

Teaching knowledge and Statistical Education: a study on statistical competences and curriculum guidelines from the perspective of a collaborative group of teachers

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Abstract: In this paper, teachers' knowledge regarding statistical competences and curriculum documents, mobilized in the Collaborative Group for the Training of Teachers in Statistical Education (MoSaiCo Edu) is highlighted. Considering the Discourse of the collective subject technique, the audio transcription of seven group meetings was analyzed. As a result, one can describe signs of mobilization of professional teaching knowledge related to the insertion of statistics in documents and textbooks. This was noticeable with regard to learning and skills developed by students, with regard to statistical competences, such as educational goals and with regard to the specificities and importance of context and the conceptual and procedural domain of Statistics. In this way, spaces for collaborative work among teachers provide opportunities for sharing and building teaching practices and understanding, favoring the proposition of categories and the legitimization of a specific basis for professional practice and teaching of Statistics.

Keywords: Statistics Education. Teaching Knowledge. Collaborative Teacher Training. Statistical competences. Curricular Guidelines.

Saber didáctico y Educación Estadística: un estudio sobre competencias estadísticas y lineamientos curriculares desde la perspectiva de un grupo colaborativo de docentes


Resumen: En este artículo, se destaca el conocimiento de los profesores, referente a las competencias estadísticas y los documentos curriculares movilizados en el Grupo Colaborativo para la Formación de Profesores en Educación Estadística (MoSaiCo Edu). Hay una mirada técnica a un Discurso del Discurso del Sujeto, el audio de siete encuentros. Como resultado, los documentos relacionados con la comunicación del conocimiento profesional relacionado con la comunicación de la Estadística pueden ser descritos en los libros de texto. Esto se notó en el proceso de aprendizaje y en las especificidades definidas por los estudiantes, en cuanto a estadística y competencias relacionadas con la importancia del contexto y el dominio conceptual del proceso estadístico. De esta manera, espacios de trabajo colaborativo entre el compartir y la construcción de prácticas y entendimientos docentes, favoreciendo la proposición de categorías y la legitimación de los docentes de sus propias bases para la práctica profesional y la enseñanza de la Estadística.

Palabras clave: Educación Estadística. Enseñanza del Conocimiento. Formación Docente Colaborativa. Habilidades Estadísticas. Directrices Curriculares.

Conhecimentos docentes e Educação Estatística: um estudo sobre

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as competências estatísticas e as orientações curriculares na perspectiva de um grupo colaborativo de professores

Resumo: Neste artigo, são evidenciados os conhecimentos docentes referentes às competências estatísticas e aos documentos curriculares, mobilizados no Grupo Colaborativo de Formação de Professores em Educação Estatística (MoSaiCo Edu). Haja vista a técnica do Discurso do Sujeito Coletivo, a transcrição do áudio de sete encontros do grupo foi analisada. Como resultados, pode-se descrever indícios da mobilização de conhecimentos profissionais docentes relacionados à inserção da Estatística nos documentos e livros didáticos. Isso ficou perceptível no que se refere à aprendizagem e às habilidades desenvolvidas pelos discentes, no que tange às competências estatísticas, como metas educacionais e no referente às especificidades e à importância do contexto e do domínio conceitual e processual da Estatística. Desse modo, espaços de trabalho colaborativo entre professores oportunizam a partilha e a construção de práticas e compreensões docentes, favorecendo a proposição de categorias e a legitimação de uma base própria ao exercício profissional e ao ensino de Estatística.

Palavras-chave: Educação Estatística. Conhecimentos Docentes. Formação Colaborativa de Professores. Competências Estatísticas. Orientações Curriculares.

1 Initial considerations

This paper aims to systematize teaching knowledge from the perspective of Statistical Education. In the central axis, there are the teachers' understanding of statistical competences³ and curricular documents, topics discussed among the participants of the Collaborative Group for the Training of Teachers in Statistical Education (MoSaiCo Edu).

It is important to highlight that collaborative practices have already shown to be promising dynamics for teachers training process, because, in collective spaces, such as groups, participants share experiences, resignify their knowledge, what they know, and difficulties related to teaching (FIORENTINI, 2004). The dialogue among educators who socialize and reflect on their professional experiences provides, besides the creation and consolidation of professional knowledge, the isolation breakage and the discussion of issues associated with identity and power (COELHO, 2010).

In view of this scenario, the MoSaiCo Edu Group was chosen to carry out the present study, where teachers share and learn from their experiences in the field of Statistics, encouraged by theoretical-scientific texts and by the discursive relationships with their partners. In this way, this dynamic of collaborative work can contribute to the

³ The expression "statistical competences" is used in reference to the pedagogical meaning of Statistical Literacy, Thinking and Reasoning, as described by Campos, Wodewotzki and Jacobini (2011).

identification and systematization of the specificities of teaching knowledge, as the school constitutes a favorable space for a dialogue and collective learning.

The particularities of teaching knowledge are key points to the discussion proposed in this text. Although statistical content, in general, is integrated into mathematics curriculum, Statistics encompasses specific practices, objects and processes, which require professional understandings that is inherent to this area (GROTH, 2007; GODINO et al., 2011). In fact, according to Watson, Callingham and Donne (2008), throughout the 1990s, there was a growing interest in studies about teachers' understanding of statistical concepts and processes, teaching and professional development. Such studies were encouraged by research developed by Shulman (1986; 2014), especially Pedagogical Content Knowledge (PCK). However, despite advances in the international scientific scenario, research on Statistics is recent and imprecise when compared to Mathematics Education (BURGESS, 2008).

Furthermore, as some studies point out (PIETROPAOLO, SILVA and AMORIM, 2019), teachers have weaknesses in the knowledge necessary for teaching statistical concepts and procedures. This is noticeable when identifying errors in graphs and understanding measures of central tendency. In this sense, to differentiate the understandings that make up the fundamental basis for pedagogical activity, taking into account the characteristics of Statistics, as has been sought in this and other research in Brazilian national and international scenario (GROTH, 2007; BURGESS, 2008; WATSON, CALLINGHAM and DONNE, 2008; GODINO et al., 2011; PIETROPAOLO, SILVA and AMORIM, 2019), it can contribute to discussions regarding the training of teachers who teach Statistics.

Among this knowledge, there are those linked to curricular documents and their corresponding materials, which Shulman (1986) has called pedagogical material" or "pharmacopoeia" for students' knowledge difficulties. These guidelines, namely those of the National Common Curricular Base (BNCC) (BRASIL, 2018), were issues addressed in the group and reflected in the analyzes presented. That document, in the conception of Giordano, Araújo and Coutinho (2019), details the steps related to the scientific production process, in addition to comprising a transdisciplinary approach to Statistics and Probability, with other curricular subjects and with other fields of Mathematics itself.

