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Technological Learning Tools in Mathematics and the Nutrition Course: the Perceptions of Professionals and Students

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ABSTRACT

Introduction: The offer of undergraduate distance learning (DL) courses, through Universidade Aberta do Brasil or Open University of Brazil (UAB) within Public Establishments of Higher Education (IPES), generates changes in university institutional organization, which have strongly resulted in a flexibilization of the threefold mission of teaching, research, and extension. **Objectives:** Thus, this paper aims at inquiring about how UAB has been made part of the Federal University of Pará (UFPA) and which consequences that system has had for university education. **Methodology:** The research adopts a qualitative approach, with document for data analysis. Data were gathered through official documents published by UFPA itself: Pedagogical Projects of its DL courses and announcements of programs, scholarships and financial assistance, as they are present in the Social Action Management System (SIGAEST) website, from 2013 to 2022. **Results:** Results revealed how weakened the threefold mission of teaching, research, and extension has become within the scope of DL/UAB undergraduate course offering, due to the Pedagogical Projects not being aligned to UFPA proposals that preside over research and extension. In addition, DL/UAB students are not included in several different announcements for social action and financial assistance published by the university, for the announcements analyzed stablish that only regular traditional course students are suitable to partake in such opportunities. **Conclusion:** Conclude that DL being incorporated into IPES, through the UAB system, causes academic structure flexibilization, which in turn may impact teaching and learning processes in the realm of public university, resulting in major harms in education.

KEYWORDS

Open University of Brazil. Institutional flexibilization. Federal University of Pará.

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As ferramentas tecnológicas de aprendizagem em matemática e o curso de nutrição: as percepções de profissionais e estudantes

RESUMO

Introdução: O uso de ferramentas para cálculo no ensino da matemática é histórico e impõe aos alunos diferentes demandas cognitivas, que revelam a perspectiva de ensino e de aprendizagem da matemática adotada pela instituição. **Objetivo:** analisar as percepções de sujeitos que vivenciam o currículo com relação ao uso das ferramentas tecnológicas de aprendizagem em matemática no curso de nutrição, identificando as possíveis coerências e incoerências entre os recursos utilizados e as necessidades formativas e profissionais do nutricionista. **Metodologia**: realizou-se entrevistas semiestruturadas com uma estudante e uma professora do curso de nutrição da Universidade Federal de Goiás, uma nutricionista em atuação e uma representante do Conselho Federal de Nutrição, que foram investigadas por meio da técnica de análise de conteúdo, de Bardin. **Resultados:** a categoria de ferramentas tecnológicas de aprendizagem em matemática é dividida nas subcategorias: “lápis, papel e calculadora” e “software”. Revelou-se a ênfase nos cálculos manuais com o auxílio da calculadora, a partir da substituição de dados em fórmulas fornecidas previamente, em detrimento do uso dos softwares, que são pouco explorados. Tal prática é dissonante da necessidade profissional do conhecimento computacional, amplamente demandado pelos nutricionistas. **Conclusão:** apesar de o uso da abordagem mecanicista não ser um objetivo do curso, a manutenção dos cálculos manuais revela uma concepção algoritmizada, ao não estimular a compreensão dos conhecimentos subjacentes aos caminhos percorridos de forma mecânica. A maneira ideal de resolução das fórmulas requer mais do que a memorização de algoritmos e inclui uma reflexão dos princípios matemáticos presentes nas equações utilizadas.

PALAVRAS-CHAVE

Educação matemática. Ensino superior. Nutrição. Tecnologia.

Herramientas tecnológicas de aprendizaje en matemáticas y el curso de nutrición: las percepciones de profesionales y estudiantes

