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Teaching statistics in EYA: application of the methodology of problem solving

Ensino de estatística na EJA: aplicação da metodologia da resolução de problemas

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Abstract

This article aimed to present a proposal using the problem solving methodology for the Teaching of Statistics, in the YAE, focused on High School, in a state public school of Paraná. The data collection procedures were: records of the observations and the productions of the students that generated empirical data and were analyzed using the methodology of the Discursive Textual Analysis - DTA. The Teaching Sequences - TS were elaborated from the problem solving methodology, including statistical knowledge objects. The research results indicate on the one hand, that the problem solving methodology can contribute to the development of students' statistical reasoning, on the other, that formalization of concepts by the teacher proved to be relevant because together, teacher and students, discuss the attempts to solve the proposed problem, contributing to the construction of statistical knowledge and citizen formation.

Keywords: Statistical Education; Youth and Adult Education - YAE; High school; Problem Solving Methodology.

Resumo

Este artigo objetivou apresentar uma proposta utilizando a metodologia de resolução de problemas para o Ensino de Estatística, na EJA, voltadas ao Ensino Médio, em um colégio público estadual paranaense. Os procedimentos de coleta de dados foram: os registros das observações e as produções dos alunos que geraram dados empíricos e foram analisados a partir da metodologia da Análise Textual Discursiva – ATD. As Sequências de Ensino – SE foram elaboradas a partir da metodologia da resolução de problemas contemplando objetos de conhecimento de Estatística. Os resultados da pesquisa indicam por um lado, que a metodologia da resolução de problemas pode contribuir para o desenvolvimento do raciocínio estatístico dos alunos; por outro, que a formalização dos conceitos pelo professor mostrou-se relevante porque juntos, professor e alunos, discutem as tentativas de resolução do problema proposto, contribuindo para a construção do conhecimento estatístico e formação cidadã.

Palavras-chave: Educação Estatística; Educação de Jovens e Adultos – EJA; Ensino Médio; Metodologia da Resolução de Problemas.

Introduction

Statistical Education is fundamental to the life of the citizen, because through it one can develop the capacity for analysis and criticality about a variety of information.

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Lopes, Coutinho and Almouloud (2010, p. 22) explain that Statistics is seen "as a science that aims to develop methods to collect, organize and analyze data".

In the sense of Lopes, Coutinho and Almouloud (2010, p. 53), the resolution of problems in Statistics can be considered as an investigative process and can involve four essential components, such as: "the formulation of questions, the collection of data, the data analysis and interpretation of the results".

Fonseca and Cardoso (2005) emphasize the importance of creating possibilities for students to solve problem situations that are close to them, encouraging them to look for a solution. For the student to be able to analyze and interpret what he experiences, it is necessary that he experiences learning situations related to the resolution of problems faced in daily life.

Thus, as expressed in the guidelines of the National Curriculum Parameters (+) of Secondary Education in High School - PCNEM (+), the starting point in the process of teaching and learning of mathematics is problem solving, therefore, this methodology is indicated as an organizer of the teaching process, through which the student is encouraged to understand the data, develop strategies, build relationships and socialize the results, in order to improve the use of the techniques already known (Zuffi & Onuchic, 2007) .

Likewise, the National Common Curricular Base - BNCC, for Secondary Education in High School, approved on December 14th, 2018, proposes that the resolution of problems advocates as a central point for students to formulate and solve problems in different contexts using different mathematical resources and with greater autonomy. In addition, the student needs to develop "skills related to the processes of investigation, model building and problem solving" (MEC, 2018, p. 529).

It is noteworthy, then, that the problem solving methodology, when well used in any degree and/or teaching modality, can lead the student to acquire new mathematical knowledge, developing his/her analytical and critical skills. Therefore, by relating the problem solving methodology to the teaching of Statistics for the Youth and Adult Education - YAE, it is possible to enhance the student learning process and to contribute to a meaningful learning experience, necessary for the democratic formation of active subjects, critical and creative, considering, in particular, the specific clientele of the YAE.

The purpose of this paper is to present a proposal using the problem solving methodology for teaching Statistics, at YAE, aimed at high school.

