



Statistics in High School: a potentially meaningful material for teaching the subject

Estatística no ensino médio: um material potencialmente significativo para o ensino da área

*Rejane Padilha Quedi*¹

*Luiz Marcelo Darroz*²

*Cleci T. Werner da Rosa*³

Abstract

This study presents the results of an investigation that aimed to identify how a didactic sequence based on the Meaningful Learning Theory may be considered a potentially meaningful material for studying statistics in High School. The sequence was presented to a group of High School mathematics teachers. The data was collected using the logbook created by the research teacher and semi-structured interviews performed with the teachers. The data was analyzed in the following three a priori categories: relationship of the contents in the didactic sequence with students' previous knowledge; progressive differentiation and integrative reconciliation; materials used and proposal structure. As a result, it was noted that the didactic sequence proposed might be considered a potentially meaningful material for the study of statistics, considering it favors the relationship of students' previous knowledge with the topics addressed and allows establishing connections with such knowledge.

Keywords: Mathematics teaching; Statistics; Meaningful learning; Potentially meaningful material.

Resumo

Apresentam-se, neste artigo, os resultados de uma investigação que buscou identificar como uma sequência didática fundamentada na Teoria da Aprendizagem Significativa pode ser considerada um material potencialmente significativo para o estudo de Estatística do ensino médio. A sequência foi apresentada a um grupo de professores de Matemática do ensino médio. Para a coleta de dados, utilizaram-se o diário de bordo elaborado pela professora pesquisadora e entrevistas semiestruturadas realizadas com os participantes. A análise dos dados teve três categorias *a priori*: relação dos conteúdos contidos na sequência didática com os conhecimentos anteriores dos estudantes; diferenciação progressiva e reconciliação integrativa; e materiais utilizados e estrutura da proposta. Como resultado, percebeu-se que a sequência didática em questão pode ser considerada um material potencialmente significativo para o estudo da área, visto que favorece a relação dos conhecimentos prévios dos estudantes com os assuntos abordados e possibilita estabelecer ligações entre esses conhecimentos.

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¹ Master's in science and Math's Education by University of Passo Fundo. Statistics Professor at the University of Passo Fundo, Brazil. quedi@upf.br

² Doctor in Science Education by Federal University of Rio Grande do Sul. Professor at the Program of Science and Math's Postgraduate Education at the University of Passo Fundo, Brazil. ldarroz@upf.br

³ Doctor in Science and Technology Education by Federal University of Santa Catarina. Professor at the Program of Science and Math's Postgraduate Education and of Program of Postgraduate Education at the University of Passo Fundo, Brazil. cwerner@upf.br

Palavras-chave: Ensino de Matemática; Estatística; Aprendizagem significativa; Material potencialmente significativo.

Introduction

Statistics is the Mathematics' field responsible for methods and techniques of research involving experiments, data collection, processing, graphics, analysis and dissemination of information. According to Echeveste, Bittencourt, Bayer and Rocha (2005, p. 6), this important area date back to ancient times, when operations to count the population were already utilized to obtain information about inhabitants, wealth and military power of the people.

In the contemporary world, the huge flow of knowledge deriving of a society in constant transformation has required of the citizens the capacity of summarizing and analyzing a great quantity of information, being essential the domain of the pertinent knowledge to any professional (Gal, 2002). In this context, Statistics is becoming a tool for the development of important skills of the decision making process in the modern days.

Therefore, several official documents that govern Brazil's education emphasize the necessity of learning these concepts in Basic Education. The National Curricular Parameters (PCNs), published in 1997, for instance, by the time of enactment, suggested these knowledge should take part of the school life, so the student would build the procedures to collect, organize, communicate and interpret data, using tables, graphics and representations that appear frequently in their routine (MEC, 1997). Such a concept was pointed out again in the text of the National Common Basis Curriculum (BNCC) of High School, adopted by the end of 2017. This document highlights, among the specific skills of Mathematics and its technologies for High School, the need to

utilize strategies, concepts and mathematics procedures, in its fields – arithmetic, algebra, quantities and measures, geometry, probability and statistics -, to interpret and build models and solve problems in several contexts, analyzing the plausibility of the results and the suitability of proposed solutions, in a way to build a consistent debate (MEC, 2017, p. 523).

Yet, even though the need of comprehending the statistics concepts is evident, and even before the recommendation of this science teaching during Basic Education, done by official documents, the lack of dominance of these concepts in the usage during interpreting situations or in data analysis is noticeable among the entrants of the Higher Education (Quedi & Darroz, 2018).

The specific literature has shown that a lot of difficulties faced by these academic students are arising from the studies held in the medium level (Baccarin & Neves, 2011). In other words, the hypothesis is that many conceptual gaps presented by these academic students have been established during the Basic Education. According to Oliveira (2007 apud Lopes & Coutinho, 2009), the formation of these gaps can be due to the way these subjects are approached in the medium level, many times in distant ways from the context the students are in, involving artificial situations where the repetitions and memorization of the concepts are privileged.