RESUMEN

Introducción: El uso de herramientas de cálculo en la enseñanza de las matemáticas es histórico e impone a los estudiantes diferentes demandas cognitivas, que revelan la perspectiva de enseñanza y aprendizaje de las matemáticas adoptada por la institución. **Objetivo:** analizar las percepciones de los sujetos que viven el currículo sobre el uso de herramientas tecnológicas de aprendizaje en matemáticas en la carrera de nutrición, identificando posibles coherencias e inconsistencias entre los recursos utilizados y las necesidades formativas y profesionales del nutricionista. **Metodología:** se realizaron entrevistas semiestructuradas a un estudiante y un profesor de la carrera de nutrición de la Universidad Federal de Goiás, un nutricionista en ejercicio y un representante del Consejo Federal de Nutrición, que fueron investigados mediante la técnica de análisis de contenido de Bardin. **Resultados:** la categoría de herramientas tecnológicas de aprendizaje en matemáticas se divide en las subcategorías: “lápiz, papel y calculadora” y “software”. Se reveló el énfasis en el cálculo manual con ayuda de una calculadora, basado en la sustitución de datos en fórmulas previamente proporcionadas, en detrimento del uso de software, poco explorado. Esta práctica es disonante con la necesidad profesional de conocimiento computacional, ampliamente demandada por los nutricionistas. **Conclusión:** aunque el uso del enfoque mecanicista no sea un objetivo del curso, el mantenimiento de los cálculos manuales revela una concepción algorítmica, ya que no estimula la comprensión de los conocimientos que subyacen a los caminos recorridos mecánicamente. La forma ideal de resolver fórmulas requiere más que memorizar algoritmos e incluye una reflexión sobre los principios matemáticos presentes en las ecuaciones utilizadas.

PALABRAS CLAVE

Enseñanza de las matemáticas. Enseñanza superior. Nutrición. Tecnología**.**

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Introduction

This paper presents a section of a doctoral research project, the subject of which is the analysis of mathematics in the training of nutritionists. In this article, our main objective is to analyze the perceptions of subjects involved in the nutrition course regarding the use of technological learning tools in mathematics. To support our research, we adopted the investigative question: what are the perceptions of nutrition professionals and students about the tools used to perform calculations?

Four semi-structured interviews were carried out with a teacher and a student on the nutrition course at a federal teaching institution in the state of Goiás; a graduate nutritionist working in the area of mass feeding; and a nutritionist representing the Federal Council of Nutritionists (FCN). The interviews were examined using Bardin's (2016) content analysis (CA) technique. The questions were guided by the search for an understanding of the importance attributed to mathematics, the way in which it is integrated into the course subjects, the knowledge present, the professional needs and the gaps in its teaching for the training of nutritionists. The analysis of the interviews supported our understanding of the reasons for and consequences of the use of technology in teaching mathematics to nutritionists.

Palis (2009) states that the gap between mathematics education and higher mathematics education is wide, and it is difficult to bring them closer together. In 2009, the author noted that there was an increasing number of students with mathematical learning difficulties during the transition from secondary to higher education and reported several concerns regarding pedagogical and curricular changes that need to be investigated, such as the growing development of technologies, calls for greater articulation with the other components of the course and the improvement of service courses. The lack of research into these aspects of mathematics education in higher education contributes to the continuation of learning problems supported by the curriculum.

In health courses, mathematics is a necessary component, present in several undergraduate curricula and as a tool in professional practice. However, there is little research exploring its development in training or proposing methodological teaching strategies to improve learning (Priebe; Alvarenga, 2022).

In medicine, Weyne (2012, p. 20) mentions that "mathematics is a fundamental tool or language for understanding or modeling biological phenomena and diseases". According to the author, the evolution of computational performance and modeling techniques has enabled the solution of highly complex and sophisticated models. As a result, the need to deepen mathematical knowledge demands the inclusion of modeling in medical curricula and integration between areas. However, the author points out that there is resistance from doctors and medical students to incorporating this tool into their courses (Weyne, 2012).

In nutrition, despite the various contributions of mathematics to research and professional practice, such as the optimization of menus and the development of equations for dietary assessment, the scarcity of research focused on the articulation of fields in training is more critical, as it makes it impossible to explore the characteristics of interdisciplinary teaching and to dissolve existing gaps, inconsistencies, and inadequacies.

From this perspective, Priebe and Alvarenga's study (2022b) found implicit and explicit mathematics in the nutrition curriculum, based on an analysis of national and local curriculum documents. However, to fully understand the aspects of mathematics studied in this course, it is necessary to know the context in which the curriculum is carried out, which includes investigating the conceptions of those involved, how they interpret and use mathematical content in their practice, and identifying the needs arising from the professional context. According to O'Neill (2015, p. 10), "the curriculum is highly influenced by the social, physical, economic, and cultural environment". The author emphasizes that the context strongly influences what is inserted into it, especially regarding the characteristics of the students. The difficulties in understanding contextual influences consist of their constant change and the unique particularities of each program, such as place, time, and people involved.

