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Research on variability in Statistical Education: a systematic review of literature

Pesquisa sobre variabilidade na Educação Estatística: uma revisão sistemática da literatura

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Abstract

This article is a clipping of a master's dissertation, which aimed to investigate the reasoning about variability according to the perspective of Statistical Education. This work describes the Systematic Review of Literature performed in order to verify researches that present resources which help the process of teaching and learning of concepts involving the study of variability. The sources of literature used were national and international periodicals in Educational area in the last 10 years (2008-2018) published in Brazilian Portuguese, European Portuguese, Spanish and English. These journals were evaluated by the CAPES WebQualis system in the 2013-2016 quadrennium as A1, A2, B1, B2, and B3. The Systematic Review of Literature has shown that there is little research addressing the reasoning about variability in Basic Education, an important skill for the development of statistical literacy in student education.

Keywords: Statistical Education; Statistical Literacy; Reasoning about variability; Systematic Reviews of Literature.

Resumo

O presente artigo é um recorte de uma dissertação de mestrado, que teve por objetivo realizar uma investigação a respeito do raciocínio sobre variabilidade de acordo com a perspectiva da Educação Estatística. Aqui é descrita a Revisão Sistemática da Literatura (RSL) executada a fim de verificar as pesquisas que apresentam recursos que auxiliam no processo de ensino e de aprendizagem de conceitos envolvendo o estudo da variabilidade. As fontes de materiais para a busca de trabalhos foram os periódicos nacionais e internacionais na área de Educação e Ensino dos últimos 10 anos (2008-2018), publicadas no Português do Brasil, Português de Portugal, Espanhol e Inglês. Esses periódicos foram avaliados pelo sistema CAPES *WebQualis* no quadriênio de 2013-2016 como A1, A2, B1, B2, B3. A Revisão Sistemática da Literatura mostrou que há poucas pesquisas que abordam o raciocínio sobre variabilidade na Educação Básica, uma habilidade importante para o desenvolvimento da literacia estatística na formação dos alunos.

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Palavras-chave: Educação Estatística; Literacia Estatística; Raciocínio Sobre Variabilidade; Revisão Sistemática da Literatura.

Initial Considerations

A study in which there is data gathering, processing, and analyses, requires statistical knowledge to draw interpretations and concepts, as well as to qualify and systematize the information gathered. This process involves one's capacity for dealing with statistical concepts to establish parameters between the results and the hypothesis of the study.

This type of knowledge is not only necessary in scientific research, but also at every moment that we get in contact with information through the most varied kinds of media and means of communication. Knowing how to read and interpret different types of charts and understanding probability as an uncertainty measure is paramount to comprehend the concepts of statistics and variability, hence helping one in his decision making.

Gal (2002) talks about statistical literacy, that helps individuals to be aware of social phenomena, being able to make mindful choices in daily situations such as acquiring insurance or playing in the lottery. In possession of this knowledge, these individuals' participation in society becomes more active, thus being able to contribute to public debates and actions for the community, intervening in their work and personal environment.

Statistical Knowledge is necessary during Basic Education since it is part of many daily situations of a common citizen. Starting from the moment this individual is able to recognize these contents in a piece of news, for instance about the rise of criminality in Brazil recently, represented in a column chart, he can notice the temporal variation, is able to measure the numbers, identifying the year in which there were more or less crime occurrences, if there is a tendency of rising or decreasing of these numbers if there is an interval with a greater rise or fall, and correlate these numbers with political events happening at the time.

Moreover, the overflow of information, nowadays, which demands interpretation and sharpened critical thinking, besides being broadcasted through state of the art media technology, has required statistical knowledge and a level of education from people that provides them with techniques, reasoning and adequate language to deal with this information.

Among the statistical concepts that are essential for the development of statistical literacy is variability. The recognition of the variation in quantities, in certain situations, allows the observation of the changes and the measurement of this variation. Variability is part of the quotidian and noticing it and analyzing it statistically makes one's perception of the world more critical, helping his formation development and his social participation.

