ridgway et al. (2016)
Models related to statistical literacy, probability literacy, risk literacy, data literacy, and official statistics literacy	Callingham and Watson (2017), Gal (2002, 2005), Gal and Ograjenšek (2017), Gould (2017), Watson (2013)
Models describing cognitive processes in understanding tables and graphs	Friel et al. (2001), Kemp and Kisanne (2010), Sharma (2013), Prodromou (2015), Schield (2016)
Models and perspectives describing desired behaviours of citizens and citizen engagement, as well as outcomes of statistics education or needed extensions in the twenty-first century, given trends regarding digitization, big data, data science, etc.	Ben-Zvi and Garfield (2004), Engel (2017), GAISE (2016), Gal et al. (2020), Gould (2017), OECD (2009), Ridgway (2016), Wild and Pfannkuch (1999)
Models related to dispositions and enabling processes that can support numerate behaviour and statistically literate behaviour	Gal (2002), Kilpatrick (2001), Gal et al. (2005)

some overlap between the constructs and conceptual frameworks, but each one offers additional ideas that can inform theorizing about the skills that adults (citizens) need in modern societies, hence can be of value in planning educational work on Civic Statistics.

In the second stage, the ProCivicStat partners analysed the demands of dozens of examples concerning Civic Statistics issues taken from various sources in several countries, such as articles on Civic Statistics topics in newspapers (print or digital versions), press releases from official statistics agencies, and open data sources. Just as we asked of readers in Sect. 3.2, we examined the demands of each task, i.e., what kinds of knowledge, skills, dispositions, and other enabling processes are needed to be known, used, or activated, in order to understand and engage with the diverse messages encountered on Civic Statistics topics.

In the third stage, task demands identified in the analysis were compared to the constructs and ideas included in the theoretical models. This process enabled us to identify topics that were not previously noted in the scholarly literature, expand on prior theoretical ideas, and design the conceptual framework summarized in Fig. 3.1. Section 3.4 further elaborates on the 11 facets and tools included in this framework.

3.4 The Conceptual Framework in Detail

This section elaborates each of the 11 facets and tools in the conceptual framework shown in Fig. 3.1. This elaboration is essential for understanding *why* these facets and tools are important and should be addressed in instruction and in assessment tasks. This section also includes short illustrative activities or "thinking exercises". Some can perhaps be used as classroom activities for students, but their primary intention is to help readers familiarise themselves with the 11 facets and tools, and connect them to each other, and to Civic Statistics. More tasks and ideas for classroom use appear in later chapters in this book.

Facet 1: Meaning for Society and Policy
This facet is the heart of Civic Statistics, where the focus is on the social implications of evidence. It provides the rationale for why data are needed and why statistical findings are published: societies need information about their current status, trends or changes from the past to the present, and projections to the future. Hence, statistics education classes should highlight the meaning of statistics for citizens and for social policy.

Social policy is a broad term that refers to the strategic plans, decisions about allocation of resources (i.e., in what we choose to invest public money), and other broad actions of governmental bodies or institutional agencies. Social policy aims to respond to (or pre-empt) pressing needs and gaps and improve or reform societal or economic issues. It may be enacted in many ways, such as via laws and regulations, budget allocations, and other means at the national or local levels. As Chap. 2 argued, citizens (and learners) need to be aware of key 'burning' issues regarding social and economic matters that affect society, e.g., regarding health, wages, unemployment, crime, environment, economic opportunities and equality, and access to services. (Teachers may want to discuss this topic with their students, ask them to find examples for social policy, and describe the intentions and implications of such policies).

Citizens need to know that there are social policies dealing with all these issues—and that choosing to do nothing is, by itself, a social policy. Policy is shaped by politicians & decision-makers. Decisions involve choices and risks, weighing existing evidence, options and their probabilities, costs and benefits, expected values, and subjective utilities. Evidence-informed decision making is not easy. Citizens need to worry about the quality of evidence, its timeliness and relevance. It follows that the learning of statistics should put data in context. Statistical analysis should be complemented by discussions of plausible causal factors and the likely social and policy implications of actions, both in terms of immediate impact and likely longer-term effects. Possible implications for different groups of stakeholders should be considered. It follows that education systems should produce citizens who are willing and able to provoke debate and evidence-informed action on "burning social issues" they judge to be important, and understand the connection with social policy.

Thinking Exercise/Activity #1: Aging and Public Budgets
Q1. What is the proportion of older people (65+, or 75+) in your country, and how is it projected to change or grow in the next 20–40 years? Why are these changes happening, i.e., what are the causal factors? *Most important:* What are the social or economic or business-related *consequences* or *implications*, and what changes in social policy are needed (e.g., in pensions, social security, health care plans, retirement age)?

Q2. What is the role of statistics in all of the above, i.e., in describing current trends, understanding causes and possible consequences, regarding aging and related public budgets and policies? Ask students to find relevant information sources (articles, reports, tables), discuss their social and economic implications, and support their ideas and conclusions with data. They may work with population pyramids (see Chap. 5) and various indicators from official statistics agencies.

Facet 2: Critical Evaluation and Reflection
Here we discuss issues pertaining to critical evaluation of, and reflection on, statistical messages. (Meta-cognitive and dispositional issues are also relevant, but covered in Facet 3). The core idea here is that citizens need to be able to ask critical questions to evaluate the credibility and soundness of any data, finding, or conclusion they encounter, both on technical and logical grounds—even data or reports from credible sources such as official statistics agencies.

For example, critical or reflective questions about the methods used in surveys and official statistics (see also Facet 6) could include (but are not limited to):

- Are the measures (e.g., a questionnaire) well defined? Are the measures robust and appropriate for the purposes for which they are being used? (e.g. Ridgway et al., 2018, challenge the use of a measure of 30-day mortality to judge the risks associated with hospital admissions at weekends).
- Are metadata (i.e. detailed explanations of how variables were defined, sample characteristics etc.) available?
- Were the sampling procedures appropriate? who is missing from the collected data? (e.g. measuring how citizens feel about a certain topic by analysing twitter streams fails to sample non-twitter users).

