ETHICAL-POLITICAL ASPECTS OF STATISTICAL LITERACY

Karen François and Jean Paul Van Bendegem
Centre for Logic and Philosophy of Science (CLWF), Free University Brussels, Belgium
Karen.Francois@vub.ac.be

The aim of this paper is to give a philosophical insight into the ethical and political aspects of the concept of statistical literacy from a historical perspective. The growing interest into the accessibility of statistics goes hand in hand with the fact that statistical information is penetrating in growing measure the forms of personal and public life. It was part of the ethical-political agenda of the Wiener Kreis in 1929 to bring the scientific world-conception closer to human beings living in this world. We can see the same ethical-political programme within educational theory where the questions of literacy became a matter of ethics based on the general idea of emancipation which can be found in the UNESCO's view on education (1948). Moreover we see in its mission a tight connection with the socio-economic development, focusing on an enduring and peaceful world, while respecting diversity and maintaining human rights.

INTRODUCTION

The meaning of *statistical literacy* has no static content but a rather dynamic one. The meaning of the concept shifted over the years. In the late seventies, only the technical dimension of the concept was emphasized. It was in the early nineties that the concept was connected to some ethical and political aspects. Looking at the most recent description of the concept of statistical literacy given by Garfield & Ben-Zvi's (2008) we can still see the connection between the purely technical aspects of statistics and its ethical-political project. The idea of generalizing statistical literacy to educate and emancipate citizens and to go beyond the purely technical dimension of statistics is not all that new. Upon retrospect, the manifest of the *Wiener Kreis* from 1929–written by Rudolf Carnap, Otto Neurath and Hans Hahn and published as *Wissenschaftliche Weltauffassung–Der Wiener Kreis*–includes an ethical-political commitment which is a most striking and peculiar feature since the *Wiener Kries* and its logical empiricism are often depicted as a purely scientific undertaking. It is often stereotyped as being primarily focused on logic, mathematics, and physics –the *unity of science* idea was to reduce all other sciences to physics anyway, so there is nothing wrong to limit your self to physics, as physics will be the only true science. As a consequence the philosophers of the logical empiricism are usually not regarded as being involved with societal matters, let alone ethical matters. This is however erroneous. In the following passage from the manifest, it becomes immediately clear that they had an ethical-political agenda as well. "We witness the spirit of the scientific world-conception penetrating in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles. The scientific world-conception serves life, and life receives it." (Neurath & Cohen, 1973, pp. 317-318). It is especially Otto Neurath, one of the three authors of the manifest, who tried extremely hard to bridge the gap between the scientific world-conception and the personal and public life. In collaboration with his wife Maria Neurath he developed a universal pictorial language, the so called ISOTYPE (International System Of Typographic Picture Education) (see Lehrer & Marek, 1997; Nemeth & Stadler, 1996 for the main sources). It was one of the most innovative approaches to the representation of statistics in such a way that the greatest accessibility can be guaranteed. The idea of the ISOTYPE is that a graphical-visual language might better succeed in transmitting information like ideas, concepts and theories. ISOTYPE was mainly to be used for societal matters. It was Neurath's hope that well-informed citizens would on the community level reach wiser decisions for the general benefit. This picture language has made its mark on education on a world scale and it is precisely the ethical-political part of Neurath's project that in the late nineties became a topic of interest within statistics education and in the description of statistical literacy.

STATISTICS EDUCATION

The understanding that statistics is not just mathematics has given rise to a new field of study which is called statistics education. This field of study has emerged as an important

In C. Reading (Ed.), *Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia*. Voorburg, The Netherlands: International Statistical Institute. www.stat.auckland.ac.nz/~iase/publications.php [© 2010 ISI/IASE]

discipline–with its own conferences and journals–that supports the teaching and learning of statistics. Statistics education, as a specific area within educational theory, is an emerging field that grew out of two main disciplines–statistics and mathematics education–and it is currently establishing itself as a unique field of study (Garfield & Ben-Zvi, 2008). The question raised by Neurath about the accessibility of information became a central topic within statistics education. The concept of the accessibility of statistical information became meaningful as part of the larger discussion on literacy. The concept of literacy which was originally connected to a competence with written language, both in reading and writing, is broadened out to include mathematics and even statistics.

The growing interest into the accessibility of statistics goes hand in hand with the fact that statistical information is "penetrating in growing measure the forms of personal and public life". It was part of the ethical-political agenda of the Wiener Kreis as referred to above, to bring the scientific world-conception closer to human beings living in this world. We can see the same ethical-political programme within educational theory where the questions of literacy became a matter of ethics based on the general idea of emancipation which can be found in the UNESCO's view on education. Moreover we see in its mission a tight connection not only with the socio-economic development, but also with working on an enduring and peaceful world, while respecting diversity and maintaining human rights.