Consequently, it is understandable that to provide the comprehension of the basic concepts of Statistics, it's necessary to promote a methodology that turn the studied contents meaningful for the students. It is considered equally important that these subjects relate with

the previous knowledge of these students, making it possible for them to apply the concepts in different situations than the ones presented inside the classroom.

These thoughts lead to the research problem presented in this essay: **how can a didactic sequence of basic concepts of Statistics be a potentially meaningful material for the educational area?** Searching to answer that question, a theoretical-methodological proposal of basic concepts of Statistics founded in the Theory of Meaningful Learning (TML), from David Paul Ausubel is presented, in the perspective of evaluating the pertinence of its usage as a potentially meaningful material for the area of education, in the perception of Mathematics' teachers. For this purpose, the essay is structured in the following way: the next section presents the basic ideas of TML, that substantiates the didactic proposal and the methodology developed in the research; in sequence, the didactic sequence is described; to follow, the reached results are presented; and to finish, the final considerations are exposed.

Theoretical and methodological Aspects

As the main assumption, the TML, from David Paul Ausubel, comes from the conception that the most important isolated factor, and that affects the learning, is something that the student already knows (Moreira & Masini, 2001, p.17). In this direction, the goal of this theory consists in the occurrence of meaningful learning, process in which a new information relates with a relevant aspect present in the cognitive structure of the person (hierarchic structure of concepts), which Ausubel nominates "subsumer".

As these new concepts are learned in a meaningful way, that is to say, in a non-literal and non-arbitrary way, the expansion and elaboration of the initial subsumer's concepts occur. In other words, as the learning becomes more meaningful, the subsumers get more elaborated and capable of anchoring a bigger number of information.

In Ausubel's elaboration, the meaningful learning is different from the mechanical learning, which refers to the learning of new information with little or no interaction with the relevant and pre-existent concepts in the cognitive structure. In this case, the information is arbitrarily stored in the cognitive structure, therefore, without connection to the specific subsumers concepts (Moreira, 1999; Moreira & Masini, 2001, p. 32).

To make the occurrence of the meaningful learning easier, the author recommends the use of advanced organizers, introductory materials presented before the material itself to be learned and that can be a bridge to a new learning, taking to the development of subsumer's concepts that are able to anchor it. This way, the use of advanced organizers is a strategy proposed by Ausubel to manipulate the cognitive structure, in order to promote the meaningful learning occurrence (Moreira, 1999).

According to Ausubel (apud Moreira & Masini, 2001), two conditions are necessary for the occurrence of the meaningful learning. The first one is that the material to be learned needs to show itself potentially meaningful for the learner, in other words, the content about to be taught must interact, in a non-arbitrary and non-literal (substantive) way, with the specific subsumer's concepts relatable to the new material. The second condition is that the learner expresses willingness to relate the new material in a substantive way and not arbitrary to its cognitive structure. In accordance with the author, if one of the conditions is not satisfied, there will be a mechanical learning.

The acquisition process and organization of new knowledge in the cognitive structure of a student is called by Ausubel (Moreira, 2012) “Assimilation Theory”. In this theory, a new potentially meaningful information is related and assimilated to a pre-existing subsumer’s concept in the student’s cognitive structure. As a result of this relation and assimilation, there is the interactional product, that is, the modified subsumer.

From Ausubel’s point of view, the development of concepts is eased when the more general elements, more inclusive of a concept, are introduced in the first place. This process, which is dominated by the author “progressive differentiation”, occurs, according to Darroz (2008), when the subsumer observed has been modified by the introduction of a new information, that was also altered and received a new meaning. Therefore, according to Ausubel, the principle of progressive differentiation must be considered when programming the content, that is, the more general and more inclusive ideas of the subject must be presented in the beginning, so they can be progressively differentiated, in terms of details and specificity (Moreira, 2012).

In line with Moreira and Masini (2001, p. 29-30), when proposing the progressive differentiation, the theorist based himself in two hypotheses:

- a) It is easier for human beings to capture unique aspects from a more previously learned inclusive whole than to get to the whole as of from its different parts.
- b) The content organization of a certain subject in the mind of a person is a hierarchical structure in which the more inclusive ideas are on the top of the structure and progressively incorporate propositions, concepts and less inclusive and more unique facts.