More broadly, in recent years we have seen attacks on evidence-informed policy-setting, and a proliferation of untruths labelled as ‘alternative facts’ or ‘fake news’, a term which those propagating misinformation have hijacked to describe mainstream media reporting of reality. However, most statistical findings about civic issues are released as *text* (e.g. from government agencies) and are then interpreted and re-presented for public consumption by journalists and politicians. It is important, therefore, to examine narratives and interpretations that involve statistical evidence and that touch on public policy from a critical perspective. Such criticality may

involve a reflection on underlying 'power' or bias issues, such as: whose interests are served (or protected) by studying, framing, or reporting on this civic issue in this way? Are there 'political' motives behind the way the problem is being examined? Are there alternative ways to examine the social problem at hand, what correlates are considered), to improve what we know about the topic? In addition, criticality can also relate to broad methodological and interpretation issues, for example:

- What is the quality of the evidence presented in a media article or a political speech to support assertions about needed policy (e.g., regarding recycling laws, wage equality, or vaccination)?
- How sensible are the projections and how appropriate are the underlying statistical models and assumptions that have been applied to analyse data on key topics, such as regarding the progression of global warming or the rate of spread of infections such as the COVID-19 coronavirus pandemic?
- When assertions are made about a correlation between variables (e.g., smoking and risk of death), are relationships assumed to be linear, and are they really so (or perhaps curvilinear)? More important, if causal processes or cause-and-effect relationships are assumed, are there plausible rival accounts, covariates, or unexplored intervening factors which affect the findings?
- Are the conclusions consistent with other available evidence?

A more comprehensive discussion of topics for critical evaluation and reflection, including the need to be familiar with detailed "worry questions" (Gal, 2002), can be found in Chap. 13. Decisions about policy require evaluations of costs, benefits and risk. The underlying analyses and statistics can and should be examined and challenged by citizens, in terms of their quality and the soundness of the underlying statistical evidence.

Thinking Exercise/Activity #2: Health and Management

In the UK, some published statistics showed that people admitted into hospitals at the weekend were more likely to die than people admitted during the week. The Health Minister introduced major changes to staff schedules ('rotas') so more health staff are working at weekends. This triggered massive demonstrations by doctors and nurses.

Q. Should the Minister have looked at more data? What data? Why?

(Note: Here, students could explore relevant data for their country—including the days of the week on which people actually die in hospital. The UK data illustrated *sample bias*—patients with routine medical problems are commonly admitted on weekdays (and staffing levels are high because of all the routine treatments being conducted); weekend admissions are characterised by medical emergencies. People were actually less likely to die on Saturday and Sunday than on some other days.

Facet 3: Dispositions
Statistical knowledge and skills that might be acquired in an introductory course cover many subtopics, such as knowledge about ways to describe central tendency and spread, correlation, inference, and the like. Yet, such knowledge and skills are unlikely to be useful when engaging with Civic Statistics, unless they are supported by two further factors: *relevant dispositions* and *habits of mind* related to statistical and quantitative issues.

The term 'disposition' is an umbrella term that refers to a cluster of related but distinct concepts, including motivations, beliefs, attitudes, and emotions. Examples are attitudes to evidence, and personal sentiments regarding mathematics, uncertainty and risk. Dispositions are of particular importance if we envision citizens who actively engage with and critically reflect on Civic Statistics, since they have components (e.g., self-efficacy, self-confidence) that may affect engagement in both positive and negative ways. Dispositions have not only a personal dimension (a willingness to engage with and to devote time to understanding the information that is being presented) but also a social dimension (a willingness to share opinions and alternative interpretations with others).

A key disposition is *critical stance* (Gal, 2002), a willingness to engage with statistics and quantitative evidence related to social issues. Dispositions can be positive or negative, and can either support or disrupt engagement with statistics and other quantitative information (McLeod, 1992). Positive dispositions are exemplified by trust in fact-checking organisations (such as *Full Fact* in the UK) who offer non-partisan commentaries on statements by politicians and the media on issues of social relevance. Negative dispositions are exemplified by statements such as 'you cannot trust statistics in the news'. As well, dispositions about one's own state of knowledge are important. Ignoring evidence because of prior beliefs, accepting new information uncritically, or believing that social phenomena can only be understood by experts are all symptoms of unhealthy dispositions.

Habits of mind are specific ways of thinking that people adopt in different situations. What do citizens (and students) do when faced with an argument or statement based on (statistical) evidence? A positive disposition is exemplified by active engagement with the argument. Positive habits of mind are questions that immediately spring to mind (they are *habits!*). For example:

- What is the 'story' being told—whose story, and why are they telling it? Who is interested in the results of the study?
- Can I play with the data myself, or access additional information to confirm what is being presented?
- Do I understand the visualisations, texts, and terminologies being used?
- Do I need to boost my technical knowledge (means, medians, variance, comparing groups, boxplots, density plots, interactions)? And how?

Thinking Exercise/Activity #3: Public Engagement with Statistics
If you were to conduct a survey of 100 persons regarding the extent to which they trust government statistics, understand common terms such as 'representativeness' (of a national random sample of 500 persons), or where they stand on any of the dispositions listed above, what do you think will be the results? Now, actually choose one topic, and organise a survey among your students, and their parents or neighbours. Compare the results for such groups.

Facet 4: Statistics and Risk
Most real life statistical problems have one or more non-standard features. There are no routine statistical questions; only questionable statistical routines. (Cox, quoted in Chatfield, 1991, p. 240).

