PROBABILITY AND STATISTICS TEACHING IN BRAZILIAN ELEMENTARY EDUCATION

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ABSTRACT

This article presents discussions analysed Stochastics teaching within Elementary Education Mathematics curriculum. In Brazil, the Elementary Education refers to zero to seventh years of age. We aim at systematizing some theoretical perspectives as well as presenting results and discussions regarding Stochastics teaching and learning. We highlighted the fact that teaching Probability and Statistics may be open to interdisciplinary work and may provide, by means of experiments, an exploitation of the idea of variability. By performing observation, records and data representation, students will be able to read and interpret different items of information. Statistical data are important "tools" for problem solving and Probability will aid students in decision-making. We emphasize the need for proposing learning situations which allow statistical and probabilistic thought, so vital for scientific growth and development of critical citizenship.

INTRODUCTION

Contemporary society requires from their citizens skills which lead to an ability to interpret their living reality, as well as to intervene in social actions. Probability and Statistics teaching may contribute to that by promoting critical skill and autonomy development, as well as other mathematical concepts traditionally carried out at school.

Understanding percentage figures shown in statistical indexes such as population growth, inflation rates, unemployment, etc. is not enough for a citizen; it is necessary to analyse/ relate critically to such data, even questioning their truthfulness. As long as it is not enough for a student to develop organization and data representation skills, it is important to interpret and compare such data in order to draw conclusions. These considerations have guided us to rethink the mathematics curriculum for the Elementary Education.

OBJECTIVES

Arising from the above considerations, we shall discuss a pedagogical practice which promotes investigation and exploitation, allowing students to be aware of statistical and probabilistic concepts which aid their view of the world.

We shall also consider an interdisciplinary teaching of Stochastics, taken herein as the intersection between statistics and probability concepts, which may provide students with a better acquisition of less sectorized knowledge, by means of experiences allowing them to observe and draw conclusions, thus developing their scientific thought, which is fundamental for educational growth.

Our discussion has also focused on mathematics curriculum recommendations for elementary school and problem solving methodology for developing stochastic thought. When establishing any question investigation, an option for strategies that lead to an answer is needed. It is need to organize, represent and analyse data arising from the problem. Once inserted in this learning process, students are more likely to develop critical thought.

STATISTICS AND PROBABILITY IN MATHEMATICS CURRICULUM

Elementary formation in Statistics and probability is indispensable both to the current and to the future citizen. As for mathematics teaching, we commited to teach not only number but also data organization and graph reading.

From this point of view, we argue that if we include Stochastics as one mere topic to be studied, restricted to one or other grade in Elementary School, emphasizing only the Descriptive Statistics segment, its calculi and formulae, this will not lead the student towards statistical and probabilistic thought development which evolves early from a problem solving strategy up to analysis of obtained data. It seems essential that the development of statistical activities should always come from problematization, for, just like mathematical concepts, statistical ones must also be inserted in situations linked to their day-to-day experience.

As citizens, we find ourselves in a world of information where access to social and economic issues is increasingly mediated through graphs and tables. Therefore, it is necessary for the school to provide the student, from early in elementary school, with the creation of concepts which help them make use of their citizenship. We thus understand that citizenship is also their ability to act reflectively, questionably and critically of an individual within their social group. Then it urges the school to perform its role of educating for citizenship.

In order for the mathematical learning to contribute towards educating for citizenship, it is important for students to acquire mathematical procedures, to face problems derived from the real world and be able to choose their own strategies for solving them. Under such a perspective, teachers need to motivate the socialization of different thought processes, listening to criticism and give value to their assignments and their colleagues. Then, working with Statistics and Probability may be a major contribution due to its problem-generating nature, and allowing reflective process enhancement.

Mathematics performs a modeling function to society (Skovsmove, 1999) when curriculum promotes mechanization of mathematical procedures and thus generating a servant-like attitude regarding students' epistemological process. Stochastics work may promote discussions and reflections towards a problematic situation aroused by the class or elicited by the teacher. Such practice reinforces democratic attitudes regarding knowledge acquisition.

Therefore, themes may be exploited through a mathematization process in which students elaborate hypotheses, formulate arguments, criticize and develop diversified comprehension modes. In order for the process to be effective, both students and teachers have to manage learning situations.

We believe that this means an attitude of respect to the knowledge the student brings into the school, which have been acquired alongside his/her societal living. As we see it, this can be managed through discussion of themes such as river and sea pollution, populations' low welfare levels, public health abandonment, all issues presented in newspapers every day, in television or magazines. By working with the analysis of such issues, which always involve indexes, graphs, and tables, we may make feasible the formation of critical, ethica, reflective citizens.