The text is organized in four sections, in addition to this introduction and the final considerations. In the first section the discussion is centered on the assumptions of teaching Statistics in the Youth and Adult Education; the second section presents a brief theoretical contribution on the problem solving methodology in the teaching of mathematics; the third section presents the research methodology and the fourth section discusses and analyzes the data.

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Youth and Adult Education and the Teaching of Statistics

The Youth and Adult Education - YAE came to pay off a social debt with those who had no access to education or mastery of writing and reading. Not having this access to Basic Education does not only deprive citizens of scientific knowledge, but also of social coexistence. Therefore, one of the aims of YAE is to provide young people and adults with the reparation of this historical and social debt, with the possibility of giving everyone the right to equality regarding access to education (MEC, 2000).

The access to knowledge is a requirement present in our daily lives, especially regarding new social demands in relation to intellectual, basic and applied knowledge. Therefore, the reparative function proposed by YAE must be considered as an opportunity for citizens, young or adult, to access school and, at the same time, as an alternative for the performance of public policies in the qualification of the unschooled population at the right age.

When YAE addresses updating knowledge or qualification, it means that it has a permanent or qualifying function. This function can be developed at school and also outside of it. Upon qualifying, the individual can make numerous discoveries, be it intellectual or vocational. It is observed that the citizen's trajectory is not ready and finished, because when the qualification is actively present, constants and several discoveries can occur.

When producing materials to support YAE, it must be clear that the target audience of this type of education is of different ages from one another, even though they are present in the same environment, acquiring or producing knowledge, skills and competences depending on the historicity of each individual.

New knowledge comes from pre-existing knowledge and causes future knowledge, because people do not learn things all at once, but they learn through successive approaches, in which new knowledge surpasses the previous one. "It was through actions and thinking that human beings built their entire culture and it is through acting-thinking that we all continue to build and modify the world and ourselves" (MEC, 2006, p. 24).

In order to stimulate a student to learn, it is necessary to seek topics of his interest, related to the social context in which he lives, by producing didactic-pedagogical materials that encourage him to learn, leading him to a participation in the classes and creating an environment of generation of collective knowledge, based on teacher-student and student-student relationships established in the teaching and learning process of YAE.

The Curricular Guidelines for Youth and Adult Education (SEE, 2006) propose that the organization of the teaching content and methodology must be appropriate for this teaching modality in order for student learning to be effective.

In the proposed perspective, teaching methodologies will be adequate from the moment that the dialectical relationship is indeed significant with knowledge. Therefore, the teaching methodologies proposed in the curriculum of the YAE modality play a very important role in the teaching-learning process (SEE, 2006).

In the official documents guiding the mathematics curriculum, there is concern with the

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education of citizens as to the ability to interpret, analyze and, mainly, make decisions based on statistical and probabilistic knowledge.

When reflecting on statistical knowledge, the first thing that comes to mind is the construction and interpretation of tables, graphs of a set of data, widely used on television, newspapers and daily information. However, Statistical Education "not only assists the reading and interpretation of data, but provides the ability for a person to critically analyze and relate the data presented, questioning and even pondering its veracity" (Lopes, Coutinho & Almouloud, 2010, p. 52).

Statistical Education is focused on teaching and learning Statistics in Basic Education and in University Education, also including YAE. Lopes, Coutinho and Almouloud (2010) suggest that some recommendations on Statistical Education be incorporated, allowing students a study that requires to:

> Formulate questions that can be addressed with data and collection, organize and present relevant data to answer them; select and use appropriate statistical methods to analyze the data; develop and evaluate and data-based forecasts; understand and apply basic concepts of Probability (Lopes, Coutinho & Almouloud, 2010, p. 51-52).

Therefore, the purpose of Statistical Education is to develop students' statistical reasoning and, consequently, skills and competences to critically analyze the data they encounter daily. For data analysis, several types of statistical reasoning are required.

Garfield and Gal (1999, p. 207) explain that:

> reasoning can be defined as the way people reason with statistical ideas, thus managing to give meaning to statistical information. This involves making interpretations based on data sets, data representations or data summaries. Many of the statistical reasonings combine data and chance, which leads to having to be able to make statistical interpretations and inferences.