This facet encompasses much of what is commonly taught in introductory statistics college courses or in 'statistics' or 'data analysis' at the high-school level, although the emphasis for Civic Statistics is different. Every fundamental idea in 'statistics' is of relevance to understanding statistics about society—here is a partial list:

- Understanding variability and describing and comparing distributions and trends in data (e.g., via frequency tables, plots, measures of central tendency, etc.)
- Understanding association and correlation
- Informal understanding of notions of samples and populations, and of representation (as in a 'representative sample') and inference
- A sense for the notion of statistical significance or level of confidence in a statistical statement (of course, calculations of statistical significance and inferential arguments are rarely useful with large-scale data which are typical of official statistics)
- More advanced topics may include (but are not limited to): regression & associations, non-linearity, signal and noise, understanding interactions (confounding variables, Simpson's paradox), Bayesian inference, effect size, and more

In addition, this facet encompasses *risk*. Risk is a complex matter. It involves weighing evidence about the relative likelihood of different phenomena, but also about the costs and consequences associated with the results of different (in)actions. Think, for example, about global warming—what are the expected impacts of not changing current policies, as well as the results of implementing proposed policies? This requires using data, statistical methods, and models, to describe the current situation, and predict the likely impact of different (non)interventions, or making judgements about the chances of different events occurring under different scenarios (do nothing; reduce emissions; plant trees), and about causality (and indeed, about webs of causal factors). Thus, understanding risk on the *societal* level involves much more than just knowledge of the formal rules or computations of 'probability'as included in many statistics curricula.

These components of risk may also create tensions between the need to understand and think critically about current (existing) data, and the need to explore projections (with embedded causal theories) about the anticipated status and likely occurrence of hypothetical events. The notions of 'costs and consequences' noted above are also not simple, as these can be considered from both a *societal* perspective, and also from a *personal* perspective (together with points in between). Think of public discussions or media articles regarding a health epidemic. There is a need to understand the costs of some actions at a *societal level* (e.g., what happens to national death rates if there are no social restrictions?; what are the economic implications of lockdown?), and at a *personal level* (*If I don't work I don't get paid—should I hide my symptoms?*). It is clear that discussions of risk are central to facet 1: *meaning for society and policy*.

All the above demonstrates the need for citizens to develop *statistical literacy* (see Gal, 2002) and *probability literacy* (see Gal, 2005). Yet, there is also a need to understand and act upon risk hence a need to develop *risk literacy*. As Martignon, Frischemeier, McDowell, and Till explain in Chap. 19, risk literacy is a multi-faceted construct that has received much attention in recent years, in particular in connection with how people manage health or financial risks. Risk involves, among other things, some familiarity with probability and conditional probability (including an informal feeling for Bayes' theorem), but also thinking of values and expected values, costs (negative or positive) of various consequences and courses of action, and the robustness of available evidence. Overall, then, the need to engage with public dialogues about burning social issues demands that citizens understand ideas related to statistics *and* to risk, not as separate cognitive or curricular entities, but fused together.

Thinking Exercise/Activity #4: Parents, Health and Education

Herd immunity is a concept that received much public attention during the COVID-19 pandemic, but has been of longstanding interest in connection with child vaccination issues. Herd immunity arises when a sufficiently high proportion of a population becomes immune to a disease (usually through immunisation); this makes it harder for the disease to spread to unprotected persons such as infants (because immune people very rarely carry the virus, so an infant's chance of coming into contact with the disease is small). Herd immunity indirectly protects those who have not been immunised yet. However vaccination is a controversial topic in some countries, with some citizens/parents opposing mandatory vaccination, while others argue that children (or adults, such as teachers) without immunization should be prevented from entering schools.

Q. Leading doctors in a country advocate mandatory immunisation for MMR (Measles, Mumps and Rubella). What is the evidence (needed) to support such a policy? Are there credible statistics that can support parents

(continued)

Thinking Exercise/Activity #4: Parents, Health and Education (continued) who opt *against* vaccination? Should new statistics be collected (e.g., via a survey or any other means) to help public discussions on this topic? How useful is empirical evidence in discussing the right balance between the rights of the infant, the parent, and the state?

Note: This activity aims to show how statistical and risk issues are intertwined, and how understanding them is essential for engaging with certain civic issues, both at the personal level and at the societal level (and that there can be a tension between them). A discussion of such issues can also bring up ethical considerations and citizens' rights. Links to relevant data can be found in Chap. 12 by Ridgway and Ridgway, which also offers links to relevant data sets and more ideas.

Facet 5: Models, Patterns, and Representations

All models are wrong, but some are useful (Box & Draper, 1987, p 424).

The heartland of statistics is the application of mathematical and statistical models to situations of interest, e.g., in order to estimate the extent of some phenomenon or project its pattern of development over time. Recent examples which have occupied many governments are the attempts to predict the progression of disease during the COVID-19 pandemic, or to project the pace of global warming or climate change. Such predictions inform decisions on national policies in this regard.

Thus, a key component of Civic Statistics is understanding that complex social phenomena can be modelled, and that different models can be developed and used to understand the same phenomenon. For example, an economist and a sociologist might have quite different theories and methods for defining and studying *poverty* in society, and they may create different indicators to sum up different components that describe or predict poverty. Their models of the causes of, and remediation for, poverty might be quite different (they might not even agree that poverty is a problem to be solved—for example, Bishop Helder Camara is quoted[1] as saying "When I give food to the poor, they call me a saint. When I ask why they are poor, they call me a communist").

Civic Statistics requires the ability to identify and understand the use of models, and to be able to challenge the fundamental assumptions made by any model (Ridgway et al., 2016). This can be contrasted with introductory statistics courses which often teach standard procedures to model data (e.g. using linear regression) with little regard to context, underlying assumptions, or the quality of models. Facet 5 thus emphasises aspects of modelling such as making judgments about causality and about confounding or intervening variables that may help to explain the patterns seen in the data.