In this article, we continue from the investigation proposed by Pereira (2019) in a study about promoting variability within the concepts of Statistical Education. Therefore, it is presented here, a clipping of one of the main stages of the research in order to verify what is

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there in the academic field about the theme. Hence, this article brings a Systematic Review of Literature (SRL) of properly selected studies from the criteria to be mentioned in the following sections. The studies targeted in this investigation were the ones disclosed as articles describing research about activities used to teach and learn variability from different didactical resources.

Before presenting the results of the SRL, it is necessary to punctuate a few important concepts, paramount to statistical literacy and variability, in the interest of comprehending this study.

The Statistical Literacy and Reasoning about Variability

Gal (2002) points out two components with the main characteristics of his understanding of statistical literacy that are taken into account in this research. They are: a) when one evaluates and interprets the statistical information from different situations and contexts critically; b) when one is able to discuss and express oneself about this information, revealing his comprehension of its meaning, contributing with his opinions about its consequences, and takes part in the judgment of the conclusions drawn from it.

In this manner, it is understood that statistical literacy gives the individual conditions to be an active citizen in the society, mainly in its cultural sphere where he will be able to analyze and discuss statistical information and, from that, make decisions.

The decision making in different situations in one's life using statistical knowledge requires that he statistically evaluates each step of the problem, constructing arguments based on previous knowledge or built from hypotheses.

According to Watson and Callingham (2003), statistical literacy is greatly important in a citizen's life. By developing more abilities related to this subject, the student is able to acquire a critical view, thus being able to question the information he is given. In this manner, is important to highlight:

> Statistical Literacy is important not only to the society as a whole; it is also relevant to the individual members of the society, to the way they make decisions in their lives based on information and risk analyses provided by other people in the community. Decisions as to where to live, what kind of job to look for and which car to buy, may be influenced by data out of their individual experience. (Watson; Callingham, 2003, p.4)

To Gal (2002), the statistically literate individual can face a piece of information, discuss it and present his impressions critically, thoroughly thinking about the conclusions presented, making mindful decisions. According to this author, statistical literacy may be defined as the capacity to evaluate and critically interpret statistical information in different contexts. This individual shows characteristics regarding information perception and data manipulation, drawing judgments, showing control of the abilities related to the development of statistical literacy.

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The engagement of the student in didactical situations of data gathering, dealing with variables in a small sample universe, facilitates the perception of a world in which there is a natural concept of variability. Moreover, it helps students to see the variability of statistical data, and to analyze the distribution of these data, taking into account its central and dispersion measurements. These abilities are necessary when dealing with information every day. The media use many resources to broadcast some piece of news, and many of them involve graphic representations, charts, and statistical measurements. To comprehend these pieces of information and adopt a critical point of view, in order to participate in this dialogue the individual must be statistically literate (GAL, 2002).

In statistical studying, most of the time, if not all of the time, variability will be present. Moore (1997) talks about the omnipresence of variability in different study areas, and how important it is to observe it in the data distribution. Hence, we understand the importance of comprehending this concept and how necessary it is to a citizen's life.

To Pfannkuch and Wild (2004), identifying the data variability is a very important factor in the statistical investigation because, by considering the variation, it can influence the results in data analysis, whether being ignored, previewed or controlled. Thus, variability is characterized by patterns found in contexts to solve problems.

Since variability is part of many realistic situations, noticing and dealing, not only with the reasons for that variation but also describing it, is part of the comprehension of data distribution. Silva (2007, p. 37) states that "variation is the central element of statistical thought and it is one of the necessary contents one needs to be statistically literate". From that, we can infer the importance of understanding variability in the development of statistical literacy.

By discussing some specific aspects of variability thinking, Reading e Shaughnessy (2004) argue that variability does not have proper attention. In the base syllabus used in the study of Statistics, there are, almost always, two of the main statistical concepts: the central tendency measurements and dispersion measurements. Nonetheless, the approach is many times focused on the study of the mean, median and mode and little is said about variability in the study of dispersion. The same authors state that, nowadays, students cannot understand the nature of variability in distribution because of the lack of emphasis in the study of variation, both in Mathematics syllabus and in didactical books.