Besides that, Ausubel indicates that the instruction must also explore relations among ideas, point out similarities and important differences and reconcile real and apparent discrepancies. That must be done to reach what he calls “integrative reconciliation”. In this respect, Zompero and Laburú (2012, p.38) clarify that:

[...] the plurality of ways of representation can favor the meaningful learning for making it possible to connect a new knowledge to the cognitive structure of the student in a way to promote the non-arbitrary and substantive relation of these knowledge to the subsumers, and possibly assist the recognition of the knowledge that already exist in the knowledge structure of the students, producing new meanings, as occur in the integrative reconciliation. Thus, the usage of diverse ways and manners of representations in the educational activities stimulates the reorganization of the learners’ idea to build more cohesive scientific meanings.

At last, according to Ausubel, the genuine comprehension of a concept or proposition implies the possession of clear, precise, unique and transferable meanings. In this perspective the best way to search for meaningful comprehension evidences consists in formulating questions and problems in a new and unfamiliar way that requires maximum transformation of acquired knowledge.

So, facing that it’s possible to infer that the role of the teacher in the simplification of the meaningful knowledge involves at least four fundamental tasks: identifying the conceptual and propositional structure of the teaching subject; determining the subsumers that are relevant to learn of the content about to be taught and that the learner must have in his cognitive structure; proposing didactic activities which will make it possible for the new knowledge to relate with the specific relevant subsumers; and teaching using resources and

principles that facilitates the acquisition of conceptual structures of the matter of education in a meaningful way.

These theoretical conceptions allowed elaborating the proposal that originated the didactic research being here presented. For this purpose, it was considered that Statistics related concepts are already incorporated in the students' cognitive structures and are formed during their everyday coexisting, based on the transmitted information by means of communication and on the observation of the modern world.

Consequently, the methodology of the adopted research for this investigation aimed to create conditions to evaluate if the didactic sequence elaborated could be considered a potentially meaningful material for the Statistics education. This way, it involved the elaboration of a didactic unit for the treatment of basic concepts of Statistics and its presentation by the researcher teacher to a group of eight Mathematics' teachers of High School in public schools of a town of Rio Grande do Sul.

In the research held directly with the investigated people, the intention consisted of analyzing the produced material, in order to identify answers to the central question of the study. This way, for observing the educational practice, the investigation can be classified as a qualitative research that according to Triviños (2015), allows the comprehension of reality and obtaining elements to investigate it.

For the production of data that allowed obtaining elements for discussion, the collecting tools selected for the research were the logbooks elaborated by the researcher teacher and the semi-structured interview applied to the group of participants. The option of the logbook took in consideration the importance of the teacher writing his technique (Zabalza, 2004, p. 10), experience provided by this tool.

Adopting Zabalza's (2004) recommendation, at the end of each meeting, reflections about the activities were registered in the logbooks, approaching aspects as the class structure and the involvement and participation of the students. These registers built the research material, which was used to comprehend the notes proposed during the analysis of data. Besides, aiming to identify the opinion of the teachers before the activities, a semi-structured interview was held, chosen for being a flexible tool and that makes possible the great interlocution of the interviewer with the interviewee (Lüdke & André, 1986). The interviews were audio recorded and then transcribed. In the presented results, all the participants are mentioned in the male gender and nominated P1, P2, P3,... P8, in order to remain anonymous.

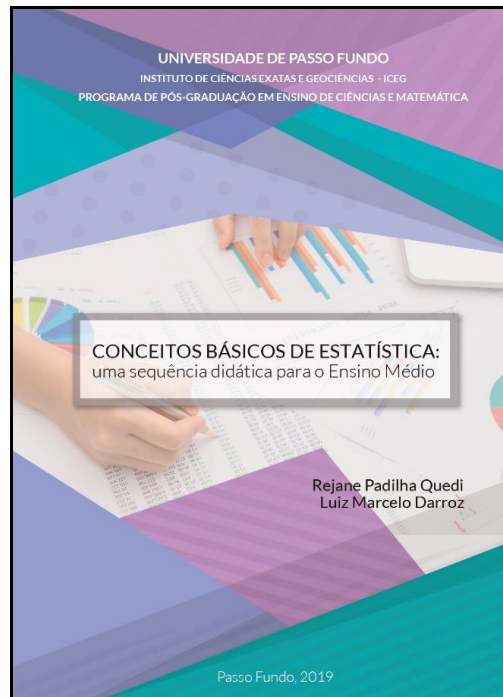
The data was analyzed according to the following aspects, which constitute the a priori categories of the study: relation of the studied contents with the previous knowledge of the students; progressive differentiation and integrative reconciliation; and used materials and the structure of the proposal. According to the description above, the investigation was developed through the didactic sequence presentation, providing the interpretations and conclusions that are registered from now on.

The didactic sequence

The proposed didactic sequence, which was presented in four meetings of four hours each, approaches the concepts related to the arithmetic average, trend, median and standard diversion for the serial data and group data. The selection of these concepts was based on the

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results of an investigation held by Quedi and Darroz (2018), that identified the conceptual gaps about basic contents of Statistics emphasized by Higher Education students. All the material presented to the participant teachers is on the educational product entitled Basic concepts of Statistics: a didactic sequence for High School (Quedi & Darroz, 2019) (Picture 1), where it's possible to find a sequence development proposal that originated this report.