At BNCC (BRASIL, 2018), from Early Childhood Education, notions of Statistics,

Combinatorics and Probability are indicated for children's learning and development. According to Jahnke, Moraes and Pereira (2021), in the fields of experience, stochastic learning objectives stand out, which prioritize the expression of the students' thoughts (through oral or written language). Likewise, the survey of hypotheses is highlighted, considering the graphic observation and/or reading; participation in investigative processes in relation to solving a problem; the classification of elements into groups (combinatory reasoning); the construction of graphs to systematize known information (such as weight, height, etc.), in addition to recording observations, manipulations and measurements through initial Statistical, Combinatorial and Probabilistic Reasoning competences. As for Elementary School, the BNCC guides the learning of concepts, facts and procedures that involve problem-situations of everyday experiences, science and technology. It also points to the development of skills related to the collection, organization, representation, interpretation and analysis of data, in different contexts, so that students can judge and make decisions critically. In High School, when Elementary School learning is expanded, this document emphasizes the understanding of statistics published in the media and the planning and development of sample research, when students interpret measures of central tendency and present the results in reports (BRASIL, 2018).

It is noteworthy that these guidelines do not guarantee the direct inclusion of Statistics in the classroom, which, in turn, requires the adequate training of educators for this area (BATANERO, BURRILL and READING, 2011; BATANERO, 2019). It should be noted, moreover, that teachers are responsible for adapting curriculum documents to student learning, with teachers' knowledge being projected in this process (SACRISTÁN, 2000). Therefore, the importance of systematizing the basic knowledge in the field of Statistics, these elements being considered in training and professional experience, also under the bias of the curriculum and its associated materials, such as textbooks.

In addition to curricular guidelines, this paper addresses teaching knowledge from the perspective of statistical competences, which were problematized in the meetings of the MoSaiCo Edu Group. By their nature and definition, it cannot be assumed that these are achieved by students if they are not explicitly considered as teaching objectives by the teacher (DELMAS, 2002). In this way, knowing which competences are involved and how they can be developed in pedagogical practice

become central aspects for teachers in the field of Statistical Education, as briefly described below.

In the context of Statistical Literacy, Gal (2019) emphasizes the importance of such competence in training subjects, so that they have the skills and willingness to effectively engage and understand statistical data and information that are part of everyday life and the exercise of citizenship. For this, it is necessary that Statistical Education and the professor emphasize the “formation of citizenship and the student’s political and social conscience”, recognizing the “individual competences necessary for an effective participation in a democratic society” (CAMPOS, WODEWOTZKI and JACOBINI, 2011, p. 49).

Teaching work, likewise, requires practices that favor Statistical Reasoning. This competence, according to Garfield and Gal (1999), represents the way in which the subject reasons with statistical ideas, attributing meaning to this information, given certain sets of data, graphical representations and summaries of statistical data. It can be determined, more precisely, through hierarchical levels of reasoning, which makes it possible to direct teaching based on the students’ understanding and possible mistakes (GARFIELD, 2002).

Finally, Statistical Thinking encompasses the subject’s ability to see the statistical process globally, considering the understanding of the meaning of variability and the statistical process (CHANCE, 2002). This competence, according to Campos, Wodewotzki and Jacobini (2011, p. 43), requires proposing activities that make students demonstrate the ability to think beyond the data of the proposed problem, analyzing the situation in its entirety, so that they can “reflect on the variables involved, to always present a high degree of skepticism in relation to the results obtained, to relate the data to the context of the problem and to interpret the conclusions also in non-statistical terms”.

It is important to note that these descriptions, within the scope of statistical competences, as well as curricular guidelines, were not presented with the intention of completely exhausting the subject, but rather with the purpose of exposing a brief explanation about these themes, considering that they supported the meetings of the MoSaiCo Edu Group, as well as the analyzes carried out. In the light of these considerations, the studies developed by Shulman (1986; 2014) and collaborators supported the construction of a possible knowledge base for the teaching of Statistics.

Continuing this paper, the characterization of the methodology and the Group, results analysis presentation are presented that are followed by discussions and considerations, based on the central results.

2 Teaching knowledge in perspective

The research carried out by Shulman (1986; 2014) and collaborators at Stanford University, from the 1980s onwards, exposed advances in the field of teacher training, when they showed “the existence of a complex network of knowledge and competences that were unique to the act of teaching”, beyond “the domain of content, personal style or good teaching communication” (BORN, PRADO and FELIPPE, 2019, p. 3). From this point of view and in a synthetic way, Shulman (2014) proposed seven categories of professional understandings, presented in Table 1.

Table 1: Knowledge Base Categories for teaching, according to Shulman (2014)

Categories	Description of teaching knowledge
Content Knowledge	Content knowledge, which encompasses the fundamental facts, concepts, and principles of the subject area in which the teacher is an expert.
General Pedagogical Knowledge	Knowledge of the more general principles and strategies of classroom management and organization, which go beyond the subject being taught.
Curriculum Knowledge	Knowledge of materials and programs related to teaching specific topics at a given level of study, which represent the teaching “tools of the trade”.
Pedagogical Content Knowledge	Knowledge that spans content and pedagogy, in understanding how specific topics, problems, or issues are organized, represented, and adapted to students’ diverse interests and aptitudes. Still, it is analyzed how they are presented in the classroom.
Knowledge of learners and their characteristics	Knowledge of students’ learning processes, particularities and context in which they are inserted.
Knowledge of Educational Contexts	Knowledge that ranges from the group or the classroom, transiting through the management and financing of educational systems, to the characteristics of communities and their cultures.
Knowledge of the Educational ends, Purposes, and Values, and their Philosophical and Historical grounds	Knowledge of the training objectives established by current laws, as well as understanding the history, legislation, values and educational guidelines, in addition to their philosophical and historical bases.

Source: Adapted from Shulman (2014)

In this way, Shulman’s model (Table 1) describes, in general, the knowledge that is necessary for teaching, without, however, focusing on a specific field. Incidentally, during the 1990s, his studies influenced research on professional development in the field of Statistics, especially in valuing knowledge and teacher

training associated with successful teaching (WATSON, CALLINGHAM and DONNE, 2008). Among these, we can highlight the investigations of Groth (2007), Burgess (2008), Watson, Callingham and Donne (2008) and Godino et al. (2011), which are presented below.

Groth (2007) sought to outline a structure of statistical knowledge for teaching, bearing in mind the specificities of this area. For this, he considered the statistical investigation components indicated in the Guidelines for Assessment and Instruction in Statistics Education (GAISE), namely: formulating questions, collecting data, analyzing data and interpreting results. For each of these items, the researcher described the common and specialized knowledge to teach Statistics, these being mathematicians and non-mathematicians. Finally, it indicated the relevance of understanding the similarities and differences between statistical and mathematical knowledge for teaching, since this information was necessary to bring Statistics present in the school context and teacher training closer together.