With this in mind, the focus of this study, in particular, is on the technological math learning tools used in the nutrition course, identified by CA from the interviewees' statements. As can be seen from Priebe and Alvarenga (2022b), this information is not made clear in the text of the official curriculum, which requires further investigation to understand this methodological aspect of the course, since knowledge of these tools and how they are used allows us to understand the perspective of teaching and learning mathematics adopted by the institution in this course and to analyze the values and beliefs implicit in these tools, the pedagogical intentions behind their use and the way mathematics is interpreted and presented.

Calculators and computers are considered levers for the evolution of practices in mathematics education and for innovation in this area (Artigue, 2019), so there is recognition that "the development of mathematics has always depended on the material and symbolic tools available for mathematical calculations" (Artigue 2002, p. 245). Furthermore, the tools influence the activity and knowledge of the subjects who use them. In this sense, Vygotsky (2012) recognizes the essentialism of psychological and material tools in human activity and quotes in his epigraph a famous saying by Francis Bacon (1600): "*Nec manus, nisi intelectus, sibi permitus, multam valent: instrumentis et auxilibus res perficitur*" [neither the hand nor the intellect, by themselves, are of great value: what gives them power are the instruments and auxiliaries provided by culture - our translation]. For Vygotsky (1981), the use of these external tools and aids alters the flow and structure of mental functions, changing the nature of the cognition process.

On the other hand, the use of these tools in teaching is based on learning mathematical knowledge and values defined long before the existence of such resources, as well as helping to combat pedagogical practices considered inadequate, such as excessive exposure or procedural learning of mathematical skills. In this way, it becomes difficult for teachers to deal sensitively with issues of computer instrumentation and the relationship between technical and instrumental learning (Artigue, 2002).

With this in mind, we aim to contribute to reflecting on these issues by exploring the mathematical learning tools present in the nutrition course and analyzing their relevance to the intended training, the effects resulting from them and the possibilities for better use, from the theoretical perspective of Artigue (2002; 2019), Chevallard (1999), Lajoie and Lavigne (n.d.) and Trouche (2004; 2014; 2016).

2 Learning tools in mathematics in the light of the literatura

Terms such as “instruments”, "technologies,” and “tools” are often used in mathematics education literature with similar meanings, and there is a need to understand their particularities. Some of them have come to be incorporated into research in various educational contexts since the introduction of computers in schools in the 1980s (Sinclair; Robutti, 2014). However, the meanings of these words can be broader than the computational scope, covering different types of materials depending on their purpose and the conception of those involved who use them (see table 1).

Table 1. Different nomenclatures and definitions associated with technological tools

Term	Definition
ICT - Information and Communication Technologies or DT - Digital Technologies	"New forms of technology that improve access to basic mathematical concepts through dynamic representations and connectivity in the classroom" (Hegedus; Moreno-Armella, 2014, p. 295).
New technologies	More modern and prominent computer hardware and software resources, in applications such as spreadsheets, presentations, e-mail, the Internet, among others (Freiman, 2014).
Technology	All mechanical tools built or used over time with the aim of assisting people in the processes of counting, calculating, measuring, constructing and recording data, such as stones, abacus, calendar, ruler, compass, weights, punch cards and spreadsheets (Freiman, 2014).
Instruments	"Things that are created and used by humans to help, assist, support, amplify, and enhance their activity" (Trouche, 2014, p. 307, our translation).
Tools	Something available to support human activity, such as a compass, a hammer, a calculator, or a language, which can be material or cultural (Trouche, 2004).
Artifacts	Objects built for a specific purpose, which become tools only when they are used by an agent to accomplish something (Monaghan; Trouche, 2016).
Math learning tools	Materials that support students in improving their understanding of concepts, principles, and practices in mathematics, classified as traditional, technological or social (Lajoie; Lavigne, n.d.).

Source: survey data

In this article, we are using the term "math learning tools" adopted by Lajoie and Lavigne (n.d.). They are classified as traditional, technological, and social. Traditional tools consist of objects that can be manipulated, such as cubes; visualization tools, such as graphs;

or pencil and paper activities, which are the most suitable for learning basic knowledge and skills. Technological activities include electronic devices such as calculators, computers, and their programs. They are more effective for understanding complex principles and concepts, perform calculations and construct graphs more quickly, and thus allow students more time to consider the reasons for obtaining results and think more deeply about the mathematics they are learning. Social refers to group work with the support of technology, which allows strategies to be shared, facilitates problem-solving skills, helps develop new perspectives and mathematical practices, and can provide feedback that makes students aware of contradictions in their thinking (Lajoie; Lavigne, n.d.).