[1] https://www.theguardian.com/commentisfree/belief/2009/oct/13/brazil-helder-camara

Another aspect of this facet is the need to be able to understand rich or novel *representations*. Representing data in an effective way is essential for understanding social phenomena and showing their patterns. Simple graphs and boxplots are included in introductory statistics instruction, in part because they help to model and represent data in a concise way, e.g., a line graph to show a trend. However, the complex nature and many features of social phenomena require more sophisticated representations that highlight the non-linear features of Civic Statistics data, and that show *dynamic changes* over time or across different groups being compared. In Chap. 5, Ridgway, Campos, Nicholson, and Teixeira show how innovations in ICT and digital technology are widening the range of available multivariate (and often interactive) representations, which can enable insights into phenomena that are difficult to portray via numeric representations.

Thinking Exercise/Activity #5: Poverty
Q. Provide a method (model) for estimating the number or proportion of workers in your country who *live in poverty, even though they are working* (i.e., employed people who are nonetheless "poor"). You can submit more than one estimate or representation based on different assumptions/logics (e.g., regarding what is "employed,", "poor," etc).

Note: There is no need to analyse raw data. The exercise is to be done by finding published sources and coming up with a *model* which defines what variables should be considered, and why (what are the underlying assumptions?). Generate a reasoned estimate, based on the figures you obtain, using any credible source that you think presents relevant data (e.g., reports with current statistics about (un)employment, wages and income, usage of public assistance, family size, etc), newspaper articles on this topic, etc.

Facet 6: Methodology and Enquiry Processes
Facet 6 refers to the statistical enquiry processes and research methods used to generate any Civic Statistics. Civic Statistics requires an understanding of the strengths and weaknesses of different discovery or data collection methods, and some procedural skills.

Facet 6 encompasses both quantitative and qualitative research and data collection methods. There is a wide range of methods involved, here are key examples:

- *Quantitative methods* include: survey research (survey types, and sampling methods; a concern is always vulnerability to bias); experiments (naturalistic, Randomised Controlled Trials; validity is always a concern), administrative records, sources of big data such as web scraping (e.g., extracting information from digital sources, such as user activity on websites), and more. Some related concepts include but are not limited to: sampling, non-response, and randomization; measurement (reliability and validity); questionnaire design; cleaning data and dealing with missing values, and more

- *Qualitative methods* include: interview techniques (e.g., as part of a pilot study); content analysis of texts (as when analysing the recorded content of calls to a service contact centre to understand typical customer complaints) and images; the use of tools for analysing posts on social media such as Twitter, Facebook, Instagram, and blogs, etc.

An understanding of *ethical issues* associated with the production of data and the use of various research methods is also an essential component of Civic Statistics. It is important by itself (i.e., related to the rights of citizens) but is also important because it can indirectly affect the results and conclusions. For example there is a need to know about issues concerning the confidentiality of data collected, and protection of the identity of respondents to surveys via anonymization; this may reduce the willingness of certain individuals to participate in a study (or not), thus affecting the sampling process and sample characteristics and representativeness.

Thinking Exercise/Activity #6: Migration
A study claims: *Recent migrants have below average intelligence*.
Q. Identify three distinct reasons (related to methodological factors) that might invalidate these conclusions or published claims.

Facet 7: Extensions in Official Statistics
Official statistics agencies (OSA) and other statistics producers operate in virtually all countries in the world. International agencies such as Eurostat, OECD and the UN, synthesise data across countries and produce additional multinational statistics. All these OSA create and publish reports, datasets, press releases, dashboards, and other data products that are critical for understanding societies and the changes they are going through—and these information sources are critical because they are the basis for much of the statistics-based information that the media reports to the general public. However, understanding information from official statistics sources requires knowledge that goes beyond what is taught in standard introductory statistics courses.

Gal & Ograjensek (2017) have proposed a model mapping six elements that characterise 'official statistics literacy'; they argue that citizens should:

1. Know about the system of official statistics and its work principles (e.g., that OSA aim to generate statistics which are based on sound scientific principles and which are credible and trustworthy, impartial and objective, ethically sound, comparable, open and transparent, etc.).
2. Understand the nature of statistics about society, i.e., that data are often multivariate, dynamic, based on rich text and visualizations, etc. (see Chap. 2).
3. Understand the nature and use of indicators (e.g., GDP, poverty threshold) for tracking changes in key social and economic phenomena.
4. Know about the specific statistical techniques and ideas that are of relevance to official statistics.

5. Understand the research methods and data sources that are common or unique to official statistics, e.g., conducting censuses; that statistics on key topics are released and updated on a regular schedule (e.g., each month or quarter); large-scale household surveys are used.
6. Be able to access statistical reports and information products from OSA (see Facet 9).

In each of the above six areas, there are 'extensions' which go beyond the basics of descriptive and inferential statistics encountered by those who learn introductory statistics at the high school or college level. For example, statistics producers use a large array of additional techniques and ideas, such as moving averages, seasonal adjustment (see Example 2 in Sect. 3.2 on 'wage adjustment'), data smoothing, case weighting, and the like. Specific areas of official statistics may have additional important approaches, such as the use of models and assumptions for population projections, or national accounts and 'purchasing power parities' when comparing economic statistics across nations or time units (Pfeffermann, 2015). Ridgway & Smith (2013) note further topics which receive rather little attention in traditional statistics courses but are of heightened importance in understanding data from official statistics sources, such as: the perils of survey research (non-response or respondent bias); use of Geographical Information Systems (GIS) and small area estimation to provide data relevant to specific locations; and synthetic methods where data gathered by conventional survey data is combined with 'big data' (e.g. data on mobile phone traffic).