Against such a perspective, our schools have reinforced determinist thought, leading students to have the impression that each question has a single, simple and clear answer, disregarding a likely intermediate point between right and wrong, discussing a single solution to a problem, thus forgetting that, all through their lifetime, they will face much less defined issues.

Therefore, we need to develop a pedagogical practice in which there are proposals for students to perform activities, observing and building possible events, though the use of concrete experience (Lopes, 1998). Stochastics learning will only complement students' background provided familiar situations are taken into account; they must be contextualized, looked into and analyzed.

Making this learning process viable requires a curriculum view for mathematics, way different from the linear one. Linearity has predominated in curricula, always justified by the fact

that in order to teach some content, you need to work on its preceding topic. According to D'Ambrosio, this is the linearity myth, which implies educational practice is bound to be uninteresting and uninterested, uninspired, unnecessary, acritical and most often misunderstood (D'Ambrosio, 1996).

Teaching Probability and Statistics may aid in breaking down such linear practice, once the concepts to be worked on can be extracted from several issues, not linked exclusively to a certain grade of school.

PERSPECTIVES OVER STOCHASTIC TEACHING AND LEARNING

Stochastic teaching and learning allow a contextualized approach to numbers in Mathematics classes; this motivates or leads students to elaborate significant procedures for interpretation of results lined by uncertainty or randomness.

The fundamental nature of many stochastic problems is that they do not have a single mathematical solution. On the other hand, realistic problems begin with a question and end up presenting an opinion supported by certain discoveries and suppositions. Judgements and inferences expected from students (predictions on a population based on sample data collected in survey) are usually not characterized as "right" or "wrong", but they are assessed in terms of thought quality, suitability of employed methods, nature of data and evidences used (Gal and Garfield, 1999).

This vision requires a discursive character to knowledge, benefitting the perception of a class centered on the dialetical exercise, focusing mathematics as a way of viewing the world and thinking about it, prioritizing a mathematization process. Teaching is then organized through activities guided by interaction and reflection; that makes classes become a space of interactive social practice constitution.

In previous studies, we considered that Statistics and Probability could be themes exploited through mathematization (Lopes, 1998). When discussing mathematical knowledge acquisition in childhood, Skovsmove's (1994) ideas are more present, for that option may help children develop comprehension modes. We agree with him when we consider that mathematizing means formulating, systematizing and making judgements over the ways of comprehending reality, and so this activity may be integrated into the learning process.

We consider that such a perspective gives students conditions for drawing logical conclusions about mathematical knowledge, using models, facts they are aware of, properties and relations which explain their thoughts, justify their responses and resolution processes, use regularities and believe that mathematics presents meaning, as knowledge produced by human necessity.

The option for this process of teaching and learning should start in the early years of schooling for children, since their early discoveries, to be able to appreciate the beauty of mathematical knowledge, expressed in the simplicity of its connections to daily problems, and they had the possibility of finding out that sharing may be much more than subtracting or dividing, that interconnections are constant amongst knowledge areas and that understanding them may contribute to a deepening of solid relationships amongst human beings.

Performing work projects which involve mathematical concepts and explore ideas shown by students tends towards a dynamic learning process, promoting creativity, relations and inference skills.

When we provide students with the opportunity of experimenting mathematization through material manipulation and experimenting, we are not only providing ludical activities, but we are also creating situations which favour abstract thought development.

In this perspective, it is necessary to think about some guidelines for Mathematics curriculum proposals which privilege teaching actions centred in aiding students to develop

mathematical thought and the ability to solve problems, formulate and communicate mathematical ideas and establish relations among the distinctive mathematical concepts, as well as from other subjects.

Teaching activities have to allow students to have a personal investigation over significant problems, relevant to them, mathematically speaking, leading them to formulate hypothesis and draw conjectures which may be represented in diversified ways. The curriculum which the teacher puts into action must be flexibilized by the context and students' development, considering conceptual contents, procedures and attitudes. Classes must be developed on sharing, co-operative and collaborative atmosphere, allowing the socialization of different ways of thinking and enabling collective mathematical knowledge building.

We take it as fundamental that stochastic study is to be developed through solving problem situations in which educators plan the study process of any issue. The latter shall formulate a question or determine an investigation theme, define data collection instruments, organize and select the most suitable representation for communication. Afterwards, they shall analyze data, interpret discoveries, discussing possible conclusions and implications.

Combination, Probability and Statistics are interrelated, providing a wide range "philosophy of change" for comprehending the current world and face people to make decisions when they have only data affected by uncertainty, common situation in our day-to-day.