Garfield and Gal (1999) explain that statistical reasoning involves making interpretations based on the group of information, data representations, statistical syntheses of data that combine ideas about information and chances that lead to making inferences and interpretations of statistical results. The authors present five types of reasoning necessary for the development of Basic Education students. They are:

> a) Reasoning about data and its representation: recognize and categorize data, read and interpret graphs, observe how each type of graph is appropriate to represent a set of data. b) Reasoning about statistical measures: understand what the position and variability measures say about the data set, what are the most appropriate measures in each case and how they represent the data set. c) Reasoning about uncertainty: understand and use the ideas of chance, randomness, probability and similarity to make judgments about events. d) Reasoning about samples: understand how samples relate to the population and what can be inferred about a sample. e) Reasoning about associations: judging and interpreting the relationships between variables (Garfield & Gal, 1999, p. 12-13).

For the development of statistical reasoning, the Basic Education teacher needs to be concerned with his teaching practice in the classroom, being it necessary to take into account the student's reality so that interest can be awakened in the study of the statistical contents that

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make up the curriculum in the area of Mathematics. For this, there are some methodological approaches indicated for the teaching and learning of Statistics, among them the problem solving methodology, which "must be considered as an investigative process that involves four components: the formulation of questions, the collection of data, data analysis and interpretation of the results" (Lopes, 2010, p. 53).

Perspectives of Problem Solving for the Teaching of Mathematics

Problem solving in the teaching of mathematics presents different perspectives. Dante (2009) presents a perspective in which there are four interpretations on the formulation and problem solving in the area of Mathematics. They are: problem solving as a goal, as a process, as a basic skill and as a methodology for teaching mathematics.

Problem solving as a goal is seen as the way that teachers teach mathematics so that their students learn to formulate and solve problems, because one of the purposes of teaching mathematics is:

> solving problem situations, knowing how to validate strategies and results, developing forms of reasoning and processes, such as deduction, induction, analogy, estimation, and using mathematical concepts and procedures, as well as available technological instruments (MEC, 1998, p. 48).

In the process of problem solving, the teacher needs to observe how the student formulates and solves a problem, that is, identify what are the strategies used by them to solve a certain problem.

Problem solving as a basic skill is identified as a basic competence that students need to acquire, throughout Basic Education, in order to understand the reality in which they live and face the problems they face. For that, it uses creativity, logical reasoning and the capacity for critical analysis.

Problem solving as a methodology for teaching mathematics considers the three previous approaches and "enriches them with an important methodological component, triggering concepts and procedures through motivating problem-situations and working with problematizing situations and also with projects and mathematical modeling" (Dante, 2009, p. 16).

The student, when faced with problem solving, needs to seek strategies to reach the resolution, in addition to knowledge already acquired during the school period; that is why the teaching methodologies adopted by teachers end up being so important for the development of the student, as he ends up building knowledge from his interpretations (Fernandes, 2009). It also represents means to introduce new content, that is, from problem solving, the student will be able to make relationships with new concepts that, later, are formalized by the teacher.

The problem solving methodology has suffered many influences from the constructivist theory. In this perspective, the student is also responsible for his knowledge-building process, so "students have more responsibility for managing their tasks and their role in the process is that of an active collaborator" (Kalinke, 2003, p. 64).

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According to Onuchic (1999, p. 210), "in the constructivist perspective, the student must be actively engaged in the construction of his own knowledge". The constructivist characteristics in the teaching of Mathematics are: “to build on prior knowledge; emphasize on thinking; give time to think; wait for explanations or justifications for the answers or the way of thinking; ask questions and know how to listen” (Onuchic, 1999, p. 210).

When problem solving is used as a teaching methodology, the student can learn mathematics by solving problems or he learns mathematics to solve problems. Onuchic (1999, p. 215) states that a problem is something that is not yet known how to solve, “but that is interested in solving, so that the problem becomes a starting point and that, through problem solving, teachers must make connections between the different branches of mathematics, generating new concepts and new content”.

The author explains that when inserting problem solving as a methodology for teaching mathematics, one should start with the problem and not with the definition of the mathematical concept to be studied. The student needs to reflect and analyze the problem so that he can discover a new concept, as the goal is not to make the student apply a technique to solve problems mechanically, but, as advocated by Onuchic (1999, p. 215), “The student does not build a concept in response to a problem, but builds a field of concepts that make sense in a field of problems”, as problem solving should be considered as a guide to be used for learning.

The proposal recommended by Onuchic (1999, p. 216-217) for the problem solving methodology comprises seven steps, which are described below.