Burgess (2008) analyzed the teacher's knowledge to teach Statistics. To this end, he considered the development of investigative processes. Based on the theoretical categories of Statistical Thinking and the knowledge for teaching Mathematics proposed by Ball, Thames and Phelps (2005), the researcher proposed a model of statistical pedagogical knowledge in which he described the reflections of teachers' understanding (or the lack of these understandings) in students' learning. Still, he pointed out the relevance of training that integrates fundamental knowledge into teaching.

Watson, Callingham and Donne (2008) focused on the characterization of the PCK for the teaching of Statistics, considering a group of teachers who are part of a professional learning program. As a result, the authors explained the relevance of carrying out teacher training focused on "developing targeted intervention with respect to students' levels of understanding" (WATSON, CALLINGHAM and DONNE, 2008, p. 6).

On the other hand, Godino et al. (2011) showed dimensions and levels to explain the knowledge needed to teach Mathematics and Statistics. As a result of this model, they indicated the fundamental competences for the Statistics teacher, whether they are: the recognition of statistical objects and processes that influence students' understanding; care regarding the norms that support and condition learning; in

addition to understandings about affection, resources and interactions in the educational context. Finally, the authors described the importance of dimensions and levels in the training and assessment of professional knowledge of Statistics teachers.

The research and references presented in this text illustrate how research on teaching knowledge has been constituted, from broader areas, described by Shulman, as well as in Statistics. Although they present contributions to research and teacher training, these studies do not describe in detail the categories or subcategories that are integrated into the Knowledge Base for teaching Statistics. Likewise, in some cases, they are restricted to investigating the PCK, not characterizing other understandings that permeate the pedagogical process. From this perspective, through this research, we seek to expand these discussions by outlining teaching knowledge in the field of Statistics, treating MoSaiCo Edu meetings as a corpus of analysis.

3 Methodological procedures

This section is presented from two moments. In the first, aspects related to the formation and development of the activities of the MoSaiCo Edu Group are presented. Next, the assumptions and theoretical-methodological procedures of the research are explained, considered for the production and analysis process of the narrative records of the teachers participating in the Group.

3.1 Characterization of the MoSaiCo Edu group

The Group was created based on the characteristic principles of collaboration — voluntariness, identity and spontaneity; in shared leadership or co-responsibility; and mutual support and respect (FIORENTINI, 2004). Researchers from the InterNational Interdisciplinary Research Group on Statistical Education (GIPEE) conceived this training space for the socialization of teaching practices and knowledge related to Statistics. In addition, they were motivated by doctoral research on this topic.

. It is in this context that, in the first half of 2018, 18 teachers from public and private institutions of Basic Education and the Federal University of Rio Grande (FURG) participated in the Group. These were invited to participate in the meetings of the MoSaiCo Edu Group, which were held monthly at the Laboratory of Cognitive Studies and Technologies in Statistical Education (LabEst). Each meeting lasted an average of two hours. Of these professors, 13 had a degree in Mathematics, two were

from the Oceanology course (these taught Statistics subjects at the university), and three were pedagogues (of these, two were also psychologists, one being a pedagogue in initial training).

In its first year of activities, MoSaiCo Edu members shared their understandings, supported by theoretical-scientific texts about statistical competences (CAMPOS, WODEWOTZKI and JACOBINE, 2011); narrative texts from other groups, pedagogical strategies and curricular guidelines, such as the BNCC (BRASIL, 2018). These themes⁴, chosen collectively, were based on the Group's interests and the purpose of contributing to training and practice. In the context of this paper, they support the analyzes and results presented.

3.2 Assumptions and theoretical-methodological procedures

The exploratory study, as a part of the analyzes of a doctoral thesis, is characterized as qualitative and descriptive (LÜDKE and ANDRÉ, 1986), which follows the procedures of a Case Study (YIN, 2010). Based on this methodological perspective, it is not intended to generalize the results presented in extension, but to subsidize the discussion and synthesis of a set of knowledge related to the teaching of Statistics. The referred knowledge was mobilized by teachers who participate in a context with a collaborative bias.

Thus, supported by the research on the Knowledge Base (SHULMAN, 1986; 2014), an attempt was made to answer the following question: what knowledge is mobilized when teachers share their experiences related to statistical competences and curriculum documents, in a context of collaborative work? According to the guiding assumptions of this investigation, the first seven meetings of the Group were considered. These took place between August 2018 and June 2019, were audio-recorded, transcribed and subsequently analyzed using the Discourse of the Collective Subject (DCS) technique, developed by Lefèvre and Lefèvre, in the late 1990s. considered the theory of Social Representation (LEFÈVRE and LEFÈVRE, 2005). According to the authors, this strategy of tabulating and organizing qualitative data makes it possible to gather parts of similar speeches, in a summary speech, written in the first person singular, based on systematic and standardized procedures.

With this intent, as proposed by Lefèvre and Lefèvre (2005), four methodological

⁴ The Group's website (<https://mosaico.furg.br>) presents, in detail, the topics discussed at the meetings.

figures were considered, namely: Key Expressions (KE) — literal, continuous or discontinuous excerpts from the transcripts of the Group's meetings, which represent the discursive content; Central Ideas (CI) — name or linguistic expression that expresses, in a synthetic way, the meaning of each discourse and each set of ECH; Anchors (AC) — explicit linguistic manifestation of a theory or ideology; and the DCS — discourse-synthesis, in which the ECH whose CI or AC have the same meaning, equivalent meaning or complementary meaning are approximated.

Considering this technique, six CIs were identified: Statistics and Probability in Textbooks; Statistics on Early Childhood Education and Early Years of Elementary School; Organization/Planning of contents; BNCC skills and competences; Statistics/Probability competences; Stages of cognitive development. As for the CA, in line with studies by Shulman (2014), five were considered: Content knowledge; Knowledge of educational purposes and goals; Knowledge of Educational Contexts; Curriculum Knowledge; Knowledge of learners and their characteristics.

In this process, the first three operations led to the formation of the synthesis discourse. For this, editing techniques were used that did not affect the individual meaning of each statement, in addition to the introduction of connecting connectors between the ECH (signaled by the underline tool). Such connectives contributed to the cohesion of the text, without harming the reading in the semantic field (LEFÈVRE and LEFÈVRE, 2005). Therefore, in the sequence, the speech-synthesis is then analyzed.

4 Descriptions and analysis of results

In the speech shown in Table 2, the teacher⁵ described how he understood statistical competences in the planning and development of activities in the classroom, with a view to student training. Likewise, in this speech, the teacher related the students' cognitive development with the use of concrete (or manipulable/pedagogical) material. He highlighted aspects related to Statistics in the BNCC and in textbooks, in addition to sharing how he organized the contents in his practice. Thus, these aspects permeate the description and analysis of the results presented in this section.