Combination requires a centre approach on problem solving, with diversified origins. Some proposals must involve the possibility of obtaining the solution straight from accounting. Others must enable students to identify the categories in which the problem situation may be suitably classified.

Regarding Probability, we shall not perceive it only by means of a mathematical definition, thus disregarding its stochastic character, and letting aside random perceptions brought by misfortune. Its conceptual meaning cannot be based simply on mathematical definition, as it usually takes place in other concepts. Students' difficulty has not been centre on the definition of probability, but on the way the concept is interpreted and applied suitably, in specific situations (Azcárate, 1996).

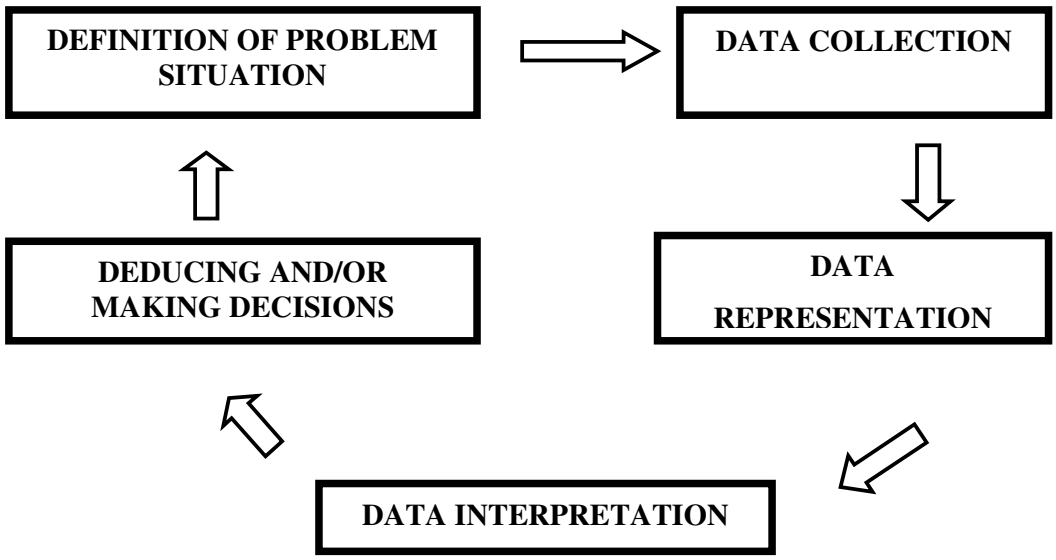
We agree with Batanero (1999), when she states that it is preferable to integrate stochastic activities to school mathematics as whenever possible, taking advantage of connections with arithmetic, geometry and student' day-to-day situations. It is needed, then, to get over the confusing role of probability and statistics on school curriculum, the weak link between investigation and instruction, the scarce preparation of mathematics teachers towards this subject and the little amount of information about the learning process and its keys to development, which are still currently being evaluated (Garfield, 1988).

Stochastics teaching should happen since the early years of school age; this is not only possible but also needed, for its absence allows people to develop wrong intuitions regarding the stochastic thought (Fischbein, 1975). According to him, intuitions are components of intelligence into action, they are structured acquisitions, they perform the role of connecting knowledge to action and they are composed of autonomous cognitive processes, having unique, relevant functions.

The need for synthesized data is present since very early in children's lives. For instance, in surveys which may be developed with older students, from other courses. In this sort of activity, they learn to get over individual opinions and analyze collective results, synthesizing predominance.

We have elaborated the scheme as follows (Lopes, 2003) in order to better illustrate our proposal. It has been based on the process presented by Hopkins & Gifford & Pepperell (1996).

DATA TREATING PROCESS



Such representation tries to guide the ways to be taken during data treating. Firstly, we need to define the issue or theme – we need to be clear about what we need to research. Afterwards, we get the search for the most suitable sort of collection instrument for acquiring information on the issue. Then we carry on the most suitable way of processing, representing and communicating data, and then we can proceed to interpretation; this will require a reflection on how efficient the process has been on problem-solving, presenting relevant answers. Next step consists of criticism usage from interpreting the relationships we may establish between the investigation issue and the results which may lead to inferences and/or decision-making.

This diagram went important for group of teachers because guided the elaboration of activities for children. They understood that this process is necessary to develop the statistical reasoning.

Combination, Probability and Statistics are daily amongst us, by means of unluck, random and by-chance. They perform an important role in comprehending nature by justifying the need of providing people with contact and confrontation with such ideas, since early school age, when performing concrete and investigative experiences. Stochastic relevant presence within our lives has influenced our thinking and acting by instructing us so that we are aware of our social reality.