> UNESCO believes that education is key to social and economic development. We work for a sustainable world with just societies that value knowledge, promote a culture of peace, celebrate diversity and defend human rights, achieved by providing education for all. The mission of the UNESCO Education Sector is to:
> Provide international leadership for creating learning societies with educational opportunities for all populations;
> Provide expertise and foster partnerships to strengthen national educational leadership and the capacity of countries to offer quality education for all. (UNESCO, 1948).

The development of the ISOTYPE was (one of) the earliest 'didactical' innovations to realize a generalized accessibility of (statistical) information. However, visualizing (statistical) information is one step in a more complex matter. The meaning of the concept statistical literacy evolved over the years and became connected to an ethical dimension (Wallman, 1993). Initially the term 'statistical literacy' is used to describe the knowledge which people need in order to technically understand and make decisions based on the analysis of statistics. Haack (1979) states that in order to interpret statistics people need to consider and to scrutinize certain aspects which include the source, the type of data, definition and measurement problems, and certain considerations concerning the survey sample. As with most authors who began to develop the concept of statistical literacy, Haack emphasizes elements which are basically related to the technical dimension of statistics knowledge. This perspective on statistical literacy seems to be based on and derived from accepted academic uses of statistics.

Different authors introduce wider perspectives on statistical literacy related to the kinds of statistical skills which are needed by people in everyday life (e.g., Evans, 1992). Wallman (1993, p. 1) states in her Presidential Address to the American Statistical Association that "statistical literacy is the ability to understand and critically evaluate statistical results that permeate our daily lives–coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions." At this point, the ethical-political dimension emerges. The comprehension of statistical information is no longer reserved to the technical-professional sphere. It is widening to the sphere of the personal life and it is connected to a notion of critical thinking.

If we compare this wider perspective on statistical literacy, given by Wallman (1993), with the description of mathematical literacy given by the Programme for International Student Assessment (PISA) 2003 establishment, we can see a high correspondence (or, might we suggest, correlation?). "Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and

reflective citizen" (Organisation for Economic Co-operation and Development [OECD], 2004, p. 37). In line with this definition, Gal (2002, 2004) emphasizes the need for statistical literacy for all citizens who interpret statistics in various everyday situations. Furthermore, Gal suggests that when people read statistics in the media they have to make inferences, quite often in the presence of irrelevant or distracting information, and they may also have to apply mathematical operations to data contained in graphs.

This statistical literacy model (Figure 1) represents two ranges of elements which, when combined, can enable readers to understand statistical messages. On one side of the diagram there are knowledge elements which involve cognitive components of statistical literacy (e.g., rational understanding of the data such as knowing how to decode and make calculations about it). On the other side are dispositional elements which comprise a range of 'non-cognitive' aspects (e.g., a person who interprets a graph can have knowledge, experiences and beliefs which might differentiate his/her interpretation of the graph). According to Gal, statistical literacy is based on the interaction of the components which comprise each range of elements. Gal's statistical literacy model underlines the fact that the academic or formal schooling background is not the only determinant of the use of statistical skills. To develop statistical literacy, it may be necessary to work with learners in ways that go beyond instructional methods currently in use. To implement all knowledge bases supporting statistical literacy, topics and skills that are normally not stressed at school may have to be addressed (Gal, 2004, p. 73).

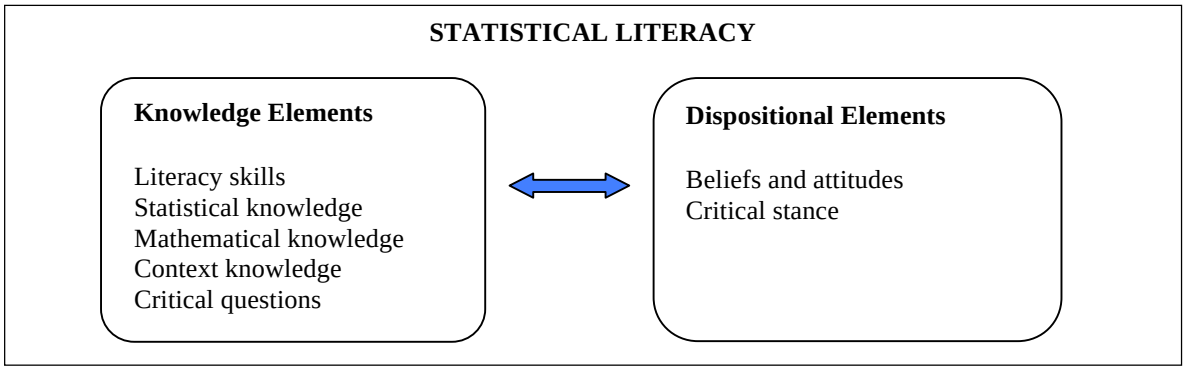

Figure 1. A statistical literacy model (adapted from Gal, 2002)