Picture 1 – Educational product Basic concepts of Statistics: a didactic sequence for High School.

Source: Quedi & Darroz (2019).

The first meeting was destined to the TML presentation, once it substantiates the sequence. For that, two videos⁴ that remind the idea of meaningful learning and provide a simple explanation about the theory were shown. Yet, a text about TML was given to the participants, which oriented the discussion about the main elements that form it.

As subjects to be approached in the second part of the sequence, it was selected the historic of Statistics emergence, the construction of the population concepts, sample, data collection, table elaboration and the clarification of the difference between serial data and group data. This way, the second meeting started with the establishment of the bridge between the subsumers knowledge and the concepts that were about to be studied, through the video History of Statistics⁵ as an advanced organizer. To promote the progressive differentiation from the sample concepts and population, it was suggested the organization of

⁴ Available on: <https://www.youtube.com/watch?v=eyz6dnIHfxQ> e <https://www.youtube.com/watch?v=hPx5hSqb9iA>.

⁵ Available on: <https://www.youtube.com/watch?v=jCzMPL7Ub2k>.

two groups of participants to precede the collection of information related to age and height of the components. Based on the collected data, building a conception that the sample corresponds to a significant part of the population was sought and the participants were requested to organize two tables: the first with the serial data and the second one with the group data.

At the end of the tables' organization, a dialogue was established as a way of reinforcing the progressive differentiation, the integrative reconciliation and promote the assimilation of the studied concepts. Finally, it was recommended to the participants to identify the subsumers knowledge of the students, related to the arithmetic average, trend, median, standard diversion and pattern diversion for serial data, as a subject for the next meeting, each teacher must transmit to the students an exercise about the medium temperatures of a given month (Quedi & Darroz, 2019, p. 15) to be resolved individually and delivered in the beginning of this next meeting.

Following up, the didactic sequence aims to handle the information presented in sequence. For that matter, in the initial part of the third meeting, there were comments among the teachers about alternatives to promote the establishment and comprehension about the determination of measures of central tendency, as the arithmetical average, trend and median, and also the standard diversion and pattern diversion.

Searching to establish a connection between the subsumers concepts and the issues approached in this step, the usage of a graphic of a report that presents the monthly bulletin of criminal statistics of the state of Alagoas⁶ was indicated as an advanced organizer. From the interpretation of this graphic, it was suggested returning to the research held in the first meeting with the table containing the serial data. With this data, and with the intention of promoting the progressive differentiation, it was informed that, initially, it's necessary to create space for a discussion directed to reinforcing the conception that each age corresponds to a student and that, for the generalization, it is possible to identify these numbers.

After the comprehension and generalization of these numbers, the study of measures of central tendency was approached, and in sequence, the average diversion and pattern diversion. As closure of this step, it was stressed out to the teachers that to identify if there are evidences that the students learned in a meaningful way the approached concepts, they must request that they answer new problem situations as the ones included in the fourth chapter of the educational product (Quedi & Darroz, 2019).

The last part of the presentation aims to treat the information for group data and has as its goal the establishment of comprehension of the way the central tendency measures, arithmetic average, trend, median, average diversion and pattern diversion for groups of data are determined. This way, it was recommended to the participants the usage of a video entitled IBGE explains⁷ as an advanced organizer, to constitute the connections between the concepts that the students present in their cognitive structure and the meeting's subjects.

With the display of the video, a retake of the research held in the first step about the students' age was suggested, once the data of this table are grouped. So, it was proved that to

⁶ Available on: <http://g1.globo.com/al/alagoas/noticia/2015/02/al-registra-618-mortes-cada-100-mil-habitantes-em-2014-aponta-secretaria.html>.

⁷ Available on: : <https://www.youtube.com/watch?v=JVCZOIIMBk>

promote a progressive differentiation, first it is necessary to promote a debate among the participants about these possibilities of numbers' representation. After the comprehension of the several ways to group them, it is possible to move forward to the central tendency measures' study, explaining that for this purpose, how the arithmetic average, trend and median for group data would be determined.

In sequence to the proposed goals, from this point on the beginning of the study related to the average diversion and the pattern diversion is indicated. In this manner, and aiming to provide the progressive differentiation, it was recommended the presentation of a new situation containing fictitious data about the production in kilograms of fifty products (Quedi & Darroz, 2019, p.39) that aims to construct the average diversion and pattern diversion's concepts.

Concluding this step, the necessity of proposing to the students' new problem situations was reiterated, as the ones contained in the educational product, searching to identify if these people meaningfully learned the approached concepts.

