

# **SOCIAL-POLITICAL INTERFACES IN TEACHING STATISTICS**

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*ABSTRACT. The objective of this article is, based on the assumptions of Critical Statistics Education, to value the social-political interfaces in teaching Statistics by modeling projects. For this, we present a practical case, one in which we address the issue of corruption in Brazil, placed in the context of the teaching of index numbers, within the discipline of statistics in an undergraduate course in Economic Sciences.*

## **INTRODUCTION**

Political awareness and the discussion of social issues related to a student's reality are the main goals of Critical Education (CE) at any level of schooling. In our view, as in the opinion of the main organizers of this theory, such a goal can be pursued regardless of the syllabus of the subjects. We understand that educators can build adaptations to embrace themes that facilitate discussion of political and social issues which are relevant to the student's reality.

Critical Statistics Education (CSE), as presented by Campos (2007), shows the possibilities of integration and combination of objectives between these approaches by connecting the fundamentals of Statistics Education (SE) and CE. In this context we take the foundations of CSE to highlight and deepen the possibilities of enhancing the socio-political interfaces within the teaching of undergraduate courses in Statistics. For this purpose, we present a fragment of the theoretical basis of CSE and show how it is possible to obtain positive results with this integration, by using a mathematical modeling project that we had developed within the discipline of Statistics and applied in an undergraduate course in economics.

Another aspect that seemed relevant in this approach was the ability to assemble multiple media types within this modeling environment. Jacobini (2011) shows us that this congregation helps to motivate students to immerse themselves in a research environment. He also pointed out that it widens and diversifies the universe of opinions on the issues worked, enriching and stimulating classroom discussions.

## **CE, SE, AND CSE**

As a development of critical thinking, CE has emerged in opposition to traditionalism in the educational system, and its foundations can be credited mainly to Jurgen Habermas in Germany and Paulo Freire in Latin America. Freire's work,

which proposes emancipatory knowledge, inspired Giroux (1997), who extended the idea of democratization and politicization of education, within a vision of the teacher as an intellectual transformer: "essential for the category of intellectual transformer is the need to make the pedagogical more political and the political more pedagogical" (p. 163). Giroux emphasized a perspective from which "critical reflection and action become part of the fundamental social project to help students to develop a deep and abiding faith in the struggle to overcome economic, political, and social injustices and further humanize themselves as part of this struggle" (p. 163). Thus, Giroux defended the use of "pedagogies that incorporate political interests that have an emancipatory nature, i.e., the use of pedagogical forms that treat students as critical agents, making knowledge problematic, using affirmative and critical dialogue, and arguing for a qualitatively better world for all people" (p. 163).

Skovsmose, in turn, incorporated these concepts, and progressed in the development of CE. He stated that "it is essential that the issues relate to fundamental social conflicts and situations and it is important that students can recognize problems as their own problems" (Skovsmose, 2004, p. 24). Centered around the question of democracy, Skovsmose emphasized that this issue must be present in mathematics education and thus he worked towards a Critical Mathematics Education, in which working with modeling projects is valued.

Mainly developed since the 1990s, SE was conceived in a context of unease, trying to question and reflect over problems related with the teaching and learning of this discipline. This education was ignited by the difficulties that students have in thinking or reasoning statistically even when they show calculation skills. Seeking to differentiate the pedagogical problems presented by Statistics from those presented by the teaching of Mathematics, several authors converged on the idea that the teaching of Statistics should focus on the development of three specific skills: statistical thinking, statistical reasoning, and statistical literacy.

Statistical literacy has been well characterized by Gal (2004), who emphasized two interrelated components:

- a) people's ability to interpret and critically evaluate statistical information, arguments relating to data from research and stochastic phenomena found in different contexts;
- b) people's ability to discuss or communicate their reactions to this statistical information, along with their interpretations, opinions, and understandings.

According to Gal, in order to develop these abilities the educators must promote activities such as dialogues and discussions to encourage the students and their ideas when faced with real-world data containing statistical elements.

Statistical thinking is linked to the idea of evaluating the statistical problem globally, understanding how and why statistical analyses are important. Thus, statistical thinking is related to the ability to identify the statistical concepts involved in the

investigations and problems dealt with, including the nature of data variability— the uncertainty, how and when to properly use the methods of analysis and estimation, etc. According to Chance (2002), this capacity provides the student with the ability to explore the data in order to extrapolate what is given in the texts and to generate new questions beyond those indicated in the research.