The first step is to form groups of students in the class and deliver an activity. At this stage, students need to realize that by forming small groups, it is possible to share and learn from each other.

In the second stage, the role of the teacher changes from a communicator of knowledge to an observer, organizer, consultant, mediator, encourager of the learning process. In this phase, the teacher raises challenging questions so that students help each other to overcome difficulties. The teacher needs to make the student think, give him time to think and follow the discussions and records of the solutions in the formed groups.

In the third step, the teacher can put all the students' answers on the board, both the right and the wrong results, so that the whole class can observe the strategies used in the attempt to solve the proposed problem.

In the fourth stage, the teacher involves all students in the discussion about the resolutions of the groups, so that they explain and defend the chosen resolution.

In the fifth stage, the results are analyzed. It is at this point that the difficulties identified by the teacher are remedied.

The sixth stage takes place after removing all doubts that arose during the fifth stage and together with the students; a consensus is sought for the result.

Finally, in the seventh stage, the work carried out together is formalized. The teacher, as the conductor of the process, and the students build the synthesis of what was intended to

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learn from the proposed problem. It is at that moment that the teacher presents the concepts and definitions that were constructed by the students using the terminology used by them.

It was in this sense of discovery, challenge and curiosity that in the research carried out, the perspective of Lourdes de La Rosa Onuchic was adopted, because it comprises problem solving as a teaching methodology for the insertion of new knowledge, but considering previous knowledge, or that is, starting from a certain problem to arrive at a new mathematical concept, which in this case were for the objects of knowledge of Statistics foreseen for YAE.

Research Methodology

The research on the teaching of Statistics at YAE was developed in an applied qualitative approach, in two classes (A and B) of High School in a public education establishment in the state of Paraná.

Initially, a questionnaire was applied to obtain some information about the profile of the students in the class regarding: age, sex, marital status, time of completion of elementary school, current job, the time they were out of school, the main reason why they left school and, finally, the main reason why they went back to school.

The procedures defined for the analysis and interpretation of the actions triggered in the classrooms, through the application of two Teaching Situations - TS of Statistics elaborated for this purpose were participant observation and field diary (record of observations during the application of the teaching situation).

Participant observation was performed during the application of the TS, which consisted of the researcher's view of the situations that occurred during the application. To record this participant observation, a field diary was created with accurate notes of the events that occurred in the classroom.

Two themes of reports aimed at consumers published in Proteste magazine were selected for the elaboration of the TS. The report on light hamburger (in weight), published in October 2015 (p. 24-25) and the report on Carioca beans: flavor and quality, published in February 2015 (p. 24-26). The themes were chosen because they deal with issues related to the feeding of the families of the students participating in the research.

The contents of Statistics contemplated in the TS proposed to the students were in accordance with the National Curriculum Parameters of High School (MEC, 2000), National Curricular Parameters (+) of High School (MEC, 2002), National Curriculum Guidelines for High School (MEC, 2012), official documents in force at the time of research data collection. They are: a) to differentiate qualitative from quantitative variables; b) conceptualize qualitative and quantitative statistical data; c) collect and organize secondary statistical data from the problem situation presented; d) present data collected in a single and double entry table; e) analyzing graphs (simple columns and juxtaposed columns) contained in the problem situation presented; f) use measures of central tendency (mean, mode, median) for analysis of quantitative data.

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The application of the TS occurred in two moments. At first, it was the application of a problem situation about the light hamburger (in weight) published by the Proteste magazine. The students were divided into groups to read the report and during the reading they made some discussions and comments. Then, some questions were given for them to discuss and elaborate the respective answers. The researcher teacher did not interfere in the students' responses, as they had autonomy in the construction of their responses.

When the groups finished responding, the researcher teacher put all the answers on the board, regardless of whether they were correct or not. At this moment there was a discussion regarding the answers, the researcher teacher could answer some questions and along with the students reach a consensus of the answers. After this discussion, the researcher teacher began to formalize the concepts, performing the formalization by step, that is, a group of questions helped in the construction of the concepts.