Among the three types of math learning tools defined by these authors, we investigated the technological ones used in the nutrition course at UFG, represented by calculators and software. They permeate the course and professional practice with different emphases, and directly influence the way mathematics is considered by educators and understood by students.

2.1 Mathematics learning tools in the higher education curriculum

Mathematical activity is not possible without tools, and many studies on issues of mathematics teaching and learning do not mention them in the learning and teaching process. They are not neutral and cannot be considered only as passive artifacts because they reflect the perspective of the institution and the actors directly involved and condition the development of the curriculum (Monaghan; Trouche; Borwein, 2016).

Among technological tools, computers have various applications for teaching purposes in higher education. Authors such as Diniz (2007), Rabello (2012), Domingues (2014) and Santos (2019) deal with their use in the learning of mathematics in higher education courses in health (Priebe; Alvarenga, 2022a). Communication resources such as chats, emails, and forums were analyzed by Rabello (2012) as methodological tools in the teaching of mathematics in the biomedical course. Interaction with videos was studied by Domingues (2014) with students in a biological sciences course in applied mathematics. About software, the study by Santos (2019) analyzed the use of R in the construction of statistical literacy, based on the application of didactic sequences, in nursing, medicine, and mathematics courses, evaluating the ability to manipulate the technological resource, the level of knowledge mobilized, as well as the ability to interpret and critically evaluate statistical information. A general approach to the use of technological tools was carried out by Diniz (2007), who studied the use of different computer resources, such as websites, e-mail, and graphics software, in the development of a mathematical modeling project in a Biological Sciences course.

Investigations into the use of computers to teach mathematics in service courses can also be seen in some research by Bianchini and Puga (2004; 2006), who analyzed the use of

Winplot to draw algebraic graphs to teach functions in a computer science course (2006), and Graphmatica and the TelEduc platform to teach equations and inequalities in the same course (2004).

These studies provide rich methodological contributions based on proposals that highlight the advantages of using different technological tools to improve mathematical learning in higher education. However, they do not examine the tools actually used in the academic context, their limitations, or their relevance to professional needs. In this sense, Artigue (2019) points out that research needs to consider two different challenges: on the one hand, exploring the teaching and learning potential of technologies that have recently entered the classroom or may do so in the future; on the other hand, finding innovative solutions and more fruitful ways of using those that have been part of teaching for decades and are evolving. It can be seen that the studies found focus on the first type of challenge, so there is a lack of research investigating the use of resources already present in classrooms.

3 Research methodology

The research has a qualitative, exploratory approach. Semi-structured, face-to-face, and remote interviews were conducted in four stages, in September and December 2021 and in January 2023, with a teacher, a student in the last semester of nutrition, a graduate nutritionist working in the area of public nutrition, and a nutritionist representing the Federal Council of Nutritionists (FCN).

The interviews were examined using the theoretical-methodological framework of content analysis (Bardin, 2016) and organized into three main axes: mathematics in the professional practice of nutritionists; mathematical knowledge in the nutrition program; and the articulation between mathematical knowledge and specific skills, competencies, and content. The interviews were recorded, and the average duration of each one was 1 hour and 17 minutes. The project was approved by UFG's Ethics and Research Committee, under approval number 4.219.549, and the interviewees signed a Free and Informed Consent Form to take part in the research.

To support the interviews and their analysis, we used course syllabuses, textbooks, the Pedagogical Course Project (PPC) for nutrition at UFG and the National Curriculum Guidelines (DCN) for the nutrition course. We followed the stages: drawing up the script, training the researcher, selecting the participants, conducting the interviews, transcribing, analyzing and reporting. During the analysis, doubts arose about the use of the calculator in manual calculations and, as a result, the interviews with the teacher and the student were supplemented in April 2022 by WhatsApp.

One of the researchers was also the interviewer, who underwent initial training to practice the skills and attitudes needed to conduct interviews properly, as recommended by

Hernández Sampieri, Fernández Collado and Baptista Lucio (2013).

The analysis process followed three stages: pre-textual; exploration of the material; treatment of the results and interpretation. Despite the existence of defined stages, Bardin (2016, p. 15) rejects the idea that the technique is rigid and points out that CA "oscillates between the two poles of rigorous objectivity and fertile subjectivity", which allows flexibility in approaching the nuances and contexts present in the data, enabling a deep and holistic understanding of the material analyzed.