By considering Stochastics work inserted in mathematics syllabus, we also take it as necessary to reflect upon interdisciplinary nature, since Statistics roots and Probability development are intrinsically linked to other sciences.

CONCLUSIONS

The issues discussed herein and in previous studies (Lopes, 1998, 1999, 2003) have led us to significant considerations over Stochastic teaching in basic education.

The first consideration refers to the need of altering statistics and probability concept in forming and extended syllabus of basic education teachers. The second one brings out the need of dialog among mathematical data and models, as essential characteristics for teaching and learning Statistics. That leads us to the considerations we have previously claimed when we recommended that statistical knowledge within the classroom must take place through problem-solving (Lopes, 1998).

This path towards statistical knowledge acquisition allows elaborating conjectures which make possible statistical thought development. We agree with Carvalho (2001) when it is stated that knowing how to think statistically allows each individual in their daily life to be able to understand the two types of messages usually present in the variety of information they have access to, not only the simple, direct ones but also the ones which involve complex inference processes. Based on this type of though, many decisions are made. Therefore, we consider that teaching activities have to go through the whole path of information treatment process.

Probabilistic and statistical thought development, undoubtedly, may effectively mathematics formative potentialities. Teaching mathematics is traditionally based on exactitude, determinism and calculus, thus opposed to exploring situations which involve approximation, randomness and estimation; this may limit mathematical vision students may develop, and possibilities of establishing problem-solving strategies to issues they will find throughout their lives may become more difficult.

REFERENCES

Azcárate Goded, P. (1996). *Estudio de las concepciones disciplinares de futuros profesores de primaria en torno a las nociones de aleatoriedad y probabilidad.* (Study of the disciplinary conceptions of future teachers of primary around the notions of randomness and probability). Granada: Comares.

Batanero, C. (1999). *Didáctica de la Probabilidad y Estadística*. (Didactical of Probability and Statistics). Granada: Departamento de Didáctica de la Matemática.

Carvalho, C. (2001). *Interacção entre pares: contributos para a promoção do desenvolvimento lógico e do desempenho estatístico, no 7º. ano de escolaridade.* (Interaction between pairs: contributions to the promotion of the development of the logical and statistical performance, at 7. Year of schooling). Unpublished Ph.D. University of Lisbon.

D'Ambrosio, U. (1996). *Educação Matemática - da teoria à prática*.(Mathematics Education - from theory to practice). Campinas: Papirus.

Fischebein, E. (1975). *The intuitive sources of probabilistic thinking in children***.** Dordrecht-Holland: D. Reidel Publishing Company.

Garfield, J. B. (1988). *Obstacles to effective teaching of probability and statistics. Proceedings of the 66° Annual Meetings of The Research Presession of the National Council of Teachers of Mathematics Education,* Chicago.

Garfield, J. B. & Gal, I. (1999). *Teaching and Assessing Statistical Reasoning*. In Stiff, L. and Curcio. F. *Developing Mathematical Reasoning in Grades K-12*.USA: The National Council of Teachers of Mathematics.

Hopkins, C. & Gifford, S. & Pepperell, S. (1996). *Mathematics in the primary school: a sense of progression*. London: David Fulton Publishers.

Lopes, C. A. E. (2003). *O Conhecimento Profissional dos professores e suas relações com Estatística e Probabilidade na Educação Infantil.* (The professional knowledge of teachers and their relations with statistics and probability in early childhood education). Unpublished Ph.D. State University of Campinas (UNICAMP).

Lopes, C. A. E. (1998). *A probabilidade e a estatística no ensino fundamental: uma análise curricular.* (The probability and statistics in elementary school: an analysis curriculum). Unpublished Master's Thesis. State University of Campinas (UNICAMP).

Lopes, C. A. E. & Moran, R.C.C.P. (1999). A estatística e a probabilidade através das atividades propostas em alguns livros didáticos brasileiros recomendados para o ensino fundamental. (The probability and statistics through the proposed activities in some textbooks Brazilian recommended for elementary schools). Proceedings of the International Conference: *Experiences and Perspectives of the Teaching of Statistics – challenge for* the twenty-first century. (pp. 167-174), Florianópolis, Brazil.

Pozo, J. I. (org). (1998). *A solução de problemas – aprender a resolver, resolver a para aprender.*(The solution of problems - learn to resolve, the resolve to learn.). Porto Alegre: Artmed.

Skovsmose, O. (1994). *Towards a philosophy of critical mathematical education.* (Mathematics Education Library, v.15). Dordrecht: Kluwer Academic Publishers.