In the second moment, the problem situation about beans from Rio de Janeiro was used: flavor and quality, published by the Proteste magazine. In this application, the researcher teacher again divided the students into groups and delivered the report on Rio beans: flavor and quality. The students read this report and held some discussions in the group. The researcher teacher gave some questions to each group, which had some differences in relation to the first application, because at that moment the students had already studied the statistical concepts proposed in the first TS. Therefore, this application was intended to verify whether students were able to learn the proposed content from the problem solving methodology.

The productions that the students carried out in the activities proposed in the teaching situations and the records of the observations in the field diary generated empirical data that was analyzed using the methodology of the Discursive Textual Analysis - DTA of Moraes and Galiazzi (2016).

The DTA stages of the data collected were: the dismantling of texts, the establishment of relationships, the capture of the new emerging. These DTA steps make up an analysis cycle.

In the first stage, a careful reading of the data is carried out, which “implies examining the texts in their details, fragmenting them in order to produce constituent units, statements referring to the studied phenomena” (Moraes & Galiazzi, 2016, p. 33). After reading, the process of deconstruction and unitarization of the *corpus* begins, which “consists of a process of dismantling or disintegrating the texts, [...] with this fragmentation or deconstruction of the texts, it is intended to be able to understand the meaning of the texts, [...] it is the researcher himself who decides to what extent he will fragment his texts, resulting in units of analysis of greater or lesser amplitude” (Moraes, 2003, p. 195).

The second stage, called 'Establishing relationships', is consistent with a “process called categorization involving building relationships between the base units, combining and classifying them, bringing these unitary elements together in the formation of sets that bring together close elements, resulting in hence category systems” (Moraes & Galiazzi, 2016, p. 34).

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The third stage 'Capture of the new emerging' the researcher seeks to develop understandings that emerged during the analysis cycle, that is, the researcher performs the interpretation of the data and presents an Interpretative Synthesis. "The Interpretative Synthesis represents a reflection around the understanding of a combination of the elements that were captured in the data collection" (Pereira, 2017, p. 45).

Results and Data Analysis

To outline the socio-educational profile of YAE students, a survey was initially carried out through the application of a questionnaire. It can be seen in this survey that the majority of the students in class A were in the 25 to 34 age group and in class B the majority were in the 45 to 54 age group, as shown in Table 1.

Table 1 – Age range of students per class – 2017.

Age Range	Class A (%)	Class B (%)
16 to 24 years	37	25
25 to 34 years	42	17
35 to 44 years	5	25
45 to 54 years	11	33
55 to 64 years	5	0
Above 65 years	0	0
Total	100	100

Source: Research data.

The majority of the students in class A were male (53%). In class B, most of the students were female (83%). The number of married and single students was the same (47%) in class A. In class B the number of married students corresponded to 67% and single students to 33%.

In class A, the completion of Elementary Education took place in regular education for 58% of the students and in YAE for 42% of the students in that class. The time away from school lasted around 2 to 3 years for 42% of the students, over 10 years for 26% of the students, between 6 and 7 years for 16% of the students and up to one, between 4 and 5 years, between 8 and 9 years and each containing 5%.

In class B, the completion of Elementary Education occurred in regular education for 50% of the students and in YAE for 50% of the students. The time away from school lasted around 2 to 3 years for 17% of the students, over 10 years for 50% of the students and the rest for one year, between 4 and 5 years, between 6 and 7 years and between 8 and 9 years, which corresponds to a total of 33%.

Most of the students in class A (68%) worked in different roles, namely: sales representative, army soldier, metallurgist, intern, confectioner, clerk, daily cleaner, butcher, driver, real estate agent and self-employed. The others (32%) declared that they were not

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working at the time of the research. Most of the students (58%) in class B declared that they were not working when they answered the survey questionnaire. Those who were working corresponded to 42% and performed the functions of: machine operator, production operator, daily cleaner and school attendant.

The main reasons for dropping out of regular school declared by the students in Class A were: the need to work full-time, failure, health problems, teenage pregnancy, among which the most evident was the need to work to have a financial income. Among the reasons stated for returning to school to conclude high school was the search for professional qualification (42%), for a new job (21%), for better salaries (16%) and due to strong competition in the job market (16%). The search for knowledge was the reason stated by only one of the students in the class.

In class B, the students declared that the reasons that triggered the abandonment of the school were: lack of interest in studies, work, the death of a father, lack of motivation, teenage pregnancy, among which the lack of interest was the most evident reason. The return to studies to finish high school was motivated by the need for professional qualification (75%), the search for a new job (17%) and the requirement for schooling in the job market (8%).