Results and discussion

In this item, the presentation of the didactic sequence's coming results are listed and discussed. According to Moreira and Masini (2001), Ausubel considers that a material is potentiality meaningful when it shows itself relatable to the previous knowledge of the students and it is able to establish connection among them. This way, it is noticeable if the didactic sequence presented in this study achieves the conditions emphasized by the theorist. From this point on the data from the nominated categories in the second section was evaluated.

Relation of the content contained in the didactic sequence with the previous knowledge of the students

For Moreira and Masini (2001, p. 23):

[...] about the nature of the material, it must be "logically meaningful", sufficiently non-arbitrary and not random itself, in a way that it can be related, in a substantive and non-arbitrary way, the relevant corresponded ideas that are situated inside the domain of the human capacity to learn. As for the cognitive structure of the learner, the specific subsumer's concepts in it must be available with the ones that are relatable to the new material.

From this conception, this category searches to prove if the didactic proposal makes the linking of the contents with the previous knowledge possible through the used material.

In the analysis of the information collected in the interviews, it was determined that the teachers consider that the subjects approached in the didactic sequence are part of the students' routine in High School. On the opinion of P6:

Everything that is in the didactic sequence interlinks well with the knowledge that we already have, right, of our experience and the students' experience, it is possible to relate well with what they normally have in their routine. It is possible that some students take a little longer to see, but I think they can. Until the end you can notice the relations.

The relation of subjects developed in the didactic sequence with the routine of the students is also proved in several records made by the researcher teacher in the logbook. In

one of the excerpts, it is verified that the reports, during the meeting, of the teachers pointed out the subjects reminded them of their routine. In the words of the researcher teacher:

When I commented about the exercise held in the previous meeting that searched to verify the subsumer knowledge about the serial data, several teachers said that when reading the exercise they were reminded of some memory of their own experiences, as in the register of a football game where the average of goals was scored or yet who scored more goals, and this way started to relate to the contents (Logbook, record of 28/08/2018).

In another excerpt of the logbook, it is proved again the manifestation of the teachers about the routine of the High School students. According to the record transcribed below, the comments of the teachers indicate that the material facilitated a lot the comprehension of the Statistic subjects:

I noticed that in certain moment two teachers were commenting [...] how the material would help in classes, [...] how the High School students would learn better, because the material connected the studied content to the knowledge the students already had (Logbook, record of 21/09/2018).

About the routines, according to the interviewees, it is more evident in the examples contained in the material. For P3: “The examples are very practical, it’s a thing that has applicability, I think it would be easy to make the association, then having the teacher as a facilitator, the student would definitely be able to associate the contents approached in their routine”.

This perception is shared by P8, who comments:

The examples help a lot, because you get the content, like, learn faster, you associate more easily. The examples make us see where the content really is. In High School, I never had this, the teacher asking me what I knew to then start the content, I had never seen that, and I liked it a lot, because we can even see that we know a little, and then we link the concepts and it gets easier to comprehend and assimilate, right?

In one of the registers of the logbook, the researcher reports the speech of a teacher who emphasizes the capacity the examples present of relating the subjects with the everyday life of the High School students:

After showing the video, which served as an advanced organizer, to introduce the concepts for group data, a teacher made the following comment: “When I see the examples of the material, I can already think of something that I went through at home or in class, then I want to formulate my own examples and see if I can get the concepts of it” (Logbook, record of 05/10/2018).

This observation is reiterated in another record of the logbook, in which the participants evaluate the examples contained in the material as being important for learning. According to the researcher teacher:

In the presentation of contents for serial data, I began with the example of the data collection of the previous meeting and I mentioned and showed in the material other examples. Several teachers talked about the importance of the examples being of situations that are close to the students and that they would be a facilitator for the learning of the High School’s contents (Logbook, record of 28/09/2018).

Through the exposed, it is determined that the contents approached in the didactic sequence can be related to the previous knowledge of the students. This perception

demonstrates that the material can promote meaningful learning of the basic contents of Statistics, since according to Ausubel (apud Moreira & Masini, 2001), the essence of the meaningful learning process is in the fact that the ideas symbolically expressed are relatable in a non-arbitrary and substantive (non-literal) way to what the learner already knows, in other words, to some relevant aspect of their knowledge structure (that is, a subsumer that can be, for example, some symbol, concept or already meaningful proposition).

Progressive differentiation and integrative reconciliation

Ausubel, Novak and Hanesian (1980) emphasize the importance of the development of the concepts beginning through the introduction of the more general and more inclusive elements. Following the recommendation of the authors, in the didactic sequence it is suggested that after the introduction, a differentiation of its details and specificities in a progressive way is established. Finally, the importance of the occurrence of a meaningful learning through the consideration of the principles of progressive differentiation and integrative reconciliation is reinforced (Moreira & Masini, 2001). This way, in this category it is aimed to examine if the principles of the progressive differentiation and the integrative reconciliation, advocated by Ausubel, are present in the proposed didactic sequence.