Pfannkuch and Wild (2004) have gone further in the study of this ability and have identified five types of thought which they consider essential for Statistics:

- a) Recognition of the need for data: proper obtainment of data is a basic requirement for a correct judgment in real situations.
- b) Transnumeration: changing registers of representation to facilitate understanding.
- c) Variation consideration: to observe the data variation in a real situation in order to guide the strategies for studying them.
- d) Reasoning with statistical models: refers to thinking about the global data behavior.
- e) Statistical contextual integration: identified as a fundamental element of statistical thought. Results must be analyzed within the problem context and they are validated in accordance with the knowledge related to this context.

In order to develop these types of thought, Falk and Konold (1992) believe that the students shall be guided to make an internal revolution in their ways of thought, leaving behind the idea of seeing the world in a deterministic way.

The way in which people reason with statistical concepts composes what is generally called statistical reasoning. According to Garfield (2002), to reason statistically means doing appropriate interpretations of a certain data set, to represent or summarize the data correctly, to make connections between the concepts involved in a problem, or to combine ideas involving variability, uncertainty, and probability.

The development of statistical reasoning should lead the student to be able to understand, interpret, and explain a statistical process based on real data. Ben-Zvi (2008) emphasizes the importance of this capability. He states that all citizens should have it and that it should be a standard ingredient in education.

As we can see by the brief descriptions above, there are many commonalities between the three capabilities, especially between statistical thinking and reasoning. The cited authors categorize thinking and reasoning quite similarly and, in attempting to explain them, show a convergence of cognitive and conceptual aspects among them. In our view, rather than highlighting the differences among these capabilities, statistical educators must undertake further research on how to develop them in students. Campos (2007) gave some suggestions for classroom works:

- a) work with real data and relate it to the context in which it is involved;

b) encourage students to interpret, explain, criticize, justify, and evaluate the results, preferably working in groups and discussing and sharing opinions.

We understand that these suggestions can be supplemented to address major aspects of CE, and with this in mind, Campos, Wodewotzi and Jacobini (2011) suggest the following actions:

a) problematize teaching, work on statistics through projects contextualized within a reality consistent with the student's;

b) promote debates and dialogues among students and between them and the teacher, assuming a pedagogical democratic attitude;

c) thematize the teaching by prioritizing activities that enable the discussion of important social and political issues;

d) use technology in teaching, valuing skills of instrumental character;

e) adopt a flexible pace for developing the themes;

f) discuss the curriculum and the pedagogical structure adopted.

According to Campos (2007), by adopting these actions in the educational process, we will be practicing a CSE that goes against the traditional teaching model, which follows an alienating path by assuming a false political neutrality.

Campos (2007), Campos, Wodewotzi and Jacobini (2011), and Campos, Jacobini, Wodewotzki and Ferreira (2011) have argued that working with mathematical modeling projects comprises an appropriate pedagogical strategy to carry out CSE. With modeling we create motivation, facilitate learning, give meaning to the contents worked, value the concepts' applicability, and develop students' thinking that is critical and transformative of their reality, and we also promote the understanding of the political and social role of statistics. We understand that CSE worked through mathematical modeling is an efficient way for the articulation between theory and practice, and favors the breakup of arbitrary boundaries between disciplines, allowing a broader and more effective scope.

## **DESCRIPTION OF THE SETTING**

In an Economic Statistics discipline, taught in an Economic Sciences course by the first author of this paper, one of the program contents is that of Economic Indices, which include index numbers and others socioeconomic indices. Throughout the discussion of these indices in the class a question arose about the possible existence of a corruption index. As this is a controversial subject and has generated much debate, we proposed an activity be held related to the subject, organizing groups, and selecting topics for each group to prepare a presentation. The 30 students in the class were divided into six groups and chose the following topics:

- 1) Misuse of public funds
- 2) Bids and overbilling
- 3) Movies about corruption
- 4) Books about corruption in Brazil
- 5) Corruption on the Internet
- 6) Corruption Index

It was suggested that students prepare a brief report on the research topic, in addition to a presentation, preferably with the aid of the Power Point program that might contain snippets of audio and/or video. After a period of two weeks the groups performed the presentations, which were followed by a session of questions and discussions. After the last presentation there was an intense debate and the students decided to undertake some actions to repudiate the corruption problem:

- a) to disclose the sites to fight corruption on their Facebook pages;
- b) to support the protests against corruption marked for the international day against corruption (December 9);
- c) to sign a petition against the unfair increase of the parliamentarians' salaries [1].