Table 2. Statistical competences in relation to documents and curricular teaching instruments

<i>We want to educate the student, <u>that is</u>, to promote the Literacy of any citizen, to place this subject in the world, so that he can understand a context, live in a world that is full of information. Literacy I think is easier, because for better or worse you are inserting terms for them, <u>so</u> somehow it won't scare</i>

⁵ The expression "teacher" is used to represent the collective of educators of the MoSaiCo Edu Group, considering that the speech is written in the first person singular, as instructed by Lefèvre and Lefèvre (2005).

them so much when they see it next time. However, there's no way you can force the guy to have a Reasoning, because he needs to feel this need. And then, the students are at the level, stage of development, operational-concrete, so we need to work on concrete issues, because otherwise they won't move from that stage to another, I mean from one level of statistical reasoning to another. Furthermore, we need Statistical Thinking to interpret that issue of variability, of randomness. So, as a teacher, we need to base our practice on this: how do I get a guy who is at the lowest level, what activity can I propose that he goes up in level, that he has clarity, that he has to develop that thought and how does it go up in level? By the way, the BNCC gives us a cue for us to act politically and Statistics is more present at school, since we gained a fifth of Mathematics in basic school, as well as this issue of Statistics since the early years. In addition, he talks a lot, in the document [BNCC], about this issue of progression, that is, that the degree of difficulty increases. I mean, from the first to the fifth year [of Elementary School], the competences, within the BNCC, they kind of repeat themselves, they just progress and become more complex over the course of the series, the years there. Thus, Early Childhood Education requires fields of experience; in the early years, he talks about notions. You have to work, for example, with the first year, the notion of chance; in the second it is the idea of chance. I'm even curious about Statistics in Kindergarten, because when they come to us, it seems like something is always missing. In addition, I don't know about it at all and I wonder how they see Statistics at the base, as I haven't been able to see it there yet. By the way, I applied with the graduations, without them knowing, activities from the first to the fifth and the third [year of Elementary School] and they already locked it. There is a specific skill that she talks about to build the single-entry or double-entry table and then the single-entry or double-entry graph. However, the double entry chart in the third year of fundamental I think is too advanced, because, in the end, the undergraduate student has difficulty. The BNCC is heavily charged where I work. There was even training and discussion, but the training was only on paper, it seems that it was just to sign the minutes, because it's been difficult and nobody is working the BNCC. And then, I realized that the professors haven't been working, that is, they don't usually work on Statistics, just like the books bring Statistics as Information Processing, at the end of each chapter, a little bit. They never update, they don't improve, they just take things away. The feeling I have that the person who produced the didactic material never entered the classroom. With that, I was more willing to create a good bank of questions, because we have them in Statistics books, but we don't have a well-elaborated, contextualized question that is not a semi-reality and that portrays the reality of the classes well. Finally, the teacher feels obliged to overcome the menu, but sometimes there is no way to overcome that from there. Also, it's no use wanting to teach everything, they won't learn anything and we don't teach anything well. Soon, you have to let go of some things, which are less relevant. I theoretically should start with trigonometry, but I think it's much more important for me to give statistics than trigonometry. In addition, we have class councils, we have some stoppages, he [public agency] does not pay the salary, where I fight and I go there and teach, but then I have to take all the classes at the same time in the auditorium, and then ruined all your planning.

Source: Authors' Collection (2020)

The presence of Curriculum Knowledge (SHULMAN, 1986; 2014) can be identified in the aforementioned speech, since such understanding was supported by the narratives referring to the guiding documents of teaching, planning and curriculum materials, such as textbooks. Regarding the BNCC (BRASIL, 2018), the teacher shared the influences of this document in the school context. He also detailed how he understood the organization of Statistics in Basic Education.

The BNCC guides the work with Probability and Statistics from the first years of schooling (BRASIL, 2018), which should encourage the expansion and implementation of practices in this area, as pointed out in the DCS, since – “gives us a cue for us to act politically and Statistics is more present at school”, despite “nobody is working the

BNCC” (DCS clippings)⁶. In these excerpts, it can be seen that the inclusion of statistical content in the curriculum documents, even with courses aimed at this purpose, did not consider the emphasis on Statistics in the school context. This situation is similar to those cited in other studies, which discuss the relationship between curriculum and school practice, describing a gap between the prescribed curriculum and the one put into action in schools (SACRISTÁN, 2000), also in the context of teaching Statistics and Probability (GAL, 2021).

Despite the problems related to the distance between the normative documents and the classroom, the teacher demonstrated to recognize the curricular organization of Statistics in the BNCC. This became noticeable when it was possible to identify evidence of mobilization of curricular knowledge (SHULMAN, 1986), which can be vertical⁷ or horizontal⁸ — “*he talks a lot, in the document [BNCC], about this issue of progression, that is, that the degree of difficulty increases*” (DCS clipping). This mastery of content, in a broader context of teaching, allows the educator to understand the knowledge that is a prerequisite for learning and at what level of difficulty concepts and statistical ideas can be addressed. In this way, among the teaching understandings, the recognition of the structure and organization of statistical concepts and procedures in teaching guiding documents stands out.

In addition to expressing how he perceives the structuring of the BNCC, the knowledge about students and their characteristics (SHULMAN, 2014), they were mobilized and can be marked, according to the speech excerpt — “*double entry chart in the third year of fundamental I think is too advanced, because, in the end, the undergraduate student has difficulty*” (DCS clipping). In this case, there is a comparison between curriculum guidelines and the educational reality – which requires understanding from the educator in relation to the curriculum, content and student learning (SHULMAN, 2014). This situation led the teacher to question himself about the suitability of the contents indicated for a certain teaching stage, given his own pedagogical experiences.

Still on the difficulties of the students, referring to Statistics, the teacher shared

⁶ To show that this excerpt refers to the narrative of the teachers participating in the MoSaiCo Edu Group, according to what was explained in the summary speech, it was decided to use the italic tool.

⁷ Vertical curriculum: ability of the teacher to relate a content or an activity to topics or issues to be discussed simultaneously in other disciplines or curricular areas.

⁸ Horizontal curriculum: educator’s familiarity with regard to the sequence of learning (and related materials) which have been and will be addressed in a subject or curriculum area

his lack of knowledge about the way this content was approached in Early Childhood Education — *“I’m even curious about Statistics in Kindergarten, because when they come to us, it seems like something is always missing. In addition, I don’t know about it at all and I wonder how they see Statistics at the base, as I haven’t been able to see it there yet”* (DCS clipping). Soon, it became clear that, although the teacher recognizes the importance of Statistics in the initial period of schooling, he may have weaknesses in terms of his training in a broad and vertical perspective of the curriculum, especially in relation to the process of building this knowledge in the early years of schooling. basic school.