Ten record units (RU) were composed of words, called descriptors, identified in the interviews and grouped by themes (see Table 2).

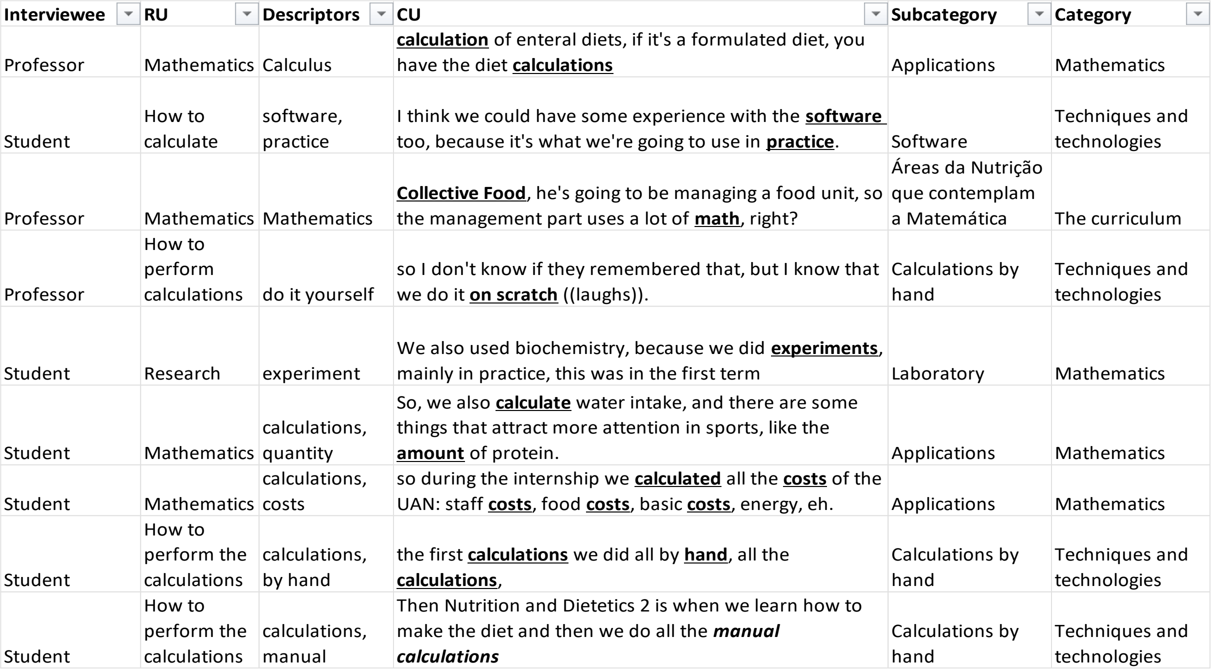
Table 2. Recording Units (RU) and examples of descriptors

Record unit	Examples of descriptors
Mathematics	abscissa; algebra; index; percentile; linear regression
Research	article; design; experiment; laboratory
Disciplines and areas of nutrition	collective nutrition; biostatistics; bromatology
Approach to mathematical content	explanation; introduction; presentation
How calculations are carried out	calculator; do it from scratch; manually, in hand/manual
Contextualization of mathematical content	applied/application/applicability; contextualization; example
Software	Application; Excel; software; program
Teaching and curriculum	curriculum; guideline; discipline; training; PPC; teacher
Perceptions of learning	catch; difficulty/difficult; easy/easy; suffer; get it right
Postgraduate studies and professional practice	doctorate; job market; master's degree; postgraduate degree

Source: survey data

The context units (CU) were made up of the sentences or paragraphs that contained the RUs and contextualized them. The RUs, CUs and preliminary categories were identified manually, and the data entered into an Excel spreadsheet (see figure 1), allowing for regrouping and refinement.