## **DESCRIPTION OF PRESENTATIONS**

### **Group 1 - Misuse of public funds**

The group presented a definition of corruption and quoted the DE\$VIÔMETRO, a kind of monitor or counter of the misuse of public funds, available on Facebook [2]. A study by FIESP (São Paulo's Industry Federation) was presented, entitled "Corruption: economic costs and proposals to combat it" which projects an average cost of corruption in Brazil of 2.3% of GDP [3]. Some graphs and tables were shown giving data on corruption in Brazil. The group displayed a video from YouTube, wherein a state Representative denounces corruption [4].

### **Group 2 - Bids and overbilling**

This group explained what overpricing is and mentioned a report issued by the Federal Police, reporting that overbilling of about R\$ 700 million was found in 303 public works inspected. They showed a chart comparing some market prices as opposed to inflated prices. A video, available on YouTube was shown by the group, pointing out some suspected fraud in bids [5].

### **Group 3 - Movies and documentaries on corruption**

This group presented a brief analysis of three films, which are summarized below. An excerpt of each movie was presented, and a debate enriched the explanations.

“*Quanto Vale ou É por Quilo?*” (How much is it worth or is it by weight?) Directed by Sergio Bianchi, this 2005 production features a parallel between the slave trade in Brazil and the fake NGOs that exploit poverty.

“*Brasília 18%*”. Directed by Nelson Pereira dos Santos, this 2006 movie is a fiction about the disappearance of a parliamentary staff member. With a plot full of corruption, the film reveals a disbelief in the punishment of crimes committed by politicians.

“*Tropa de Elite 2*” (Elite Troop 2). Launched in 2010, this film, directed by José Padilha, shows the clash between the Special Operations Battalion (BOPE) and drug trafficking in Rio de Janeiro. The film shows the involvement of police and corrupt politicians with the militias that exploit poor communities in Rio.

#### **Group 4 - Books about corruption in Brazil**

This group chose two books to analyze and do a presentation. These works, summarized below, report corruption cases that occurred over the last 20 years.

“*A Privataria Tucana*” (The Toucan Pirate-Privatization). Written by Amaury Ribeiro Jr. and edited by Geração Editorial, this book exposes the irregularities in the privatization of state enterprises that took place in Brazil during the 1990s.

“*Sanguessugas do Brasil*” (Brazil’s Bloodsuckers). Edited by Geração Editorial, this book was written by Lucio Vaz in order to report the misuse of public money and to recount the history of corrupt politicians and businessmen.

#### **Group 5 - Corruption on the Internet**

The goal of this group was to show how the issue of corruption is addressed on the Internet. The group presented several examples, like news sites, denunciation sites, and others [6].

#### **Group 6 - Corruption index**

The group mentioned Transparency International, an NGO that fights against corruption [7]. This organization produces an annual report which highlights the indices of perceived corruption in several countries around the world. The group explained that the index is composed of a combination of studies linking corruption to data collected from various institutions. The corruption perception index (CPI) of 2011 is based on 17 data sources from 13 institutions and their scale is from 0 to 10, where 0 means that a country is perceived as highly corrupt and 10 indicates the country is very transparent and not corrupt. According to the CPI, Brazil is in 73rd position and has a score of 3.8, considered by the index to be very corrupt.

## ANALYSIS

In this project, the statistical content worked on was an index calculation. Realizing its complexity, the group that presented this issue only superficially addressed the methodology for calculating this corruption index. They discussed the possibility of creating a simpler and more objective index. However, it was understood that the lack of data on levels of corruption in the countries complicates this task. We understood that the study of corruption index deepened students' knowledge about this type of calculation. However, we must emphasize that the objective of the activity was to involve the students in a discussion of a socio-political problem rather than to deepen their procedural knowledge of Statistics.