In their research, Reading and Shaughnessy (2004) defend that, even though students are surrounded by variability in their daily lives, they still do not have opportunities to describe distribution variability. The authors state that teachers must provide other learning experiences so that students are able to identify variability, observe its causes and choose different representations to measure variation.

Regarding the cognitive development of variability, Reading and Reid (2010) highlight the components of variability with the purpose of better understanding its concept. They are: the development of intuitive ideas on variability, description and representation of variability, making comparisons using variability, the perception of variability in special

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distributions, identification of variability patterns in adapted models, prediction of random samples and results using variability, make variability a part of statistical thinking, recognition of different sources of variation, observation of variation I problems and their solution. These components are within the study of variability and it is necessary to emphasize them.

Systematic Review of Literature

The Systematic Review of Literature (SRL) aroused in the medical area as a faster way to have researchers communicate with one another and continue their studies from the research of another doctor. The search for studies in a sporadic form may not result in a complete review, so information may be lost. SRL is the most current and complete way of investigating and evaluating a group of data at the same time, about a single topic.

According to Paula, Rodrigues and Silva (2016, p. 56) "a systematic review of literature is one of the current means to identify, evaluate and interpret all research concerning a specific research question." In order to have a well-done SRL, it is necessary a properly formulated research question, definition of inclusion and exclusion criteria so that the research is considered good quality research and, hence, make it possible to other researchers use it to generate new studies in that area.

For the SRL of this study, national and international periodicals in the Teaching and Educational area were used as sources of information. Those periodicals were evaluated by the CAPES *WebQualis* system in the 2013-2016 quadrennium as A1, A2, B1, B2, B3 and their access were free of charges. Initially, the studies would be selected from the past 5 years to now (2014, 2015,2016, 2017 and 2018) as a way to use more recent studies, but only two of them fit these criteria so the review was extended to publications of the past 10 years (2008-2018) and the articles could be published in Brazilian Portuguese, European Portuguese, Spanish and English.

The purpose of this systematic review was to find studies that show resources to aid the teaching and learning process of statistical contents, more specifically the concepts involving the study of the variability in a group of data, taking into account the main measures of dispersion (range, variance, standard deviation and coefficient of variation).

The research question was: what are the methodologies which give support to the teaching and learning of variability in statistical education in Basic Education?

The following search expressions were used in the research of documents to SRL:

- Educação Estatística *AND* Variabilidade *AND* Variação
- Educação Estatística *AND* Variabilidade *OR* Variação
- *Statistics Education AND Variability AND Variation*
- *Statistics Education AND Variability OR Variation*
- *Didáctica de la estadistica AND Variabilidad AND Variación*

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- *Didáctica de la estadistica AND Variabilidad OR Variación*
- Raciocínio sobre Variação
- Pensamento sobre Variação
- *Reasoning about Variation*
- *Thinking about Variation*
- *Razonamiento sobre Variación*
- *Pensamiento sobre Variación*

Using these search expressions there were 160 article hits from 37 periodicals, selected accordingly to their CAPES Area Evaluation, the period of publication and language.

To be selected, the studies should have Statistical Education, focusing on strategies for the development of variability reasoning, as the theme.

The following exclusion criteria were applied to the search results for the SRL materials:

- First Criterion: Studies that do not fit the theme of Statistical Education, focusing on research about variability.
- Second Criterion: Studies that were not published between 2008 and 2018.
- Third Criterion: Studies that were not published in the languages: Brazilian Portuguese, European Portuguese, Spanish, and English.
- Fourth Criterion: Other studies that were not from periodicals.
- Fifth Criterion: Studies that did not approach the variability reasoning of Statistical Education in Basic Education.

According to these criteria, three studies were selected to be analyzed, as it follows:

Chart 1 – Selected articles to be analyzed according to SRL.

Author	**Reasearch Title**	**Year**	**Periodical**
Jane M. Watson	The influence of Variation and expectation on the developing awareness of distribution	2009	Statistics Education Research Journal
Adri Dierdorp, Arthur Bakker, Dani Ben-Zvi, Katie Makar	Secondary students' considerations of Variability in measurement activities based on authentic practices	2017	Statistics Education Research Journal
Richard Lehrer	Modeling signal-noise processes supports student construction of a hierarchical image of sample	2017	Statistics Education Research Journal

Source: Authors (2019).