Understanding of these and related techniques may not be essential for the understanding of basic statistics reported in the media. However, knowing about their existence, even if they are treated as 'black box' techniques without understanding the underlying computations, can be important if citizens are to adopt a questioning stance and desire to understand more deeply how certain conclusions are derived. For instance, how is it possible to compare different economic, financial and social systems that have monetary systems with different characteristics, or where social or economic conditions (e.g., inflation) have changed the base against which comparisons are being made?

Thinking Exercise/Activity #7: Equality

Read again Example 2 in Sect. 3.2 (on the gender pay gap) and decide which statistical methods discussed there can be seen as "extensions in official statistics". Which important techniques or approaches are not part of *your* introductory statistics courses? Next, access the full entry about *gender pay gap* on Wikipedia, and continue your analysis for at least 4 more paragraphs. (You are not limited to English—these definitions appear in Wikipedia in multiple languages!)

Q. List the topics you found, then answer this: Do you think it is essential to understand these extensions in official statistics, in order to make sense of statistics about the gender pay gap?

Facet 8: Contextual Civic Knowledge

Statistics is about describing, comparing, projecting and modelling, but in order to do all these, one needs to have an understanding of the phenomena of interest. This requires factual knowledge about the world. For instance, knowing that absorbing one million refugees in Germany (population over 80 million) is likely to be easier than absorbing one million refugees in Hungary (population around ten million), other things being equal. Knowing that countries being compared are not necessarily equal, e.g., in terms of political climates, economic realities, or population characteristics, reflects the contextualization of civic knowledge.

Contextual civic knowledge includes, among other things:

- Factoids: sizes of populations, size of GDP, national debt and resources; demographics and population composition; history and geography of a country or region, economic sources of income
- Knowledge about institutional structures, the machinery of government, and political actors
- Knowledge about the flow of information (e.g., media and digital sources)
- Familiarity with regional and national geo-politics

A benefit of contextual civic knowledge is that one can look for alternative data analyses using knowledge of plausible covariates. For example, finding that heart disease is heritable (i.e. children of parents who suffered from heart disease are more likely to suffer from heart disease themselves) does not necessarily mean that any genetic factors are involved. Children often model their parents' behaviour in important ways, such as smoking, diet, being obese, living in the same environment, and making similar lifestyle choices about exercise. Thus, understanding 'how the world works' is also part of contextual knowledge and helps in interpretation about civic statistics. At a higher level, if one is to understand (or do) anything about social injustice, one needs to understand communication channels and governance.

It is important to understand that knowledge about the context is normally not specified within curriculum statements because it is too broad. The specific details of the contextual knowledge needed by citizens will vary depending on the tasks used (that is, depending on the civic area of interest, and the particular characteristics of the country or region or problem given). Yet such contextual knowledge is essential, because without it students and citizens cannot fully interpret and understand the importance or meaning of statistics about a social phenomenon, or its implications for social policy in a specific country or region.

Thinking Exercise/Activity #8: Demographics

In your country:

Q1. What is the annual birth rate and number of births, death rate and number of deaths? Compare these to the number of people who died from different types of transport accidents (i.e., by car, train. etc.) last year.

(continued)

Thinking Exercise/Activity #8: Demographics (continued)

Q2. What is the (approximate) total annual budget of your government? how much money was allocated during the last year to road safety (e.g., safety education, safety media campaigns, road improvement), vs. to medical or health services?

Q3. How useful are these figures for understanding and putting in perspective the number of people who died of COVID-19 (or road accidents) in your country, and associated government expenditure on medical services, payments to people who were fired (laid off from work), etc.?

Think of other questions you can pose to students that will connect different types of statistics (e.g., on demographics, employment and economic factors) and showcase the importance of contextual knowledge.

Facet 9: ICT & Search

To access and evaluate Civic Statistics, citizens need to be knowledgeable about many separate aspects of Information and Communication Technologies (ICT). At a basic technical level, students and citizens need to know how to search for information that may involve statistical evidence (using search engines effectively; locating credible information sources or relevant reports); sorting and comparing (which area has the smallest political majority?); using interactive displays effectively, e.g., choosing scales, adjusting sliders and display parameters, or using zoom functions. Some elements of Facet 9 are illustrated more fully in Chap. 5.

A different aspect of ICT and Search is knowing that citizens can access many data sources on their own. OSA and other major data providers make data publicly available. "Open data" initiatives in many countries (such as data.gov in the USA and data.gov.uk in the UK) aim to support democratic processes by giving citizens access to data that can stimulate debate and inform policy making. However, searching, accessing, and working directly with such data sets may require extra technical expertise.

Beyond traditional views of ICT or the effective use of digital tools, citizens need to be aware of the impact of digital technologies on their lives, as well as of the potential of these technologies to support Civic Statistics. 'Undoubtedly the greatest challenge and opportunity that confronts today's statisticians is the rise of Big Data' (Madigan, 2014, p4). Examples include data from wearable devices, transactional data from mobile phones, and data scraped from web pages. Civic Statistics requires an understanding of the analytic techniques suited to accessing and analysing high-volume unstructured data. As technologies have an increasing impact on many aspects of daily life, so citizens need to understand the ways data and technologies are used, in order to both protect their own direct interests, but also to engage in debates about appropriate and inappropriate uses of technologies and data. These issues are explored in detail by Ridgway, Campos and Biehler in Chap. 22, and elsewhere in Part 4.

Thinking Exercise/Activity #9: Policy Goals and International Development

The UN Sustainable Development Goals (SDGs) present many aspirations regarding desired change in 17 separate key domains related to social and economic issues, on which there is broad international agreement. To understand the role of ICT and Search enabling processes as part of understanding Civic Statistics, please:

(a) Search for basic definitions of the 17 key SDGs; choose *one* of interest to you.
(b) Find one or two repositories of data or of indicators that allow you to check on the status of your chosen SDG. Is there a single indicator or measurement model in this regard?
(c) Search for information about *your own country* and where it stands on this SDG, and compare your performance with another country you care to compare to.
(d) Reflect on the type of skills you used (this may overlap with some of the other facets and tools). What type of statistics and representations are shown? How do they relate to the regular content found in introductory statistics?