In addition to the BNCC, the teacher described his experiences with the organization of Statistics in the textbook, which is knowledge that involves curriculum and content (SHULMAN, 1986; 2014) — *“the books bring Statistics as Information Processing, at the end of each chapter, a little bit. They never update, they don’t improve, they just take things away”* (DCS clipping). There is, in this scenario, the recognition of the educator regarding the provision of Statistics in textbooks. This is observed when he made comments about a certain distance, outdatedness and fragmentation of these materials. Issues such as these are highlighted by Sacristán (2000), who adds the technical disqualification of teaching activities when teachers limit their practice to structuring means, such as textbooks, which represent the curriculum presented.

In addition to curricular knowledge, the choice, evaluation and adaptation of pedagogical materials, such as textbooks, demand understanding of the content. This needs to happen, in particular, so that the teacher can verify the suitability of these resources to the classroom, considering the educational purposes and goals (SHULMAN, 2014). Still on the curricular materials that support and guide the practice, the professor highlighted the relevance he attributed to activities contextualized in the field of Statistics — *“I was more willing to create a good bank of questions, because we have them in Statistics books, but we don’t have a well-elaborated, contextualized question that is not a semi-reality and that portrays the reality of the classes well”* (DCS clipping).

From this perspective, not only the content and strategies need to be understood by the teacher, but the specificities of the context, of the students, of the schools and of the community that are part of the planning, development and

management of pedagogical activities (GROSSMAN, 1990; SHULMAN, 2014). It must be recognized, therefore, that these are elements that make up the educational action, also necessary for the construction of learning in the field of Statistics (GAL, 2019), based on the proposition of situations familiar to students, meeting their interests, desires, doubts and curiosities. Therefore, the teacher needs to recognize the centrality of the “context” in the field of Statistics, which is a specificity of teaching in this area. It also needs to consider the interference of contextual aspects (from the school, the educational community, among others), since these permeate and condition the practice and pedagogical decisions.

Another important aspect to be observed is related to the obligation to “beat” the curriculum syllabus — *“the teacher feels obliged to overcome the menu, but sometimes there is no way to overcome that from there”* (DCS clipping). It is known that there are class councils, strikes, among other issues, involving educational institutions, as mentioned in the speech. Although these factors are capable of influencing pedagogical activities, the teacher cannot be seen as a mere applicator of the curriculum, as the way in which he interprets them reflects on the learning process. This even occurs when it prioritizes some contents over others, providing more time and strategies for certain subjects of the discipline compared to the rest of the curriculum (SACRISTÁN, 2000). This fact was presented in one of the speeches when the educator shares the relationship he establishes in teaching — *“I theoretically should start with trigonometry, but I think it’s much more important for me to give statistics than trigonometry”* (DCS clipping).

In this case, the professor favored statistical content, which may explain, for example, the choice of the MoSaiCo Edu Group — with an emphasis on Statistical Education — since it provides evidence of his interests in the educational scenario. This distinction is also related to teaching objectives, which is reflected in the selection of content and teaching strategies and materials (SHULMAN, 2014). Likewise, this decision is based on the teacher’s personal conceptions, “about their own teaching activities, through which they establish priorities on what and why to teach, and are reflected in their methodological choices and decisions in pedagogical practices” (MARCON, GRAÇA and NASCIMENTO, 2011, p. 332).

Knowledge of educational purposes and goals (SHULMAN, 2014) can also be related to statistical competences associated with the formation of critical citizenship

(CAMPOS, WODEWOTZKI and JACOBINI, 2011). This is characteristic of teaching in this area and describes the objectives surrounding the teaching of Statistics beyond calculations and formulas. When it comes to Statistical Literacy (GAL, 2019), the DCS showed how much this competence was necessary for the student to be able to — *“understand a context, live in a world that is full of information”* (DCS clipping), being this is a goal to be achieved, in the words of the teacher — *“we want to educate the student”* (DCS clipping).

With regard to Statistical Reasoning, the teacher highlighted how much such competence requires the student’s involvement — *“you can’t force the little guy to have Reasoning, because he needs to feel this need”* (DCS clipping). At another time, even without mentioning specific references, an excerpt from the speech can be approximated to the stages of cognitive development (PIAGET, 1976) and to the levels of Statistical Reasoning (GARFIELD, 2002). This fact evidenced understandings about the learning processes — *“students are at the level, stage of development, operational-concrete, so we need to work on concrete issues, because otherwise they won’t move from that stage to another, I mean from one level of statistical reasoning to another”* (DCS clipping).

In addition to Literacy and Reasoning, in his speech, the teacher describes the value he attributes to Statistical Thinking (CHANCE, 2002) — *“we need Statistical Thinking to interpret that issue of variability, of randomness”* (DCS clipping). This is also observed when he reflects on his pedagogical practices — *“how do I get a guy who is at the lowest level, what activity can I propose that he goes up in level, that he has clarity, that he has to develop that thought and how does it go up in level?”* (DCS clipping). In this situation, the teacher explained the relevance of Statistical Thinking for understanding variability and randomness. Furthermore, he expressed an interest in guiding teaching from this perspective.

It is in this context of statistical competences that the specificities of teaching knowledge in this area are understood. Thus, the teacher needs to understand what they represent and how statistical competences can be developed in pedagogical practices, with such professional understandings inserted in the field of Statistics. In addition, it needs to recognize Literacy, Reasoning and Statistical Thinking as educational objectives to be achieved from activities developed aiming at such a purpose.

As a whole, the knowledge identified through this research can be systematized according to Figure 1. This gives evidences of understandings of the teachers of the MoSaiCo Edu Group, shared while they socialized their pedagogical practices and experiences related to the teaching of Statistics.

Figure 1: Summary of teaching knowledge related to curricular guidelines and the development of statistical competences

Teaching knowledge within the scope of statistical content				Teaching knowledge in general
Statistics content specifics	Statistics specific curriculum	Purposes for Teaching Statistics	Students and the teaching of Statistics	general educational context
content specifics Have conceptual and procedural mastery in the field of statistics, considering the choice, evaluation and adaptation of materials and pedagogical strategies, as well as the interpretation of students' understandings	curriculum guidelines Recognize the structure and organization of statistical concepts and procedures in teaching guidance documents	Recognize statistical competences as educational goals to be achieved, developing practices for that purpose	Recognize students' understandings and possible mistakes in relation to statistical concepts and processes, in view of curricular guidelines and the reality of each educational context	Consider the contextual specificities that permeate and condition the practice and pedagogical decisions
Statistical Education Understand what they represent and how statistical competences can be developed in teaching practices	curriculum materials associated with teaching Know a wide variety of resources and teaching materials (such as textbooks), adapting them to the reality of the educational context, intending to develop statistical competences			
Understand the centrality of "context" in the scope of Statistical Education				

Source: Authors' collection (2021)

In summary, the teachers presented, supported by understanding of the Statistics content and issues associated with it, curricular knowledge, within the framework of normative documents (such as the BNCC), textbooks and the purposes that justify the teaching and learning of Statistics (statistical competences). These professionals also recognized the difficulties of students in Statistics, even when considering competences already expected in their training, as in the case of undergraduates, in relation to the BNCC, in addition to stages of cognitive development approximated, in speech, to statistical competences.