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A brief description of each research, identifying the main elements and resources used in the activities suggested, as well as the results and conclusions of the authors will be done, shortly.

A brief description of the studies found through SRL

Watson (2009) suggested three activities that would be the foundation for the research questions: what the performance levels were related to variation recognition according to what was expected, and if there was a tendency of improving the performance during the tasks.

The activities were done by the students and, during interviews, they explained what the reasoning was used to solve these tasks. These interviews aimed to focus on a deeper consideration of the questions proposed and comprehend the extent of students' understanding of the concepts involved in the tasks.

The author asked the students to create representations for each case that appeared in the tasks. According to Watson (2009), aspects related to inference and variation in the distribution created by the students were explored.

The three activities involved different contexts to compare the results shown by the students, according to the distribution created by each of them. The first activity, called "Books" was based on the construction of pictographs using concrete materials. Each student received a card with pictures of books and people. The activity involved the representation of the number of books the people had read. The information about the names of the people in the pictures and the quantity of books each of them read was provided by the author. Inference and interpretation questions were inserted after the conclusion of the activities by the students.

The second task, called "Time" had the description of the maximum average temperature of a specific city. After being questioned regarding the maximum temperature predictions for some specific days of the year, the students had to represent, in a chart, the daily maximum temperature of this city throughout the year.

The third and last task, called "Lollies" was based on an imagination exercise in which there was a recipient with 100 mixed lollipops, being 50 red lollipops, 20 yellow and 30 green ones. The students had to imagine the possible outcomes of withdrawing 10 lollipops of this recipient, suggesting how many of them would be red. The withdrawing would initially be done six times, with the 10 lollipops withdrawn being put back in the original recipient. After that, the students were asked to create an image representing 40 results of this experiment.

To the interview following the application of these tasks, students from 3rd to 9th grade were selected based on their uncommon or interesting answers to the activities.

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In the data analyses, Watson (2009) used two criteria. The first was related to the performance shown by the students during the tasks and in which level of performance they could be classified, according to the work of Biggs and Collis (1982 apud Watson, 2009). The five levels of suggested performance are evaluated according to the activity proposed and the expectation of fulfilling the objectives, according to the students' grades. These levels, in crescent order of development, are: pre structural, uni structural, multi structural, relational and extended abstract. The other criterion is related to an adequate statistical representation of the situations given.

During the analyses of the students' answers, according to their levels of performance, the author identified, among the relevant elements, that variation was the initial element. The author said that the element of variation was presented in a complex and proper way in the tasks given before the inference elements be observed.

In the task "Books", the pictographs presented by the students showed that variation is observed according to the distribution. Considering the levels of performance, there were students who could be classified in all the levels. Some students could not complete the activity and the pictographs while others managed to finish the task with a representation closer to the expectations for this activity. The students who reached the highest levels managed to identify some variation aspects according to the distribution done by them.

To the task "Time", no other information about temperature was provided. In the activity, there were examples of graphic representations of this situation, so that the students could make comments about it. As part of the solution of the task, some students took pictures instead of making charts, some expressing variation and others without it. The students' performance was classified at different levels. Some charts showed only the maximum temperature, others indicated a variation but could not clearly express the reasoning that led to that result, and other showed charts suggesting a random frequency in the temperatures. Part of the representations showed temperatures throughout the time, being these the charts that indicated a variation tendency. There were also graphic representations using lines to demonstrate a short period of time and bars graphs to demonstrate months or seasons.

In the "Lollies" task the students were asked to graphically represent the attempts in a white sheet of paper. As some students could not make a distribution with the center close to five, a sheet of paper with some blank axes to help students reflect about their distributions was given to them. Nevertheless, the author states that some students could not complete the activity. She states that six of them improved their performances, changing their classification, by using the axes given. Just as in the other tasks, the younger students represented the situation as drawings of the people and objects involved in the activity.

Similarly, there were students that had performances in different levels of classification in the other tasks. Some students only showed single values without any variation. Others used a graphic representation in a timeline form, suggesting the idea of variation. In some of these representations, a very realistic level of variation over the average

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value was observed, followed by explanations for the distributions. The author highlights that only four students created a typical chart of frequency distributions, hence considering the variation.