Considering the socio-educational information of the students, two Sequences of Teaching - ST were devoted to their profile and at the same time contribute to the development of statistical reasoning from everyday situations.

On the day of application in Class A, sixteen students participated in the survey and in Class B, twelve students participated. Data analysis was based on data from the application of ST in the two classes of YAE. The data was grouped by categories and units of analysis according to the DTA methodology.

Two categories emerged from the analysis of the collected data: C1 - Use of the Problem Solving methodology to enable the teaching and learning of Statistics; C2 - Limitations in the application of the problem solving methodology in YAE, composed of the units of analysis presented in Table 2.

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Table 2 – Categories, units and descriptions – 2017.

Categories	Units
C1 - Use of the problem solving methodology to enable the teaching and learning of Statistics	U1 – Group Work The excerpts from this unit represent the participation and interaction between students during the application of the proposed activity.
	U2 – Peer Discussion The excerpts highlighted in U2 reflect situations of discussions regarding the content and which led to the understanding of the concepts covered.
	U3 - Teacher intervention The excerpts that point to the need for teacher intervention during the students' calculations were classified in U3.
	U4 - Student autonomy to argue In U4, excerpts that illustrate students' autonomy in the construction of arguments to justify their answers, whether correct or not, are present.
	U5 - Formalization of the concept The excerpts from U5 correspond to situations of intervention by the teacher and the student to formalize the concept.
C2 – Limitations in the application of the problem solving methodology in YAE	U1 - Previous knowledge This U1 consists of excerpts that prove the students' lack of prior knowledge.
	U2 - Student passivity In U2 of C2 there are excerpts that point to the students' passivity as an obstacle to the application of the problem solving methodology.
	U3 – Attendance The excerpts from U2 of C2 represent situations of students' lack of attendance.

Source: Elaborated by the authors.

Category 1 (C1) “Use of the problem solving methodology to enable the teaching and learning of Statistics” brought together the data on the contribution of the methodology to the

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construction of knowledge by the student who is in the learning process and, in this case, referring to the contents of Statistics. The units of analysis contained in C1 correspond to the stages of the problem solving methodology, according to Onuchic (1999).

Category 2 (C2) "Limitations in the application of the problem solving methodology in YAE" is formed by the units of analysis that pointed out the lack of prior knowledge, the passivity of students and attendance, which was constituted by the observation of obstacles faced by the teacher when using the problem solving methodology for YAE classes.

From the analysis of the categories and their respective units of analysis and from the observations and records in the field diary, an interpretative synthesis of the research findings is presented next.

C1.U1 revealed the participation and interaction between students during the performance of the proposed activity in the TS. The group work in which the students read the problem situations, discussed and shared information regarding the teaching themes confirms what the PCNEM (+) proposes: “an important resource for the development of skills is *group work*” (MEC, 2002, p. 129, emphasis added). Barros (2008, p. 43) also points out that “in the study and/or group work, the student must interact with his colleagues in a cooperative way, working collectively and in the search for solutions to proposed problems”.

Bigode and Gimenez (2009, p. 20) add that “group activities in the classroom have many functions, among them to instigate students to think from the other's point of view, in more equal conditions, exercise their arguments, learn to work cooperatively, establish social relationships”.

PCNEM (+) (MEC, 2002) point out the importance of proposing a problem situation to the student, because problem solving is considered as the centerpiece for the teaching-learning of Mathematics. This was evidenced in C1.U2, once the students interacted with each other and ended up promoting interesting discussions during the study of the statistical concepts contained in the TS.

In relation to the calculations that the students had to perform, the teacher had to help with the doubts that gradually arose, helping “the students to support each other, to overcome the difficulties” (Onuchic, 1999, p. 216). This practice was present in C1.U3, in which the teacher performed interventions to carry out mathematical calculations.

C1.U4 refers to the students' autonomy in relation to the construction of responses, so that students have confidence and autonomy when placing responses on the board and sharing it with other classmates.

In order to formalize the statistical concepts proposed in the TS, as pointed out in C1.U5, all the students' responses were considered, which were discussed and explored by the teacher so that the students understood the proposed statistical contents and their respective concepts. According to Onuchic (1999), the problem solving methodology contributes to the construction of concepts before the formalization of the mathematical language, which was

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observed during the application of the TS, since the teacher can act in this sense at different moments of the class and not only at the end.