The increasing attention paid to statistical literacy also raises some discussion points. One important issue related to the role of statistical literacy is associated with the ethically loaded conception of the development of active and critical citizens who can read and interpret statistics making connections to different areas and 'reading' the world and its complexity. Therefore, statistical literacy should enable people to do more than just to read the data but should allow them to criticize and propose alternative interpretations to a given set of data. School systems have a crucial role in developing statistical literacy which enables students to understand why and how statistics is a way of describing the world (Frankenstein, 1998; Moreira, 2002). To emphasize this role, Garfield and Ben-Zvi (2008) distinguish between statistical literacy, statistical reasoning, and statistical thinking where statistical literacy provides the foundation for reasoning and thinking. They prefer the definition for statistical literacy as follows:

> Statistical literacy is a key ability expected of citizens in information-laden societies, and [it] is often touted as an expected outcome of schooling and as a necessary component of adults' numeracy and literacy. Statistical literacy involves understanding and using the basic language and tools of statistics: knowing what basic statistical terms mean, understanding the use of simple statistical symbols, and recognizing and being able to interpret different representations of data (Garfield & Ben-Zvi, 2008, p. 34).

This basic knowledge makes it possible to reason with statistical ideas and to make sense of statistical information. At this stage, students must be able to connect one concept to another and

to combine ideas about data and chance, what is precisely called statistical reasoning. The final stage of statistical thinking includes a deep understanding of the theories underlying statistical processes and methods. It also includes the critical competence of understanding the constraints and limitations of statistics and statistical inferences. That is why this stage of statistical thinking is called "the normative use of statistical models" by Garfield and Ben-Zvi (2008), emphasizing that values are at work here.

CONCLUSION

It was Otto Neurath's project to strive for greater human happiness. One of his projects has been to convey to the 'man-in-the-street' basic information about himself and the world. Therefore he developed an international picture language, the ISOTYPE. Today ISOTYPE charts and maps explain in a skilful and simple way economic arguments, developments in history, and relative statistics about many contemporary and historical, political and societal activities. Neurath's belief that communication of knowledge through pictures should play an increasing part in the future became true. We can recognize the same ethical-political project in recent descriptions of statistical literacy. Today statistical educators are challenged to make pupils literate to understand basic information about themselves and the world surrounding them. The connection between the accessibility of (statistical) information, called the competence of statistical literacy, became explicitly connected to the ethical dimension from the early nineties (Wallman, 1993) and it is still a central topic in Garfield and Ben-Zvi's (2008) notion of the final stage of statistical thinking which includes a deep understanding of the theories underlying statistical processes and methods.

REFERENCES

Evans, J. (1992). Mathematics for adults: Community research and 'barefoot statisticians'. In M. Nickison & S. Lerman (Eds.), *The social context of mathematics education: Theory and practice*. London: Southbank Press.

Frankenstein, M. (1998). Reading the world with maths: Goals for a critical mathematical literacy curriculum. In *Proceeding of the 1st International Mathematics Education and Society Conference*. Nottingham, UK. Online: http://www.nottingham.ac.uk/csme/meas/papers/frankenstein.html

Gal, I. (2002). Adult statistical literacy: Meanings, components, responsibilities. *International Statistical Review*, *70*(1), 1-25.

Gal, I. (2004). Statistical literacy. Meanings, components, responsibilities. In D. Ben-Zvi & J. Garfield (Eds.), *The challenge of developing statistical literacy, reasoning and thinking* (pp. 47-78). Dordrecht: Kluwer Academic Publishers.

Garfield, J. B., & Ben-Zvi, D. (2008). *Developing students' statistical reasoning: Connecting research and teaching practice*. New York: Springer.

Haack, D. (1979). *Statistical literacy: A guide to interpretation*. North Scituate: Duxbury Press.

Lehrer, K., & Marek, J. C. (Eds.) (1997). *Austrian Philosophy Past and Present. Essays in Honor of Rudolf Haller*. Dordrecht: Kluwer Academic Publishers - Boston Studies in the Philosophy of Science (Vol. 190).

Moreira, L. (2002). Mathematics education and critical consciousness. In *Proceedings of the 26th Conference of the International Group for the Psychology of Mathematics Education*. Norwich: Vol. 3, 369-376, UK.

Nemeth, E., & Stadler, F. (Eds.) (1996). *Encyclopedia and Utopia. The Life and Work of Otto Neurath (1882-1945)*. Dordrecht: Kluwer Academic Publishers - Vienna Circle Institute Yearbook (Vol. 4).

Neurath, M., & Cohen, R. S. (Eds.) (1973). *Otto Neurath: Empiricism and Sociology*. Dordrecht: Reidel. Vienna Circle Collection (Vol.1).

Organisation for Economic Co-operation and Development. (2004). *Learning for tomorrow's world: First results from PISA 2003*. Paris: OECD.

UNESCO (1948). *Universal Declaration* of *Human Rights*. http://portal.unesco.org/education.

Wallman, K. (1993). Enhancing statistical literacy: Enriching our society. *Journal of the American Statistical Association*, *88*(421), 1-8.