According to Watson (2009), in all three activities, it was possible to observe the five levels of performance, with the expected solution for the activities being identified and represented in the highest levels.

Variation is present in the task "Books", in the given values and in the students' interest on how to represent them. For the representations of the activities "Time" and "Lollies", students had a more complex task to represent the variation because it was not given in an explicit value; only one value is given at the beginning. When the students draw their charts, it is possible to identify a variation in the context, and that is an important part of the activity. Both of these tasks led students to observe that the maximum temperature would not be the same every day and that the number of red lollipops withdrawn from the recipient would not be the same either. There will always be a variation to be observed in the prediction of the maximum temperature or the number of red lollipops of each sample.

Watson (2009) concluded that the activities, "Time" and "Lollies" especially, led the students to consider the variation in the situations. The results of this study contributed to research on the complexity of the variation concept in statistical contexts with different ages and grades at school. The investigation added to studies developing this concept free of teaching intervention or any specific direction about it during the interviews, which incentivizes the understanding of variation and inferences naturally and intuitively.

The next article is from Dierdorp, Bakker, Ben-Zvi and Makar (2017) which portraits an investigation in the Netherlands with 13 students from 17 to 18 years old., about variability reasoning. The authors proposed an activity based on the professional practice of a sports physiologist with possible problems that this professional deals in his line of work. The activities focused on cardiac frequency measurements, to involve the students with variability reasoning. For the first activity, the students measured their cardiac frequency and used a specific formula (Ruffier-Dickson test) to quantify their physical prowess according to the measurements taken. The Ruffier-Dickson test uses cardiac frequency measurements from three different moments to determine physical aptitude: before the exercise, immediately after the exercise and a longer period (about a minute) after the exercise. After taking these measurements, the students verified their prowess according to the test standards.

For the second activity, students were asked to create a regression line using their cardiac frequency measurements after a physical effort activity. The task was focused on presenting and analyzing data gathered by the students who had done the Conconi test (a cardiac frequency test on a treadmill), which measures the cardiac frequency according to the variation of the treadmill speed. This task aimed to make the students reflect upon the types of variability, speed, and cardiac frequency.

Dierdorp et al (2017) concluded that the activities of the measurement based on real professional practices stimulated the students to think about variability in all four ways

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identified in the literature about statistical thinking they had researched: noticing, recognizing and describing variability; variability of measurements, explaining variability; using investigative strategies to deal with variability.

The advantage of measuring, according to the authors, is that it is in the connection between context and statistics that the students may have an idea of the origin of the variability. The students concluded that the data they found in their measurements did not exactly fit in the Ruffier-Dickson test formula, or even in the regression line between the cardiac frequency during rest and after the exercises, so they tried to find explanations for this discrepancy. To control data variability, the students suggested taking more measurements or using the same mean for all of them, since some students had used a specific device and others measured the cardiac frequency manually. According to this analysis, taking measurements using real-life situations has stimulated the students to reflect upon variability in different and relevant ways.

The last selected article is from Lehrer (2017) and is focused on three axes of statistical thinking: sampling variability concepts, students' modeling skills and criteria of statistical data, and model-based informal inference. The 12 participants of this study were 11-year-old students who lived in the south of the United States. The researcher proposed a situation to the students in which they had to measure the perimeter of a table in the classroom.

The approach adopted in this study was to involve the students in the making of probability and variability models resulting from the repeated measurements they had taken. According to the author, the inferences of measurement as composed of signal (true measure) and error may help students understand the sampling variability as reasonable, and even unavoidable.

To take the measurements, all students used a 15 cm ruler to measure the table perimeter. The students speculated about sources of variability in their measurements and considered if other groups of students also measured the table with the same tool. The author says that the intention was to help students think about taking measurements as a process, so they would start identifying possible causes for the variability.