Figure 1 – Extract from the spreadsheet drawn up for categorization



Interviewee	RU	Descriptors	CU	Subcategory	Category
Professor	Mathematics	Calculus	**calculation** of enteral diets, if it's a formulated diet, you have the diet **calculations**	Applications	Mathematics
Student	How to calculate	software, practice	I think we could have some experience with the **software** too, because it's what we're going to use in **practice**.	Software	Techniques and technologies
Professor	Mathematics	Mathematics	**Collective Food**, he's going to be managing a food unit, so the management part uses a lot of **math**, right?	Áreas da Nutrição que contemplam a Matemática	The curriculum
Professor	How to perform calculations	do it yourself	so I don't know if they remembered that, but I know that we do it **on scratch** ((laughs)).	Calculations by hand	Techniques and technologies
Student	Research	experiment	We also used biochemistry, because we did **experiments**, mainly in practice, this was in the first term	Laboratory	Mathematics
Student	Mathematics	calculations, quantity	So, we also **calculate** water intake, and there are some things that attract more attention in sports, like the **amount** of protein.	Applications	Mathematics
Student	Mathematics	calculations, costs	so during the internship we **calculated** all the **costs** of the UAN: staff **costs**, food **costs**, basic **costs**, energy, eh.	Applications	Mathematics
Student	How to perform the calculations	calculations, by hand	the first **calculations** we did all by **hand**, all the **calculations**,	Calculations by hand	Techniques and technologies
Student	How to perform the calculations	calculations, manual	Then Nutrition and Dietetics 2 is when we learn how to make the diet and then we do all the ***manual calculations***	Calculations by hand	Techniques and technologies

Source: survey data

In the results processing stage, we made interpretations and inferences, carefully analyzing each CU, revealing the underlying aspects of the statements, the relationships between them and the context and relating them to the theoretical references.

4 Data análisis

In this section, we describe the profile of the interviewees and list the categories and subcategories identified by the CA.

4.1 Characterization of the interviewees

The teachers interviewed were selected from among those whose subjects most use mathematical content (Priebe; Alvarenga, 2022b). The student was chosen by lottery from among those enrolled in the compulsory curricular internship courses, held during the 9th and 10th periods of the course. The graduate nutritionist was chosen because she works in the area of Collective Nutrition at the same institution. The CFN representative was chosen because of her participation in the process of revising the DCN-Nutrition. The characterization of the interviewees is shown in Table 3.

Table 3. Characterization of the interviewees

Code	Short description
D	Full professor at the Faculty of Nutrition at the Federal University of Goiás. She has a master's and doctorate in food science and a bachelor's degree in nutrition. She teaches Food Sensory Analysis and Bromatology. She has been teaching at the institution since 1996 and has worked exclusively as a lecturer and researcher since she graduated.
E	Student at the Faculty of Nutrition of the Federal University of Goiás. She joined the course in the first semester of 2017 and was in her 9th term when the interview took place, in December 2021. Enrolled in the Clinical Nutrition Internship, she had already completed all the other subjects in the curriculum.
N	Nutritionist who graduated from the Faculty of Nutrition at the Federal University of Goiás. She has worked in the area of Collective Nutrition as coordinator of the nutrition service of the university restaurants at the Federal University of Goiás since 1993. She graduated in nutrition in 1984 and completed her master's degree in nutrition and health in 2016.
R	Representative of the Federal Council of Nutritionists (CFN) for the 2018 – 2021 term. She coordinated the Special and Transitional Commission for the Revision of the National Curriculum Guidelines for Undergraduate Courses in Nutrition. She is a nutritionist and assistant professor at the Federal University of Campina Grande.

Source: survey data

4.2 Categories

The categories (see table 4) emerged during the analysis and interpretation stage of the material and are based on the aspects of math teaching identified in the CUs and in the interviewees' narratives.

Table 4. CA categories

Categories	Description
Technological tools for learning mathematics	Technological resources used by students to perform calculations.
Mathematics	Mathematical content used and its applications in the course and in professional practice.
The curriculum	Curricular and methodological aspects of mathematics teaching and their relationship with the specific subjects on the course.
The student perspective	Students' perceptions of their mathematical skills and competences and the obstacles they have experienced during the course.
Professionalization	Preparation offered for the different areas of activity.

Source: survey data

5 Results

In this section, we present the results of our interpretation based on the systematic and organized process of analyzing the category "Technological tools for learning mathematics", which includes the resources used in the nutrition course to perform calculations and is made up of the subcategories "pencil, paper, and calculator" and “software”.

5.1 Technological tools for learning mathematics

At each moment of curriculum renewal, the dialectical relationships between the curriculum and learning tools become more visible, so that "the integration of (sometimes old) tools into mathematics teaching and the evolution towards a more active way of learning mathematics therefore seem to be closely linked" (Trouche, 2016, p. 271). However, although the evolution between the two aspects, the curriculum and the learning tools, is intertwined, the relationship between them is far from one-way. It is often difficult to know whether the tools come from society to the school and condition the teaching of mathematics, or whether the needs of teaching and learning require the introduction of new tools. However, scholars point out that in the context of the curriculum, this discussion cannot be summarized as how to integrate new resources into the classroom, but rather how to be successful with what is already available to achieve teaching and learning goals (Trouche, 2016).