Facet 10: Quantitative Core

This facet relates to quantitative skills (many people will think of these as mathematical skills) which underpin some aspects of statistical literacy. While fluency in these topics is important, Civic Statistics needs more than simply fluency, but also numeracy (Geiger et al., 2015; PIAAC Numeracy Expert Group, 2009) because numbers are presented in contexts that require subtle understanding. Civic Statistics often involve both very large numbers (e.g. GDP measured in trillions of euros) and very small numbers (e.g. micromorts to measure the risk of death from certain activities). Conversions between measures are common; numeracy skills are needed in order to understand and compare different measures. Components of the Quantitative core include ratio, percentages, rates, fractions, and number sense. Number sense is about having a feel for numbers. In Civic Statistics, seemingly large resources may actually be small, in context. For example, a 30 million euro increase in the budget of a government department would be significant for a small department, but if the current budget is 6 billion euro, then it is likely to have little or no observable impact on department performance. There is a considerable literature on the problems associated with understanding ratio, percentages and rates—a good starting point is the StatLit webpage.[2]

[2] http://web.augsburg.edu/~schield/

In the context of Civic Statistics, it is easy to find examples where an author has deliberately chosen to report (accurately) data that are misleading—for example, reporting a percentage increase, where the absolute number of the starting value is very small. Civic Statistics requires an understanding of the difference between absolute and relative quantities—such as claim that the national deficit has been reduced, when what is being reported is the deficit as a proportion of GDP, in a period when the GDP denominator has increased.

Thinking Exercise/Activity #10: Safety in Transportation—Comparing Metrics

The activity below focuses on measurement issues relevant to transportation, similar activities could refer to indicators about pollution, crime, well-being, and so forth.

Q1. How safe is it to travel by different modes of transport? Rank order the following methods of travel from most to least dangerous: car, ferry/boat, rail/train, transit rail/metro. Find published statistics on deaths for each of them. What did you find, and how much safer is one method compared to the other?

Q2. The most commonly used metric is *deaths per 1 billion passenger miles* (a car carrying 4 people on a journey of 100 miles = 400 passenger miles; a flight carrying 150 passengers on a journey of 400 miles = 60,000 passenger miles). However, this metric only uses *deaths* and *passenger miles* as the basis for calculating *safety*. Can you think of other models to capture other aspects of *safety* of transport modes, beyond just deaths?

Facet 11: Literacy and Communication

A great deal of information concerning Civic Statistics is presented as text, whether in printed or digital or spoken formats, and some via tables or images, charts, and graphs. Being able to read fluently and absorb the overall sense of the article or report as well as the detailed statistical information, and ask critical questions (see Facet 2) about the information, is an essential skill. Yet, reading and comprehension are not always easy since text may be dense, and difficulty increases substantially if the language of the report is not the reader's first language, a common situation in many countries.

However, in the context of Civic Statistics, both literacy and communication are moving targets. New forms of communication are emerging, that include social media, new ways to visualise data (e.g. Yau 2011; McCandless 2014, or the GapMinder resources[3]), and video (such as Hans Rosling's TED talks on YouTube). Citizens need to be able to learn how to understand and deconstruct messages conveyed in multiple or new communication forms. This requires the development of new forms of literacy—notably visual literacy (McKim, 1972), data literacy and

[3] www.gapminder.org

media literacy. Chapter 16 presents more examples for deconstructing newspaper reports with statistical information.

For fuller engagement in Civic Statistics, citizens also need to be able to communicate in new ways. Those wanting to communicate with others about Civic Statistics need to take care (and invest time and effort) in writing and talking in ways that the audience can absorb easily—even things like speaking slowly enough for a multilingual audience requires a conscious (and continuous) effort.

Thinking Exercise/Activity #11: 'Statistical Storytelling' About a Civic Issue

Find a recent *news story* (an article in the printed or digital media) from your own country which has some statistical information about any topic that might be called Civic Statistics (e.g., health, pollution, crime, or education). Then, find the *press release* which was published by the agency responsible (e.g., a government statistical office, a research institute). There is likely to be a number of media outlets (or social networks such as Facebook or twitter) running a story on the same topic (newspapers, TV news, etc.).

Q1. How consistent is the message from different outlets on this topic—and how compatible is it with the original press release?

Q2. From looking at the news story and the press release, what can you conclude about the *role of literacy and language skills* (and the understanding of jargon) in understanding statistical communication about civic issues?

3.5 Task Analysis: Analysing the Demands of Possible Activities via 'Radar Plots'

The prior section clarified and illustrated the nature of the 11 facets and tools included in the conceptual framework, which are needed (by students and citizens in general) so that they can critically understand Civic Statistics that they see/read/hear, and engage with the underlying societal, political, or economic issues (Nicholson et al., 2013). Before discussing the implications of this framework for planning instruction (see Sect. 3.6 and Chap. 4), first we focus in this section on an important question: How can you analyse which of the 11 facets and tools are involved in or invoked by a certain task or activity? We advocate the use of *radar plots* (also referred to as: spider, web, star, and polar plots, or Kiviat diagrams) to support the analysis.

A radar plot analysis involves three steps:

1. **Choose a given task** (e.g., an instructional activity, class assignment, or test question that is of potential interest)
2. **Examine and reflect** on its demands, in terms of knowledge-bases, skills, dispositions, and other enabling processes—essentially thinking through the features of the resource in terms of the 11 facets of the conceptual framework.