The students finished their sample variability exploration by creating statistics to estimate both the "real perimeter" and "the accuracy and how much our measurements tend to match". After those discussions, the students considered their measurements data focusing on their best estimative of the table perimeter, and on finding the sources for errors in their measurements. At this point, modeling was introduced as a way to explain how the observed results were generated. To build these models, students used the software Tinker Plots, with the purpose of creating a model of "perfect measurement". This tool was introduced to call students' attention to the adjustment between the simulated results and the empirical sample the students had previously built. When the students noticed the lack of adjustment between data and model, they started to list possible sources of error as random slides done when completing the measurements of the table with a 15 cm ruler.

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Lehrer (2017), states that, during the study, the students created and revised models mainly the ones that represented the variability of the process involving signal and error. They used their own models to make inferences about the changes in the process of measurement and analysis. In the end, a sample of the students who took part in the study answered an interview about their understanding of the connection between sampling variability and modeling.

Lehrer (2017) states that the students' answers to the questions about the activity revealed the way they understood sampling variability and how they thought the size of the sample could influence variability. Besides that, given that the initial measurement task was tangible, and the source of variability was evident through the results, the students were able to build an image of variability as a result of a repeated process. The author could also notice that the inferences of measurement as composed of signal (true measure) and error helped students relate the expectation and variability, paramount concepts to understand variability.

Final Considerations

These studies found during the systematic literature review phase contributed to the ideas concerning different methodologies involved in the process of developing the reasoning about variation by students from Basic Education. With the results presented by the researchers in the studies, it was possible to create a few expectations regarding the methodology implemented in Pereira (2019) and, thus, made it possible to compare some of the results in order to continue to contribute and incentivize the research around this subject in Statistical Education.

The methodology used in Watson (2009) highlights different tasks ("Books, "Time", "Lollies") that emphasize the perception of variability. In "Books" it was possible to observe the variability from pictographs built with concrete materials by the students themselves. In "Time", there is the perception of the temperature variation in a specific city, by observing the maximums and minimums. In "Lollies", there is the variation of possible samples of a population. The answers and conclusions of the students for each one of the activities, aligned with the interviews, made Watson (2009) conclude that only a few students were able to reach the highest levels of performance. Nonetheless, she also observed that students somehow were able to consider variability in the development of their tasks. This fact aroused from activities free of the teacher's intervention, allowing the observation of variability in a natural and intuitive form.

In Dierdorp et al. (2017) we could observe practical activities that involved the cardiac frequency measurement concerning the physical prowess of the individuals. The variability could be identified from the different moments in which the cardiac frequency was measured. It was also possible for students to construct a regression line linking the cardiac frequency with the different velocities in which they had to run on a treadmill. The author concluded that by bringing a learning situation that involved professional practices made the students identify the variation through the measurements, noticing not only data variability

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but also the source of this variability. Creating activities that are connected to the students' reality may also be a factor that effectively contributes to their learning process and their development of variability reasoning.

Lehrer (2017) proposed to his students the task of measuring the perimeter of a table using a ruler with 15 cm. The different measurements found by the students made it possible for them to observe the variability in these measurements, besides identifying the possible causes for this variation. Using software to help in the error analysis made the students utilize technology for the benefit of their discoveries, helping them draw conclusions about the most acceptable measurement of the table perimeter. Making it possible to use specific software to treat the data presents a different studying scenario for the student, since, with the aid of technology students will be able to notice results that had previously ignored, thus being able to contribute to the analyses with their conclusions.

Answering the question that guided this SRL, the studies have in common the methodology of the activities, which had the specific goal of stimulating the perception and the reasoning about variability on the students. The activities alone allowed, through the data collected by the students (the withdrawing of lollipops, cardiac frequency measurements, the measurement of a table perimeter), the students to observe the origin of variability among the data. It was noticeable that developing these kinds of activities in the classroom created an environment in which the students were able to develop their own thoughts on variability, by obtaining the data, manipulating and analyzing them. They were also able to notice the variation among the data and, at times, investigate the source of this variation. The planning of such tasks needs to be very thorough, to give the students a real opportunity to reach the expected goals, being especially attentive to the teaching level to be worked with and the prerequisites to develop the activities.

Watson (2009) states that some of her students could not finish the tasks and the representations, neither could they express their thoughts nor build charts. As the author worked with students from different grades, the difficulty some of them had may have happened because they had not learned some of the necessary subjects to fulfill the activity, for instance, how to make charts.