Lavicza (2008) observed that, in general, the number of investigations in mathematics education aimed at basic education far exceeds those aimed at the university level. This phenomenon also applies to research on technologies in mathematics education, whether at the university level or in vocational education. In this sense, general discussions on the insertion and use of calculation tools in basic education, such as those by Monaghan, Trouche and Borwein (2016), Aldon and Trgalová (2019) and Guin, Ruthven and Trouche (2005), have been contextualized for the academic environment, with the appropriate specific adaptations for this level.

The use of computational tools is an important part of curriculum development, so that "mathematical learning actually develops 'under the umbrella' of 'actually used' tools" (Trouche, 2016, p. 267). In this sense, the author points out that they condition the development of curricula, citing as an example the clay tablets used in Mesopotamia, at a time when the nature of this writing instrument conditioned the work, since the fresh clay allowed one to write and erase as needed. This revealed a context in which writing and memorization were of great importance for learning.

Gradually, other tools were developed, such as multiplication tables, slide rules, calculators, and software. The reduction in their price and the improvement in their performance and ergonomics contributed to their increasingly rapid diffusion (Guin; Ruthven, and Trouche, 2005). For these authors (2005, p. 11), "the rapid evolution of computer tools available to students probably complicates the task of establishing a new balance in mathematics education.

On the other hand, the interaction between the development of curricula and the evolution of tools often causes tension and different interpretations about the possibility of integration. Furthermore, the effects of changing a tool can be strong when it occupies a central place in teaching (Trouche, 2016). In this sense, Nunes (2014, p. 347) points out that:

> The tools used in mathematics, such as numerical and algebraic representation systems, calculation procedures, calculators and computer programs, are increasingly varied across cultures. These tools clearly place different types of cognitive demands on students, but very little is known about the continuities and discontinuities in learning.

Technological evolution has upset the traditional balance between technical and conceptual work, changing the pragmatic and epistemic values of techniques instrumentalized by computer technology. This has led to new procedural needs in mathematics related to the computational implementation of knowledge and the representation systems involved, which are not easily identifiable (ARTIGUE, 2002).

Therefore, given the importance of the tool in teaching to carry out calculations, from the simplest to the most sophisticated, we paid attention to the possible approaches that could appear in the interviews. We identified some ways of carrying out these calculations during the course, including understanding the resources used, the perspectives related to their adoption, and the complexity of producing knowledge and learning mathematics, questioning the changes and their possible impact on teaching, and addressing important aspects of the educational use of technology, such as the mathematical needs of the instrumentation and the problems arising from the link with manual pencil and paper procedures.

5.1.1 Pencil, paper, and calculator

The category pencil, paper, and calculator refers to the results found in the interviews through the CA, which refer to doing calculations on paper, using only the calculator, considered by Lajoie and Lavigne (n.d.) as a technological tool. The teacher interviewed also uses the terms "do it on your fingernail" or "do it on your hand" as synonyms. These terms were used in the context of diets and statistical calculations, justified by the need to know the formulas used. In the following excerpts from the interviews, we can see some of the UC that supported this subcategory:

> D: But you have to know how to do it manually, right?
> D: [...] I know that we do it on scratch there ((laughs)) Anova [...] (Teacher, 2021).
> E: Then, Nutrition and Dietetics II is when we learn how to make the diet, and then we do all the manual calculations (Student, 2021).

The use of artifacts in arithmetic has been practiced by humans for millennia, and the advancement of computational tools is deeply linked to the development of writing (Trouche, 2016). The execution of calculations manually became possible with the development of writing tools, which allowed the replacement of mental calculations. Since then, the execution of algorithms with pencil and paper has become widespread in classrooms around the world, being one of the main techniques used during the course analyzed, associated with the use of calculators to perform basic arithmetic operations.

The technique was reported for the subjects Nutrition and Dietetics II, Biostatistics, Bromatology and Sensory Analysis of Food. However, the student interviewed said that these calculations could be done using specific software, which is often used in professional practice, but little studied in the course.