3. **Rate on a scale** to what extent each of the 11 facets and tools are involved in or invoked by this task or activity. The rating scale can be simple and go from 1 to 3, or be more detailed, e.g., 0 to 4: "none"-"very little"-"some"-"moderate"-"a lot"; or any other labels you desire. More levels can be used, if a sensible differentiation between that many levels can be developed).

Figure 3.3 illustrates possible results from such a rating process, using a 1–8 rating scale. (Appendix A offers two empty plots for your use, with an 8-level scale and a 5-level scale, and an empty table for ratings with any number of levels). Chapter 4 shows more worked-out examples. (See Ridgway et al., 2017 for further illustrations).

Before asking you to try out such an analysis, we emphasise that a radar plot is *not* an accurate analytical tool. Different educators may vary in their interpretation of the demands of any given task across the 11 facets, especially if a very detailed scale is used. It is clear that the ratings depend on the student target group; a question where students compare means and medians may be given a high score on Statistics and Risk for young students, yet a very low score for older students. However, the radar plot is very useful because the rating process promotes a valuable intellectual analysis, and the ratings can help you to evaluate the *relative* weights or level of involvement of all facets and tools in different tasks that you are considering for a particular target group. It can also identify gaps in a curriculum if no activity engages with some of the facets in the conceptual structure.

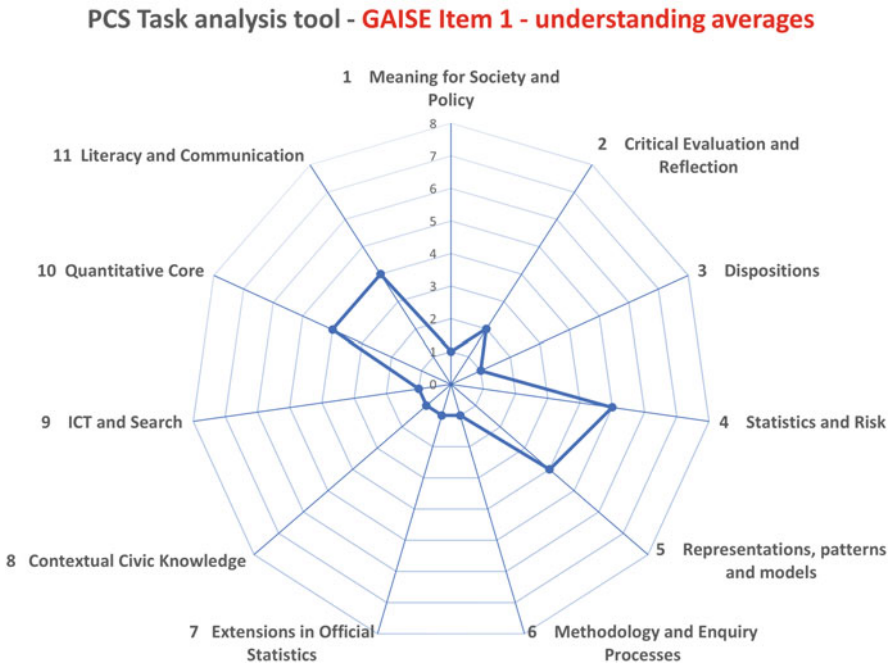

Fig. 3.3 Sample radar plot ratings for a teaching task

Further, a radar plot can be used by teams of teachers (e.g., in a workshop) to engage and bring out personal perceptions, and discuss, justify, or compare what facets and tools are demanded by different tasks or activities. All this can serve the planning of a mix of tasks that can create an effective instructional sequence covering all 11 facets and tools discussed in this chapter.

Example 3: Analysing the Facets and Tools Invoked by a Sample Statistics Task

There are ten people in an elevator, four women and six men. The average weight of the women is 120 pounds and the average weight of the men 180 pounds.

What is the average of the weight of the ten people in the elevator? Explain.

Reader—your task: please read the item above (from Pollatsek et al., 1981). Then, rate the extent to which this item involves or demands each of the 11 facets and tools. We suggest using the 0-4 scale described earlier by using the plot or the table in Appendix A. However, you can design your own empty plot via a simple chart in Excel, or just construct a simple table, and use any rating scale you desire.

Write your ideas in the empty plot/table as in Appendix A**. Only then, continue to read.**

Analysis of Example 3: This example illustrates a task which addresses conceptual understanding of averages. It is set in a reality which students can relate to, yet it is contrived, i.e., it does not relate to any civic context and has no social implications (see Chap. 13; and Carter & Nicholson, 2016, about contexts). It does require some understanding of statistical concepts and possibly some computation (Facets 5, 10). Some communication (Facet 11) is required by asking for an explanation, but this is not part of the task itself, which has minimal text. *What other thoughts do* you *have about the facets and tools demanded by this task?*

The example above is given only to help familiarisation with the analysis of task demands using the conceptual framework described in this chapter. What matters is to go through the reflection process, externalise your own perceptions, and be honest with yourself about the relative demands along the points of the rating scale you chose. See Chap. 4 for more examples of a radar plot analysis, using more authentic Civic Statistics tasks.

3.6 Summary and Suggestions for Planning Instruction from the Viewpoint of the 11 Facets and Tools

Civic Statistics has an important place in both statistics and social science curricula. This chapter focused on introducing a conceptual framework with three organizing dimensions (Engagement & Action, Knowledge, Enabling Processes), and 11 facets

and tools that should be developed through instruction. Examples and short activities were provided for each facet and tool to highlight their nature and interconnectedness.