Regarding the presentation of the broader aspects of the subjects approached in the didactic sequence that precedes the development of the specific concepts, the following record made by the researcher teacher on the logbook is highlighted:

In this meeting a video was shown, which served as an advanced organizer to the concepts that were developed. Through the presentation of the video I could establish with the teachers, in a broader way, the concept of population. With this, the concept of samples and ways of representation and then develop the content in the next meetings (Logbook, record of 21/09/2018).

The development of the concepts in a more general way was also noticed by the teachers. For them, initiating the studies in a broader way facilitates the comprehension of the basic concepts of Statistics, as it is noticeable in the following speech of P2:

In the way that was shown, going from the broader, that is, if it was asked of them to do a data collection, it would be easier to work with the information, in other words, tabulate the data, calculate the average, trend and other worked concepts. Because this way they have a more general vision, they understand better and are more interested.

As mentioned before, after the introduction of the broader concepts, the realization of the progressive differentiation of the proposed contents is necessary. This differentiation is proved in several segments of the interviews. In the following segment, P2 emphasizes that the material explains in detail the difference between serial data and group data:

There in the material it was very well explained what each content was, which one group data was and which one serial data was, what average was, what pattern diversion was, it was very well explained, the student can understand very well and make the difference.

In the same direction, another teacher admits the material helped comprehending the distinction between the concepts of arithmetical average and median. According to his report, initially he comprehended both concepts as synonyms, and after the participation in the meetings of the didactic sequence development he was able to differentiate them. Because of it, he believes High School students will also be able to notice the difference and reach the desired education more easily. To continue, his speech is transcribed:

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In one of the meetings, when we were presented the way how the concepts related to serial data were approached, I was able to realize and understand the difference between average and median. I thought they were the same thing because by the name it is very similar. You see, I didn't really have these contents in High School. Now I can understand in average I add all the elements and divide by the number of elements, and the median is where the serial divides itself in two equal parts. [...]. I think when the contents are being presented to High School students this way, they will also easily understand and then will learn with more logic, with more meaning (P1).

The progressive differentiation, advocated by TML, is also noticed in the registers of the researcher teacher, of which the following segments are highlighted:

Today the concepts relating group data were approached. We began the class, and with the goal of building a connection among the concepts proven on the previous exercise and the subjects that will be approached, a video named IBGE explains was shown as an advanced organizer. After watching the video, I asked them to retake the research held previously to work with the table where the data was grouped. During the development of the activities, I noticed a group of teachers talking about the approached subjects. One of them commented he was able to clearly differentiate what serial data and group data were. I noticed in these comments the teachers presented each other the concepts and demonstrated daily situations where they judged the data to be serial or grouped (Logbook, record of 05/10/2018).

After the progressive differentiation, the didactic sequence made it possible to promote situations of integrative reconciliation of the approached concepts. In the interviews, the integrative reconciliation is referred repeatedly. In one of them, the interviewee report that what was presented as example represents only the beginning of the applications the students could do. In that perspective, the teacher emphasizes the proposed activities can contribute to alter the daily routine, helping their life quality and the medium level students', according to what is visible in the following excerpt:

The data collection there proposed about the ideas of the school's students or students from certain grades would make them associate with the presented content in a broader way. Since now the age, but if some other interesting thing appears, then maybe it is one thing, yes, that we talk about a lot today, weight, we see a lot of the discussion about the story of the school's lunch being healthy or not. That could be the beginning and then start doing about weight, then about height, then start doing about the body mass index, and then it goes on. And with that he can embrace and relate the approached contents, and like and from this some other thing would appear. It opens the mind for new applications, and it can alter our daily life. My life as much as the High School students' lives (P3).

The same can be verified in another logbook's record of the researcher teacher:

During the meeting's exercises, I could notice teachers commenting that, when reading the problem situations, they easily identified the data, if they were serial or grouped. Already organized for the application of the concepts, respectively. They could differentiate all the subjects and apply them on the same situation (Logbook, record of 19/10/2018).

The progressive differentiation and the integrative reconciliation are processes that make part of the meaningful learning. As far as new information is acquired, already existent elements in the cognitive structure can be noticed as related and reorganized in the cognitive

structure, acquiring new meanings (Moreira & Masini, 2001). Such elements were identified in the analyzed material, demonstrating that the proposed didactic sequence facilitates the differentiation and reconciliation of the subjects related to the basic concepts of Statistics. This way, it is possible to conclude the organization of activities can favor the promotion of progressive differentiation and integrative reconciliation, fostered by Ausubel about the proposed themes.