For the three skills cited by SE's theoretical foundations, we had observed that working with the real situations involved in the corruption index calculation allowed students to have an overview of the problem. This overview manifested itself when we proposed a problem (to develop an index calculation) and the students needed to research a calculation methodology, as well as find a way to obtain the necessary data and, in addition, to proceed with an analysis of the results. As we said on the description of SE theory, statistical thought is related to the idea of making a global evaluation of a problem, and understanding how and why statistical analyses are important. In this way, like we said, statistical thinking is connected to the capability of identifying statistical concepts involved in the investigations and in the problems worked. This was accomplished in this activity when students were able to see the difficulties that surround the complexity of this index and followed some statistical tools used in its determination. Thus, we understand that this activity advanced their development of statistical thought.

In the theoretical part of this work we had observed that the development of statistical reasoning should lead students to be able to understand, interpret, and explain a real data-based statistical process. The group that researched the corruption index experienced this process, including doing their interpretations and explanations about the studied content. The other groups were able to follow the reports and presentations, as well as take part in the discussions and debates. Thus, we believe that this activity favored the development of statistical reasoning, especially that identified by Pfannkuch and Wild in the (a) item.

As we described in the theoretical part of this work, statistical literacy manifests itself by someone's ability to discuss or communicate their reactions to statistical information, and render their interpretations, opinions and understandings. In this context, we understand that the group who presented the corruption index work had advanced in the development of statistical literacy, as they had elaborated a report which contained statistical data and calculation methodologies of the index. They also made a theme presentation, putting their arguments into words, based on statistical information, using their own vocabulary to do so.

Concerning the other groups, we could observe in the reports and in the presentations the use of typical expressions and terminologies from statistics. Also, we observed some graphs and tables presented, which makes us believe that a contribution had been made to advance this literacy.

We would like to point out that there is no objective methodology capable of measuring the development of the three capacities yet. Thus, the only thing we can do is to observe whether we are stimulating their development or not, based on the theoretical indications that we had presented.

Regarding CE, we understand that we had highlighted it in many ways. Both in the analysis of films and of books, at various opportunities students were placed face to face with the problem of human poverty, of social and racial discrimination. The discussions showed a sense of rebellion and rejection of humiliating and degrading situations that were shown by groups 3 and 4. The social problem of unequal distribution of wealth in the country was wide open to students, who reacted angrily. The problem of misuse of public money for illicit enrichment by politicians, businessmen, and their allies was highlighted in the presentations of groups 1 and 2, generating intense debate and discussions to bring to the forefront the idea that people can and should unite themselves against rampant corruption. Full of indignation for the many examples of the misuse of public money that were presented, with the presentation of group 5, students could realize that there are tools to combat the crimes committed by those engaged in corruption, especially if people united themselves around actions ranging from public protests to the drafting of petitions that could become law by popular initiative against politicians and corrupt businessmen. Students realized that social networks and the Internet can be powerful allies for this purpose.

As for CSE, we see that throughout the project we were on the path traced by the theoretical considerations foreseen by Campos, Wodewotzi and Jacobini (2011), because:

- a) we had problematized the course, working topics related to Statistics through contextualized projects, linked to a reality consistent with that of the student;
- b) we had encouraged the debates and discussions among students and between them and the teacher, thus taking a pedagogically democratic posture;
- c) we thematized the teaching and focused the activities that emphasized the debate of several important social and political issues;
- d) we used a technological basis in the education and valued the skills of an instrumental nature to the student who lives in a highly technological society;
- e) we adopted a flexible pace in implementing the work presentations.



## **FINAL CONSIDERATIONS**

In carrying out educational activities related to the project described here, we sought to show one possibility of working at the insertion of CSE into the content of the discipline of Statistics in an undergraduate course. In this context, we emphasized the interfaces involved in the proposed socio-political themes, which emerged from the pedagogical environment experienced by the teacher. Our interest in reporting this experience was to show that opportunities to introduce a theme related to social and political problems occur at various times in the pedagogical process, and it is up to the educator to take advantage of these situations to encourage critical, investigative, and challenging thoughts among the students who excel when they are placed face to face with a social problem that involves their realities.

It should be emphasized that throughout the project execution reported here we observed that the diverse media used as a research source (books, movies, and Internet), combined with the possibility of integrating several technological devices (the use of softwares, audio, video and slide projections) enriched the themes as they showed the reality closest to the student, increasing their involvement and causing their reaction, maximizing the enhancement of the analyses and discussions.