The educational context, on the other hand, was considered not only as a conditioner of practice and pedagogical decisions, but also as being a part of the construction of significant learning in the field of Statistics, in view of the role of context in this area. Thus, the discussions emphasized in the meetings of the MoSaiCo Edu group highlighted the need for understanding about the particularities and characteristics of the context. This was considered to allow the teacher to adapt the other members of the professional base in the teaching and learning process, paying attention to the conditions and content to be addressed.

5 Discussion of results

In the course of the analyzes presented in this paper, we sought to highlight the understandings present in the teachers' narratives under the collaborative bias, given the studies already developed about teachers' knowledge (SHULMAN, 1986; 2014) and the specificities of Statistics. In the shared narratives, the BNCC (BRASIL, 2018) proved to be a way to ratify the presence of Statistics in the school context, even if, sometimes, the practice did not meet these guidelines. As Pereira and Dias (2021) explain, there is an initial movement to implement the BNCC in schools, but such documents are still far from the teacher, who does not see significant changes in the educational process.

In this sense, the importance of the teacher can be highlighted, since their knowledge and the way they apply these understandings in the classroom can help in the reflection on the pedagogical process in Statistics. Therefore, although curricular documents are part of the teaching repertoire and are necessary for practice, it is not possible to determine how these curricular guidelines are considered in the classroom. This is stated because the proposition of activities that develop students' statistical and probabilistic thinking requires specific professional teaching training (VILAS BÔAS and CONTI, 2018).

As noted in the analyses, when one thinks of the curriculum as a social process, as suggested by Sacristán (2000, p. 21), one understands the differences between intention and reality, since the "curriculum is modeled within a concrete school system, is addressed to certain teachers and students, makes use of certain means, finally crystallizes in a context, which is what ends up giving it real meaning". The changes proposed in these documents, in the contents or in the teaching, do not occur directly and mechanically, as different elements interfere for them to occur. Therefore, in addition to mastering the statistical content, teachers need to "develop competence to recognize the statistical objects and processes that intervene in the students' statistical practices, be aware of the norms that support and condition learning, affect, resources and interactions in the classroom" (GODINO et al., 2011, p. 12).

In the discourse of the group's participants, the provision of statistical content in the BNCC (BRASIL, 2018) was also highlighted, with emphasis on a possible sequencing and progressiveness of learning in basic education, which is a curricular knowledge (SHULMAN, 1986). From this perspective, it is important to indicate the

need for teachers to understand Statistics in integrated and broader teaching units, so that teachers can “understand, gradually and at increasingly higher levels, the necessary prerequisites for learning, the most important concepts or ideas and even predict [...] the most common doubts of students” (LOPES and PONTUSCHKA, 2015, p. 82).

In addition to knowing the curriculum, it is also necessary to understand the educational process and possible difficulties faced by students, which may be associated with a gap between what is foreseen in the documents and the school reality. In the conception of Gal (2021), this distance between what is foreseen in the curriculum and the classroom, in the scope of Statistics and Probability, can also be explained by the gaps in the pedagogical training of teachers in this area, by the lack of time to working with all the contents foreseen or, still, due to the little personal exposure of the educators with regard to information and statistical research. In this way, mathematical and statistical knowledge does not guarantee the teaching competence to teach these contents, since, in the same way, knowledge is needed “about how students learn, their conceptions, types of thinking, strategies, difficulties, and potential errors” (GODINO et al., 2011, p. 1-2). This, in turn, requires professional training that focuses on student learning (WATSON, CALLINGHAM and DONNE, 2008; BURGESS, 2008).

Furthermore, according to Sacristán (1998), the differences between curricular guidelines and educational work may be responses to a lack of knowledge by politicians and specialists about educational contexts, which can lead to few effective changes in the pedagogical context. In the speech, the teacher’s lack of knowledge about the curricular guidelines for statistical content in Early Childhood Education was also shared. This panoramic and integrated view of the curriculum is necessary for teaching practice (LOPES and PONTUSCHKA, 2015), since, if the teacher does not know how the educational process is built on the basis of student training, this professional may have difficulties with regard to the pedagogical proposals of the curriculum and about the relationships that can be established between them, in addition to hiding and neglecting “other aspects that should also be considered as part of the curriculum” (ALVES and CARMO, 2020, p. 4-5).

Curriculum Knowledge, likewise, can be identified in discussions about the textbook, especially in the way in which this manual presents topics related to

Statistics. These topics may be far from classroom experiences and only inserted at the end of textbook chapters, complementing other curricular content. This result can be approximated to the research developed by Coutinho and Spina (2015). In this study, the inadequacy of Mathematics books for High School in relation to statistical competences was evidenced. A limited number of collections were found that addressed statistical research, critical interpretation of statistical data and the concept of variability. Still, a scarcity in the use of computational resources was noted, such as spreadsheets, simple and scientific calculators.

However, even if there are weaknesses in relation to Statistics in textbooks, these are intermediary agents in terms of the curriculum, as they present teachers with an interpretation of the meaning and contents of the prescribed curriculum (SACRISTÁN, 2000). In this way, teacher training needs to support him in this educational process, especially regarding curricular knowledge and statistical content. Thus, even with the omission or presence of errors in these pedagogical materials, the teacher will be able to complement, correct and adapt them, with a view to developing statistical competences. Therefore, “in addition to [teachers] knowing what is available, professors must also know how to criticize curricular materials”, in view of the teaching objectives and perspectives that underlie them (GROSSMAN and SCHOENFELD, 2019, p. 187).

The context was also evidenced in the analyses, being fundamental for the understanding of the concepts, as well as the interpretation of data and statistical information (GAL, 2019). According to Cobb and Moore (1997), unlike Mathematics, in which improvised examples can be used to illustrate a given situation; in Statistics, these examples created may not contribute to learning, as they do not represent an authentic interaction between the pattern and the context. This, in turn, can be described as this “semi-reality”, presented in the DCS, since the teachers address themes close to the students, but do not establish a direct association with reality.

Knowledge of educational contexts was also made explicit in the analyses. This was mentioned, in particular, in the imposition of the teacher to comply with the contents provided in the curriculum, in the prioritization of certain contents, to the detriment of others, in addition to the influences of meetings, stoppages and salary issues in professional practice. In the case of the influences of institutional activities and strikes at work, the speech made it clear how much social and institutional

structures influence and sometimes limit the actions of teachers, who need to adapt pedagogical activities and, in some cases, “join” classes.