Materials used and structure of the proposal

This category aims to present the perception of the participants relating the videos, the graphics, the figure, the texts, the dialogue balloons directed to the teacher, the language used in the elaborated materials and the structure of the proposal.

Taking in consideration Moreira's (1999, p.51) speech that "the meaning is in people, not in things", meaningful books or meaningful lectures do not exist, but books, lectures, instructional materials that, in a general way, are potentially meaningful. For this purpose, these materials must have a logical meaning (present structure, organization, suitable language, finally, be learnable), and the learners must have adequate previous knowledge to give a meaning to the knowledge disseminated by themselves (Moreira, 1999).

In relation to the videos, graphics, figure and texts present in the material, the reports of P5, P6, and P7, transcribed below, prove that, in the opinion of teachers, these material will be important for the maintenance of the High School students' attention in the future implementations of the didactic sequence.

Particularly, in the videos, what called my attention the most is that they weren't, how can I say, they weren't videos with a lot of writing or long videos, because, want it or not, if it's something too long or too full of writings, in the first moment when you are introducing the subject, the student won't be able to catch everything. Since it's more images and less writings, it's simpler, leaner, I think the student memorizes better, they absorb, they absorb more relations of what's happening. They were very relevant (P5).

The visual helps a lot the students to understand and also localize themselves, right, as for the content, so, the videos as much as the graphics, I think it's really valid for us to have something different, not only there on paper, on the board, and I think that it's very suitable for High School. The video about IBGE, I thought it was more interesting, like, it has more information, different things, figures, but in a general way all of them, I think nowadays are in line with High School (P6).

It's a very nice way for you to introduce what you want to teach, right? I thought it was very interesting, I would use it too, I thought it was good. The videos, the figures were appropriate, it's a good content. I think it was in a certain pattern for understanding. They'll help the students comprehend the proposed subjects a lot (P7).

The interest, the motivation and the involvement of the teachers, to be in touch with the videos, the graphic, the figure and the text, were also proven during the analysis of the material. According to the reports of the researcher teacher done in the meetings, the participants, besides demonstrating their satisfaction with the material, showed the intention of using them in their future professional activity.

When I handed the introductory text about the Meaningful Learning Theory, the teachers showed themselves very welcoming to the reading and in the moment of socialization and debate about the theme, they said the reading was approachable and

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it facilitated the comprehension of itself. I noticed through the comments, that the teachers, while reading the text, could easily interpret the vocabulary contained in TML (Logbook, record of 14/09/2018).

[...] still in the meeting I noticed the following speech: “The videos helped a lot, they were short but well illustrative, they helped thinking about the subject”, words of a teacher after watching the video of the meeting (Logbook, record of 21/09/2018).

Intending to build a connection between the concepts proven in the previous exercise and the subjects that will be approached in this meeting, a video entitled IBGE explains was shown. This video resulted in a lot of interest and debate among the teachers who showed the interest of using the material in their lessons, since they believe they are capable of getting the attention of the High School students (Logbook, record of 05/10/2018).

The dialogue balloons directed to teachers were another element emphasized by the participants in the material used in the didactic sequence. In their opinion, these dialogues help comprehend the answer, as prove the speeches of P5 and P8, transcribed below:

The usage of dialogue balloons with the teacher was very good, they are very well written. Personally, I even put it in my report, it seems like talking to the person, it seems like someone is talking to you. Like, I, a teacher, am here, and someone is telling me what to do, do this, do that, then I think the contrary, you know, as if there were no balloons, I think it would be harder, so if taken off the sequence I think it wouldn't be clear enough to be a teacher's material, so, that what is in the balloons is the teacher who will mediate in the classroom. This sort of conversation with the teacher is very important, since it's what will pass the content, if not the teacher is also without mediation, so that in there will fill some gaps that can happen from a misinterpretation of the teacher, it will avoid them so then the teacher won't be teaching wrongly, I think the balloons are really valid (P5).

The balloons, actually, they explain better, right? Like, if you don't understand what's above, it helps you there in the balloon, and you understand better. I could use this material with my students. I thought the material was very good, a very good didactic sequence, like, you can teach very nice lessons, you can understand (P8).

The same impression is proven in the notes of the researcher teacher, according to her the students expressed the importance of the dialogue balloons, highlighting how well written they were and with a clear language.

During the meeting, I noticed the teachers were commenting about the dialogue with the teachers contained in the balloons. They complimented this method a lot. They said they were well written; they facilitated the understanding of the concepts and that they approved the usage of them. Yet, they commented that most materials that are used in class just present the content and don't explain how to work with it (Logbook, record of 19/09/2018).

Ausubel (1968 apud Moreira & Masini, 2001) considers that all the aspects relatable capable of conferring to a material the status of potentially meaningful are conditioned to the coherence of the logical and conceptual point of view. This way, the perception of the participants relating to the language and structure of the proposal was sought.