In the process of formalizing the concepts, the teacher and the students need to work together, because "a synthesis is made of what was intended to learn from the given problem. The necessary definitions are placed, the properties are identified, and the demonstrations are made" (Onuchic, 1999, p. 217). The author argues that "teaching and learning mathematics through problem solving is based on the belief that the most important reason for this type of teaching is to help students understand the concepts, processes and operating techniques" (Onuchic, 1999, p. 208).

In relation to the unit of analysis, the previous knowledge of C2.U1 indicated their importance for the teaching of statistical content in YAE, because, as explained by Barros (2008, p. 50), "teachers feel difficulties to teach the new contents, since they need to review basic knowledge necessary for students' learning".

The curriculum guidelines for High School Mathematics indicate that knowledge is built during the teaching and learning process with an emphasis on mathematical reasoning and, at the same time, values the use of mathematics to solve everyday problems (MEC, 2006a).

Barros (2008, p. 36) points out that "the YAE student who has lived, in general, a history of exclusion, lacks mathematical knowledge and the education at the secondary level must take this into account". The collection of YAE guiding thematic notebooks explains that the role of the teacher who works at YAE is to prevent the student from giving up, in which it is necessary to use the knowledge already acquired from the student in the classroom, because the use of prior knowledge of students is important for them to be able to continue their studies.

Silva (2013, p. 101) explains that, when analyzing the answers to subjective questions, he noticed the "passivity on part of the students" in relation to the implicit information. Some students end up, perhaps due to tiredness, failing to argue with their colleagues and often agree with the answers without raising any questions. The passivity of the students was noticed during the application of the TS, as revealed by C2.U2.

Regarding the attendance analyzed in C2.U3, Barros (2008, p. 18) explains that "the students of Youth and Adult Education - YAE are part of a special audience, in a course with time limitations", because due to daily appointments some students were unable to go to class every day. This is a challenge when developing a teaching activity, since the teacher needs, in almost all classes, to be situating some student regarding the work developed in previous classes in which he was unable to attend.

YAE students have their specificities and need an articulation of the content with their daily lives and with the use of problem situations. Polya (1995) reinforces this by saying that the problem, however simple it may be, will always challenge the student to solve it and thereby trigger a new discovery.

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Final considerations

The analysis of the use of the problem solving methodology for the teaching of Statistics in High School, with the use of the TS's related to the profile of the students of YAE allows pointing out that:

- the group work used in the methodology of problem solving for the teaching of Mathematics provides an interaction between students and generates discussions about the mathematical and statistical content under study;
- in the problem solving methodology there is a need for teacher intervention so that students understand the contents studied, which, in the case of the research carried out, were: a) statistical data; b) qualitative and quantitative variables; c) collection and organization of secondary statistical data; d) tabular representation: simple, double entry tables; e) graph analysis; f) measures of central tendency: arithmetic mean, mode and median range;
- the problem solving methodology used in the TS provided students with the freedom to construct the arguments and responses to the proposed activities;
- the formalization of concepts by the teacher is extremely relevant because together, teacher and students, discuss attempts to solve the proposed problem in order to build knowledge of the mathematical and statistical concepts under study;
- the teacher needs to pay attention to students who have been out of school for a longer time, as they generally have more difficulty in learning the proposed content;
- one of the limitations perceived in the development of the TS's was in relation to previous knowledge of mathematics to understand the proposed statistical concepts, which requires the teacher to be attentive to supply the lack of knowledge of each student in particular;
- given the characteristics of YAE students, as an employee/worker, responsible for their family income, the teacher often observes passivity to interact with colleagues during classes;
- the low attendance of students in class often complicates the teaching and learning process because the student ends up discouraging himself since he is not able to follow the development of the proposed content.

Thus, it is concluded that the TS's, based on the problem solving methodology, can contribute to the understanding of the statistical contents and, consequently, to the development of the students' statistical reasoning. In addition, the application of the TS's in YAE, using the problem solving methodology, revealed that it is possible to involve students, of different age groups, actively in the teaching and learning process, thus surpassing the traditional model of teaching statistical content in High school.

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