Despite the existence of external issues, which can interfere with educational activities, the teacher plays a fundamental role in the contents that he prioritizes, in the strategies and in the curricular materials that he considers for the practice and learning of students. This is said because “the curriculum shapes the teachers, but it is translated into practice by themselves — the influence is reciprocal” (SACRISTÁN, 2000, p. 165). The teaching choices, when they prioritize certain contents, in addition to indicating knowledge about the curricular organization, expose the educational objectives considered and the professional understanding, which can also be related to the statistical competences described in the discourse.

Statistical competences cannot be “taught” through direct instruction, although they can be developed when pedagogical proposals cover real, contextualized data that can be interpreted, judged and validated by students (CAMPOS, WODEWOTZKI and JACOBINI, 2011). According to these authors, statistical competences must represent the objectives to be followed in the context of statistics, in the planning, development and evaluation of educational activities.

In this situation, it is important for the teacher to recognize the similarities and differences between Literacy, Reasoning and Statistical Thinking, since the content does not determine the competence to be developed, but rather the proposition and evaluation of strategies planned for this purpose (DELMAS, 2002). Therefore, these competences can be considered as part of the Knowledge Base within the scope of Statistical Education whenever the purposes for teaching maintain a close relationship with the content and with a group of students in particular.

6 Final considerations

In this paper, teachers’ knowledge (SHULMAN, 1986; 2014) related to statistical competences and curriculum documents was analyzed. In the summary speech, advances in the inclusion of Statistics in the BNCC were evidenced, although the resistance of the teachers themselves to employing these norms was also shared. In general, the educators explained how they saw Statistics in the BNCC, sequential and progressive, despite indicating a certain lack of knowledge about the learning processes in Early Childhood Education. Such situations highlighted that, even if

teachers had knowledge about the curriculum, sometimes these understandings were limited to the contents worked on in the discipline or at the level of education in which they worked. This, in turn, can affect the relationships established between the contents and the prerequisites considered for learning subsequent levels of education.

The textbooks, which are part of the curriculum presented to the teacher, based on the guidelines prescribed for teaching practices (SACRISTÁN, 2000), were also mentioned in the speech, in particular, the scarce attention of these materials in relation to statistics, in addition to the distance between the curricular proposals and the school context. In this sense, corroborating Shulman (2014), it is highlighted that, if the teacher understands how statistical concepts should be defined, in view of the other curricular contents, in addition to understanding the specific teaching and learning processes, he will be able to critically evaluate, teaching materials, adapting them to the reality of the school and the students, in addition to prioritizing the development of statistical competences.

In addition to knowledge of the curriculum (SHULMAN, 1986; 2014), the mobilization of understandings about students can be identified. These were related to the students' difficulties in learning the statistical content provided for in the BNCC, which could be at the forefront of that school context. From this perspective, the teacher's mediating function with regard to the curriculum set out in normative documents stands out. The teacher needs to adapt the BNCC curriculum guidelines to the school reality, the interests and needs of the students, as well as the educational demands.

Knowledge of educational purposes and goals (SHULMAN, 2014) also supported the discussions of the group's teachers, more specifically, during reflections on the importance of Statistical Literacy, Reasoning and Thinking for the training of students and the prioritization of statistics in training of the students. As evidenced in the exposed results, in terms of statistics, the competences refer to the purposes to be sought in the classroom, developed through activities close to the students' experiences, which requires professional understandings of the teacher in this context.

In this perspective, it is necessary to emphasize that, although the teacher has autonomy to shape the curriculum, plan and propose activities, his practice is conditioned to the educational system in which he operates. This involves, among other elements, the classroom, students, school, curriculum guidelines, community,

books and teaching materials. Therefore, it is necessary to develop broad understandings about the teaching practice scenario, since this knowledge is necessary for the other members of the Knowledge Base to be adapted to the particularities of the teaching context.

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References

ALVES, Cleide Teixeira; CARMO, Edinaldo Medeiros. Currículo: as concepções e a prática dos professores frente às prescrições oficiais. **Revista Cocar**, Belém, v. 14, n. 30, p. 1-21, Sept./ Dec. 2020.

BALL, Deborah Loewenberg; THAMES, Mark Hoover; PHELPS, Geoffrey Charles. Articulating domains of mathematical knowledge for teaching. **Paper presented at the annual meeting of the American Educational Research Association**, Montreal, QC, Canada, Apr. 2005.

BATANERO, Carmen. Thirty years of stochastics education research: Reflections and challenges. In: CONTRERAS, José Manuel; GEA, María Magdalena; LÓPEZ-MARTÍN, María del Mar; MOLINA-PORTILLO, Elena (Eds.). **Actas del Tercer Congreso Internacional Virtual de Educación Estadística**. Universidade de Granada, Granada, Feb. 2019, p. 1-15.

BATANERO, Carmen; BURRILL, Gail; READING, Chris. Overview: challenges for teaching statistics in school mathematics and preparing mathematics teachers. In: BATANERO, Carmen; BURRILL, Gail; READING, Chris (Eds.). **Teaching Statistics in School-Mathematics – Challenges for Teaching and Teacher Education: A Joint ICMI/IASE Study**. Springer, 2011, p. 407- 418.

BORN, Bárbara Barbosa; PRADO, Ana Pires do; FELIPPE, Janaína Mourão Freire Gori. Profissionalismo docente e estratégias para o seu fortalecimento: entrevista com Lee Shulman. **Educação Pesquisa**, São Paulo, v. 45, p. 1-22, Nov. 2019.

BRASIL. Ministério da Educação. Secretaria de Educação Básica. **Base Nacional Comum Curricular**. Brasília: MEC/SEB, 2018.

BURGESS, Tim. Teacher knowledge for teaching statistics through investigations. In: BATANERO, Carmen. et al. (Eds.). **Joint ICMI/IASE Study: Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education. Proceedings of the ICMI Study 18 and 2008 IASE Round Table Conference**. Monterrey: ICMI and IASE, 2008, p. 1-6.

CAMPOS, Celso Ribeiro; WODEWOTZKI, Maria Lúcia Lorenzetti; JACOBINI, Otávio Roberto. **Educação Estatística: teoria e prática em ambientes de modelagem matemática**. Belo Horizonte: Autêntica Editora, 2011.

CHANCE, Beth L. Components of statistical thinking and implications for instruction and assessment. **Journal of Statistics Education**, v. 10, n. 3, p. 1-14, 2002.

COBB, George W. MOORE, David S. Mathematics, statistics, and teaching. **American Mathematical Monthly**, v. 104, p. 801-823, 1997.

COELHO, Maria Aparecida Vilela Mendonça Pinto. **Os saberes profissionais dos professores**: a problematização das práticas pedagógicas em estatística mediadas pelas práticas colaborativas. 2010. 228f. Thesis (Doctorate in Mathematics Education) – Faculdade de Educação. Universidade Estadual de Campinas. Campinas.