For that matter, the data demonstrate the language of the material was considered clear and inside the students' reality. For P2, the material “[...] is very well written, with an

approachable language and near the High School's students' reality, like that it's going to awake bigger interest in the involvement during the activities, providing better learning".

In the same direction, P4 and P5 emphasize: "Wow! If all the books had this approach, with reachable language and that the High School students can relate with their routine, the students' performance would be a lot better" (A4). "The material presented is very reachable for the comprehension of the concepts by the High School students, because it uses a language very similar to their realities" (A5).

In the segments of the logbook, the researcher teacher confirms that "[...] the teachers expressed themselves and said a lot about how clear and approachable the language of the material was, they also said that this way it would be easier to develop the contents for High School" (Logbook, record of 05/10/2018). In another record, complements:

[...] in the end a dialogue with all the teachers about the problem situations resolved in the meeting and of all the implementation of the proposal was established. Their manifestation was that the material contained a reachable language and was close to the reality of the High School student (Logbook, record of 19/10/2018).

A didactic sequence must be developed to attend the necessities of the students, and for that to happen, it is fundamentally important its form of structure is adequate to this goal and this target audience. As for this aspect, it was observed that the teachers evaluated as really valid and of significant relevance the way how the sequence was structured and based according to TML. For them, it makes the difference in the process of teach-learning the option of initiating identifying the subsumers concepts of the students related to the subjects approached and planning the development of the activities based on these evidences, by means of group projects. In an excerpt of their report, P1 says that they didn't know this methodology and expresses that they liked the way the concepts were developed, as of the search of previous knowledge of the students:

The sequence of the material to develop the content is really good, I didn't know this way of working, this methodology. I really liked it, since you first verify what the student already knows and then based on that prepare the lesson, I can use several resources. In this manner the student will feel appreciated and doing the exercises with situations experienced by them will establish relations assimilate better the contents. Group activities are a thing that the students like and are really important for their improvement.

This perception is also verified in the records of the researcher teacher's logbook. According to the data obtained in the fourth meeting, she highlights that:

When finishing a closing activity of this step where the teachers applied the concepts developed in a situation different from what was presented [sic], some collocations appeared. A teacher said that the structure whereby was developed the content was really good and that the High School student would enjoy a lot more this methodology was used with them. Another one said that the fact of verifying what the student already knows is very important for him to feel as part as the process too, and not the teacher discharging the content. Another still said that the fact of the material containing problem situations close to the student's reality gives him a huge potential, since it brings the student and the content together (Logbook, record of 05/10/2018).

Through the analysis of transcriptions of the semi-structured interviews and from the records of the researcher teacher in the logbook, it is possible to conclude that the used materials and the structure of the proposal are important to awake motivation and interest of

the students during the implementation of the didactic sequence. With this, it's believable that composing a didactic sequence with several materials, creative strategies and methodologies that conduct to think, reflect and expose the previous knowledge of the students can favor the promotion of meaningful learning. Finally, it is inferred that the material here presented proves structures that describes it as potentially meaningful.

Final considerations

The study presented in this text has as its base the perception that, when entering Higher Education, the students demonstrate a lot of difficulties in the subjects of Statistics. It is also noticeable that this group of people presents conceptual gaps in basic precepts of the area. Such evidences call the attention, once the study of these contents is recommended by the official documents since the initial years of Elementary School.

Therefore, it is understandable that to provide these concepts it is necessary to promote a methodology that turns the elements studied meaningful for the learners and that relates the subjects seen in the scholar banks to the previous knowledge of the students. This way, a didactic proposal founded in a theory that relates the scholar concepts referring to the arithmetic average, trend, median and pattern diversion for serial data and group data was presented.

The presentation of the proposal to a group of Mathematics' teachers originated a range of materials that constituted itself in the list of the research's data. These data were analyzed under the following aspects, which constituted the categories of the study: the relation of the contents contained in the didactic sequence with the previous knowledge of the students; progressive differentiation and integrative reconciliation; and utilized materials and structure of the proposal. As for the first category, it was determined that the contents contained in the didactic sequence relate themselves with the previous knowledge of the High School students. In the second category, it was proven that the way how the activities were organized showed itself inspiring of the promotion of progressive differentiation and integrative reconciliation. Finally, in the third category, it was verified that the used material and the structure of the proposal were essential to motivate the students for the involvement in the planned activities.

From the data collected from the logbook and semi-structured interviews, it was concluded the built material can be considered potentially meaningful in the perception of Mathematics' teachers and presents itself as an alternative to Statistics education in medium level.

Pelos dados extraídos do diário de bordo e das entrevistas semiestruturadas, concluiu-se que o material construído pode ser considerado potencialmente significativo na percepção dos professores de Matemática e apresenta-se como uma alternativa ao ensino de Estatística em nível médio.

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