Those three studies influenced the investigation of Pereira (2019), in the making of an Educational Product that would bring the same theme. The approach of the contents, the contextualization and interdisciplinarity are elements that could be identified in the studies described previously. These studies move towards better education in terms of variability reasoning. Observing variation in real-life situations shows that the perception of variability is followed by a context that will give meaning to the knowledge construction around this subject.

All the aspects observed in those studies contributed to the conception of the characteristics that should be present in a didactical resource that aims at aiding the learning process of variation measurements and variability reasoning. The conclusions of the authors,

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according to the results achieved, served as expectations of the range of the didactical resource presented in Pereira (2019).

Given this theoretical framework, in the systematic review of literature (SRL), it was found only three studies related to the theme of this investigation (Watson, 2009; Dierdorp et al., 2017; Lehrer, 2017). This could be considered evidence of the scarcity of studies in the Statistical Education area focusing on variability reasoning in Basic Education, which reinforces, even more, the necessity of investigations on this subject.

References

Dierdorp, A., Bakker, A., Ben-zvi, D., & Makar, K. (2017). Secondary Students' Considerations of variability in measurement activities based on authentic practices. *Statistics Education Research Journal: International Association for Statistical Education*, 16(2), 397-418. Available in: http://iase-web.org/Publications.ph p?p=SERJ.

Gal, I. (2002). Adult's Statistical Literacy: meanings, components, responsibilities. *International Statistical Review*, 70(1), 1 – 25.

Lehrer, R. (2017) Modeling signal-noise processes supports student construction of a hierarchical image of sample. *Statistics Education Research Journal: International Association for Statistical Education*, 16(2), 64-85. Available in: http://iase-web.org/Pu blications.php?p=SER.

Moore, D. (1997). New pedagogy and new content: The case for statistics. *International Statistical Review*, 65(2), 123–165. Available in: https://iase-web.org/documents/ints tatreview/97.Moore.pdf

Paula, S. C. R., Rodrigues, C. K., & Silva, J. C. (2016*). Educação Matemática e Tecnologia: articulando práticas geométrica*. Curitiba: Appris.

Pereira, F. A. (2019). *A Educação Estatística e a elaboração de vídeos para a promoção do Raciocínio sobre Variabilidade na Educação Básica*. Master's Dissertation in Mathematics Education. Juiz de Fora: Federal University of Juiz de Fora.

Pfannkuch, M., & Wild, C. (2004). Towards an understanding of Statistical thinking. In: Ben-zvi, D. & Garfield, J. (org.), *The Challenge of Developing Statistical Literacy, Reasoning and Thinking* (pp. 17-46). Dordrecht: Kluwer Academic Publishers.

Reading, C., & Reid, J. (2010) Reasoning about variation: rethinking theoretical frameworks to inform practice. In C. Reading (Ed), *Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS 8)*. Ljubljana, Slovenia. Voorburg, The Netherlands: International Statistical Institute.

Reading, C., & Shaughnessy, J. M. (2004). Reasoning about Variation. In: Garfield, J. & Ben-zvi, D. (org.). *The challenge of developing statistical literacy, reasoning and thinking (*pp. 201- 226). Dordrecht: Kluwer Academic Publishers.

Silva, C. B. (2007) *O Pensamento Estatístico e Raciocínio sobre variação: um estudo com professores de Matemática*. Doctoral Thesis in Mathematics Education. São Paulo: Pontifical Catholic University of São Paulo.

DOI: 10.20396/zet.v28i0.8656884

Watson, J. M. (2009). The influence of variation and expectation on the developing awareness of distributions. *Statistics Education Research Journal: International Association for Statistical Education*, 8(1), 32-61. Available in: https://iase-web.org/docum ents/SERJ/SERJ8(1)_Watson.pdf.

Watson, J. M., & Callingham, A. R. (2003). Statistical literacy: a complex hierarchical construct. *Statistical Education Research Journal*, 2(2), 3-46. Available in: iase-web.org/documents/SERJ/SERJ2(2)_Watson_Callingham.pdf.