COUTINHO, Cileda de Queiroz e Silva; SPINA, Gabriela. A Estatística nos Livros Didáticos de Ensino Médio. **Ensino da Matemática em Debate**, São Paulo, v. 2, n. 2, p. 1-23, Apr. 2015.

DELMAS, Robert C. Statistical Literacy, Reasoning, and Thinking: a commentary. **Journal of Statistics Education**, v. 10, n. 2, p. 1-11, 2002.

FIORENTINI, Dario. Pesquisar práticas colaborativas ou pesquisar colaborativamente? In: BORBA, Marcelo de Carvalho; ARAÚJO, Jussara de Loiola (Eds.). **Pesquisa qualitativa em Educação Matemática**. Belo Horizonte: Autêntica, 2004, p. 47-76.

GAL, Iddo. Promoting statistical literacy: challenges and reflections with a Brazilian perspective. In: MONTERIO, Carlos Eduardo Ferreira; CARVALHO, Liliene Maria Teixeira Lima de (Eds.). **Temas emergentes em Letramento Estatístico**. UFPE press, 2021, p. 37-59.

GAL, Iddo. Understanding statistical literacy: About knowledge of contexts and models. In: CONTRERA, José Miguel et al. (Eds.). **Actas del Tercer Congreso Internacional Virtual de Educación Estadística**, 2019, p. 1-15.

GARFIELD, Joan. The challenge of developing statistical reasoning. **Journal of Statistics Education**, v. 10, n. 3, p. 1-11, 2002.

GARFIELD, Joan; GAL, Iddo. Teaching and assessing statistical reasoning. In: STIFF, Lee; CURCIO, Frances R. (Eds.). **Developing mathematical reasoning in grades K-12**. Reston, VA: National Council Teachers of Mathematics, 1999, p. 207-219.

GIORDANO, Cassio Cristiano; ARAÚJO, José Ronaldo Alves; COUTINHO, Cileda de Queiroz e Silva. Educação Estatística e a Base Nacional Comum Curricular: o incentivo aos projetos. **Revista Eletrônica de Educação Matemática**, Florianópolis, v. 14, p. 1-20, Sept. 2019.

GODINO, Juan D. et al. Models for statistical pedagogical knowledge. In: BATANERO, Carmen; BURRILL, Gail; READING, Chris (Eds.). **Teaching statistics in school mathematics** – Challenges for teaching and teacher education. Dordrecht: Springer, 2011, p. 271-282.

GROSSMAN, Pamela. **The Making of a Teacher**. Teacher Knowledge and Teacher Education. Chicago: Teacher College Press, 1990.

GROSSMAN, Pamela; SCHOENFELD, Alan. O ensino do conteúdo da disciplina. In: DARLING-HAMMOND, Linda; BRANSFORD, John (Orgs.). **Preparando professores para um mundo em transformação**: o que devem aprender e estar aptos a fazer. São Paulo: Penso editora, 2019, p. 170-196.

JAHNKE, Thuanne Souza; MORAES, João Carlos Pereira de; PEREIRA, Ana Lúcia. Pensamento e Raciocínio Estocástico na BNCC de Educação Infantil: inferências para o Letramento. **Tear**, Canoas, v. 10, n. 1, p. 1-17, Jul. 2021.

LEFÈVRE, Fernando; LEFÈVRE, Ana Maria Cavalcanti. **O Discurso do Sujeito Coletivo**: um novo enfoque em pesquisa qualitativa (desdobramentos). Caxias do Sul: EducS, 2005.

LOPES, Claudivan Sanches; PONTUSCHKA, Nídia Nacib. O conhecimento pedagógico do conteúdo na prática profissional de professores de Geografia. **GEOUSP – Espaço e Tempo**, São Paulo, v. 19, n. 1, p. 76-92, Apr. 2015.

LÜDKE, Menga; ANDRÉ, Marli E. D. A. **Pesquisa em educação**: abordagens qualitativas. São Paulo, Editora Pedagógica e Universitária. 1986.

MARCON, Daniel; GRAÇA, Amândio Braga dos Santos; NASCIMENTO, Juarez Vieira do. Reinterpretação da estrutura teórico-conceitual do conhecimento pedagógico do conteúdo. **Revista Brasileira de Educação Física e Esporte**, São Paulo, v. 25, n. 2, p. 323-39, Jul. 2011.

PEREIRA, Valmíria Barcellos; DIAS, Marcelo Oliveira. A BNCC de matemática para os anos finais no contexto de prática: possibilidades de autonomia do professor. **Revista @mbienteeducação**, São Paulo, v. 14, n. 1, p. 187-213, Jan./ Apr. 2021.

PIAGET, Jean. **A equilibração das estruturas cognitivas** – o problema central do conhecimento. Rio de Janeiro: Kahar Editores, 1976.

PIETROPAOLO, Ruy César; SILVA, Angélica da Fontoura Garcia; AMORIM, Marta Élid. É. Conhecimentos de professores de Matemática para o ensino de noções relativas à Estatística na Educação Básica. **Revista Eletrônica de Educação Matemática**, Florianópolis, v. 14, p. 1-20, Sept. 2019.

SACRISTÁN, José Gimeno. O currículo: conteúdos do ensino ou uma análise prática? In: SACRISTÁN, José Gimeno; GÓMEZ, Ángel I. Pérez. **Comprender e Transformar o Ensino**. Porto Alegre: Artmed, 1998, p. 119-148.

SACRISTÁN, José Gimeno. **O currículo**: uma reflexão sobre a prática. 3. ed. Translated by Ernani Ferreira da Fonseca Rosa. Porto Alegre: Artmed, 2000.

SHULMAN, Lee Seymour. Conhecimento e ensino: fundamentos para a nova reforma. **Cadernos Cenpec**, São Paulo, v. 4, n. 2, p. 196-229, 2014. Translated by Leda Beck. Technical review by Paula Louzano.

SHULMAN, Lee Seymour. Those who understand: Knowledge growth in teaching. **Educational Researcher**, v. 15, n. 2, 1986.

VILAS BÔAS, Sandra Gonçalves; CONTI, Keli Cristina. Base Nacional Comum

Curricular: um olhar para Estatística e Probabilidade nos Anos Iniciais do Ensino Fundamental. **Ensino em Revista**, Uberlândia, v. 25, special edition, p. 984-1003, Dec. 2018.

WATSON, Jane M.; CALLINGHAM, Rosemary. A.; DONNE, Julie M. Establishing PCK for teaching statistics. In: BATANERO, Carmen. et al. (Eds.) **Joint ICMI/IASE Study: Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education. Proceedings of the ICMI Study 18 and 2008 IASE Round Table Conference.** Monterrey, Mexico: International Commission on Mathematical Instruction and International Association for Statistical Education, 2008, p. 1-6.

YIN, Robert K. **Estudo de caso: planejamento e métodos.** 4. ed. Translated by Ana Thorell. Porto Alegre: Bookman, 2010.