Without losing focus on the statistical contents, we believe that adopting the CSE in a multimedia environment can greatly enrich the education process. Thus, we give the students the opportunity to better understand their own reality and to find the paths that can lead them to actions against the unjust and unequal system in which they live. Thus, we understand that the teacher performs a much broader role and makes their education more meaningful, interesting, and true.

## **NOTES**

1. [www.avaaz.org/po/petition/Fim\\_do\\_aumento\\_salarial\\_parlamentar\\_acima\\_da\\_inflacao](http://www.avaaz.org/po/petition/Fim_do_aumento_salarial_parlamentar_acima_da_inflacao)
2. [www.facebook.com/Desviometro](http://www.facebook.com/Desviometro)
3. <http://www.fiesp.com.br/indices-pesquisas-e-publicacoes/?tema=competitividade>
4. [www.youtube.com/watch?v=q21rM03\\_R18](http://www.youtube.com/watch?v=q21rM03_R18)
5. [www.youtube.com/watch?v=pE96Q1m1I50](http://www.youtube.com/watch?v=pE96Q1m1I50)
6. [www.transparencia.org.br/](http://www.transparencia.org.br/); [www.facebook.com/queroofimdacorrupcao](http://www.facebook.com/queroofimdacorrupcao) ; [www.mcce.org.br/](http://www.mcce.org.br/) ; <http://topicos.estadao.com.br/corrupcao>
7. [www.transparency.org/](http://www.transparency.org/)

## **REFERENCES**

- Ben-Zvi, D. (2008, July). Research on developing statistical reasoning: reflections, lessons learned, and challenges. *Proceedings of the International Congress on Mathematical Education*, Monterrey, Mexico, 11.
- Campos, C. R. (2007). *A Educação Estatística: uma investigação acerca dos aspectos relevantes à didática da estatística em cursos de graduação*. Doctoral dissertation, Universidade Estadual Paulista, UNESP, Brasil.
- Campos, C. R.; Jacobini, O. R.; Wodewotzki, M. L. L. & Ferreira, D. H. L. (2011). Educação Estatística no contexto da Educação Crítica. *Boletim de Educação Matemática*, 24(39), 473-494.
- Campos, C. R.; Wodewotzki, M. L. L. & Jacobini, O. R. (2011). *Educação Estatística: teoria e prática em ambientes de modelagem matemática*. Belo Horizonte, MG: Autêntica.
- Chance, B. L. (2002). Components of statistical thinking and implications for instruction and assessment. *Journal of Statistics Education*, 10 (3). Retrieved December 3, 2012, from [www.amstat.org/publications/jse/v10n3/chance.html](http://www.amstat.org/publications/jse/v10n3/chance.html).
- Falk, R. & Konold, C. (1992). The psychology of learning probability, In F. S. Gordon & S. P. Gordon (Eds.). *Statistics for the twenty-first century* (MAA Notes #26, pp. 151-164). Washington, DC: Mathematical Association of America.
- Gal, I. (2004). Statistical literacy: meanings, components, responsibilities. In D. Ben-Zvi & J. Garfield (Eds.). *The challenge of developing statistical literacy, reasoning and thinking* (Chap. 3, pp. 47-78). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Garfield, J. (2002). The challenge of developing statistical reasoning. *Journal of Statistics Education*, 10 (3). Retrieved December 3, 2012, from [www.amstat.org/publications/jse/v10n3/garfield.html](http://www.amstat.org/publications/jse/v10n3/garfield.html).
- Giroux, H. (1997). *Os professores como intelectuais: rumo a uma pedagogia crítica da aprendizagem*. Porto Alegre, RS: Artmed.
- Jacobini, O. R. (2011, November). A modelagem matemática em ambientes de investigação nas aulas de Estatística: experiências pedagógicas no GPEE. *Proceedings of the National Conference on Mathematical Modeling*, Belém, PA, Brasil, 7.
- Pfannkuch, M. & Wild, C. (2004). Towards an understanding of statistical thinking. In D. Ben-Zvi & J. Garfield (Eds.). *The challenge of developing statistical literacy, reasoning and thinking* (Chap. 2, pp. 17-46). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Skovsmose, O. (2004). *Educação Matemática Crítica: a questão da democracia* (2nd ed.). Campinas, SP: Papirus.