The 11 facets and tools discussed in this chapter have many implications for teaching/learning processes and for assessment, which are discussed in detail in Chap. 4. Here we offer two brief concluding suggestions regarding the planning of instruction on Civic Statistics, in order to sensitise you to some of the many ideas in Chap. 4:

- **Plan instruction and analyse, select, and mix examples, tasks and activities that can together cover all the 11 facets and tools, not just conventional data analysis.** A key assertion throughout this book is that just teaching traditional statistics to students is insufficient to prepare them for engagement with Civic Statistics. Instruction involves, among other things, the planning and sequencing of multiple examples and explanations, tasks and activities, and assignments and tests. While each example or activity may cover or invoke only some of the facets and tools, the idea is that over time, all 11 facets and tools discussed in this chapter will be covered, explained, and practiced, in integration. To help the planning of such instruction, a key suggestion is that teachers *analyse, select and mix in a pre-planned way* different tasks—see Sect. 3.5 for guidance on how to analyse task demands
- **Contextualise!** For instruction in Civic Statistics to be meaningful and effective, examples and activities used in the classroom have to be set in realistic social contexts. Tasks can refer to health, crime, employment, wages, equality, pollution, global warming, or any other preferred area that is of interest—but have to be contextualised. Part 3 of this book is entitled Design Principles in Practice, and provides a rich variety of starting points in this regard (e.g., see Chap. 13 on contextualization by using rich realistic texts and task design; Chap. 18 on contextualization via cross-curricular projects, or Chap. 19 for contextualization related to notions of chance and risk)

We urge you to repeat the task analysis process sketched in Sect. 3.5 with other tasks (which you may use already, or from other sources). You may find that many tasks and activities which are typically used when teaching statistics can be useful for developing procedural or conceptual understanding, but hardly touch on many important facets and tools discussed in this chapter. This is why in this section we suggest planning a mix of tasks and instructional sequences that cover all 11 facets and tools, and ensuring tasks derive from realistic social contexts. Chapter 4 discusses further examples of using radar plots and presents broader recommendations, including ideas about assessment and systemic issues. Other chapters in this book offer additional pragmatic suggestions for teachers.

Appendix A

This appendix contains two empty radar plots, with a 5-level scale (Fig. 3.A.1) or an 8-level scale (Fig. 3.A.2) and a simple table (Table 3.A.1), that can be used by teachers or researchers for rating Civic Statistics tasks. Also, see the text box for simple instructions on how to create your own radar plot in Excel.

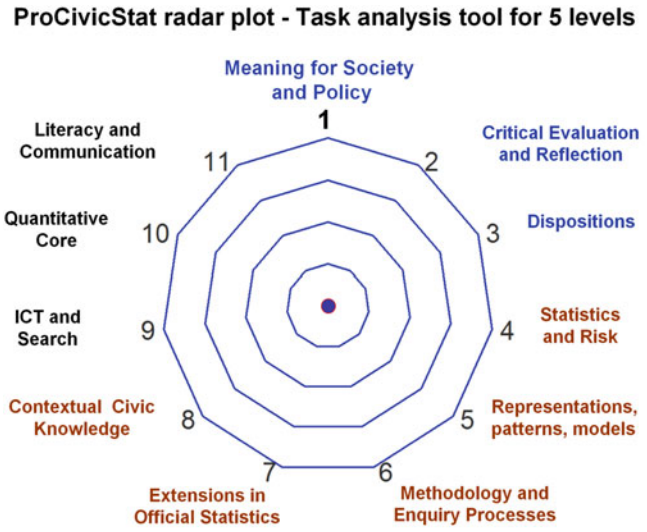

Fig. 3.A.1 Empty radar plot for an 5-level rating scale

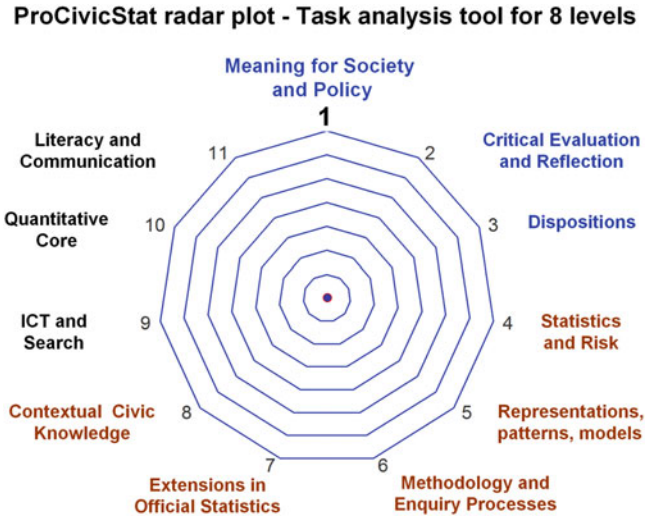

Fig. 3.A.2 Empty radar plot for an 8-level rating scale

Table 3.A.1 Empty table for rating a task

Facet	Rating	Comments
1 Meaning for Society and Policy		
2 Critical Evaluation and Reflection		
3 Dispositions		
4 Statistics and Risk		
5 Representations, patterns, models		
6 Methodology & Enquiry Processes		
7 Extensions in Official Statistics		
8 Contextual Civic Knowledge		
9 ICT and Search		
10 Quantitative Core		
11 Literacy and Communication		

The plot in Fig. 3.A.1 is suitable for a 5-level rating scale. Possible labels are: 0—none, 1—very little, 2—some, 3—moderate, 4—a lot. (Feel free to change!).

Do it yourself—create your own radar plot in Excel! Enter labels from 1 to 11 as listed in Table 3.A.1 under "facet" (i.e., vertically), then click the 'chart/graph' icon and choose chart type "radar" and follow the instructions that appear. You can change the number of levels (i.e., the number of concentric circles in the radar plot) by entering the 'scale' tab and changing the value for units compared to the maximum value For example, for 5 levels, set the maximum to 1 and the unit values to 0.25. Depending on your version of Excel, some trial and error will yield the desired chart based on the ratings you enter in each cell.

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