Performing calculations with pencil, paper, and calculator, even with the existence of software, may be based on a mechanistic conception of mathematics education, in which the emphasis is on learning isolated procedures, memorizing formulas, and repeating algorithms, harming conceptual understanding, critical reflection, and practical application of mathematics in the real world. Mathematics in this approach is conceived as a set of rules and formulas to be memorized and applied in a technical and mechanical way to specific situations, without a more profound understanding of the mathematical reasoning involved. This conception is historically reproduced under the justification of the need to develop manual skills, knowledge of the formulas used, and independence from external resources to carry out the work, as we can see in the excerpts below:

> N: I was able to overcome all the challenges because I had done them and knew what was being calculated. So it's easier for me to calculate a diet for diabetes, for example. If you say: **-** I need a diet of 1500 calories with so many grams of protein – if I couldn't do it manually, to face the calculations, I don't know if another professional would have the same ability. [...]
> N: If I didn't have an understanding of mathematics, I would simply be dependent on the program.
> N: [...] when you work on things manually, your brain has more connections, it develops more [...] (Nutritionist, 2023).
> Researcher: And do you think there was a need for you to calculate manually, since there is software that calculates everything?
> E: I think so, once to learn, a few times to learn, you know, how the formula works (Student, 2021).

The speech of the former nutritionist associates the manual execution of calculations with the knowledge of the underlying mathematical meaning, under the justification of the need for greater professional autonomy and independence from software, which may not always be available during professional practice. The student, on the other hand, emphasizes the idea of the need for training and mechanization based on the memorization of algorithms for solving equations. With this, we can see that she defends the operationalization of concepts, which, although not an objective of the course, characterizes algorithmic teaching, highlighted by the recurrent use of formulas in which it is up to the student to substitute the values and perform the operations to obtain the result.

These formulas were cited for cost management calculations and for sizing a food and nutrition unit, for stoichiometric calculations and for food and anthropometric assessment, such as energy requirements, dietary adequacy index, among others. Some of the respondents' comments on this practice are highlighted below:

> I: Well, there are also formulas already given, and we can substitute them, right?
> E: [...] we measure the circumference, and then we do the muscle circumference of the arm, we use other formulas there.

> E: [...] there were also formulas, to estimate costs, we used the methods. We used the Gambardan and Kimura methods, then we had to replace the values (Student, 2021).
> D: So, from here on in, everything is calculation, but, like, applying a formula, right? [...]
> D: I make a spreadsheet for them that's already ready, you know, this spreadsheet there with the calculations, it already has the formulas, they just have to substitute the data (Teacher, 2021).

The statements show the significant use of formulas during the course and highlight the idea that mathematics is fundamentally associated with the application of this item. The formulas mentioned by the interviewees generally consist of 1st and 2nd degree equations and require arithmetic knowledge to be used, such as percentages, logarithms, among others (see table 5). However, the interviewees did not explain or discuss the principles that gave rise to them and their relationship to the results sought. This allows us to see that students are not led to reflect on or understand the mathematical foundations of the formulas used.

Table 5. Calculation of interindividual intake variance

$$V_{intrapessoal} = \sum_{i} \frac{(Y_i - \bar{y})^2}{n-1}$$

Being:
$Y_i =$ observed individual intake
$\bar{y} =$ average observed intake
$n =$ number of days of observed intake

Source: adapted from Silva and Ferreira (2020)

The large number of similar exercises, solved mechanically by applying a series of formulas, characterizes the traditional model of mathematics education, which has been severely criticized but is still widely used. We found that in the course analyzed, applying a formula by substituting data is interpreted as an exercise in understanding the mathematical process involved. However, although this practice helps to memorize and train basic arithmetic skills, it does not contribute to the understanding of the principles behind the calculations or the meaning of the results obtained, since we did not see any attempt to justify the origin of the formulas or the reason for their use. In this sense, the absence of these aspects indicates that the relationship between nutritionists and mathematics appears to be merely technical, instrumental, and pragmatic, which is in line with what the FCN representative said:

> A: I believe they can never do this math manually, never, but I need to understand where it came from because otherwise it's a mechanical thing; otherwise there's no need for a nutritionist, right? Everyone gets a piece of software, puts in their weight, their height, and their needs, and lets the beast do their diet. If you think about it like that, you wouldn't need it [...] That's the practice, a lot of software, a lot of it, makes it so that the individual doesn't need to do any math, they just type the little things in and everything comes out, right, and then the fight and the arguments have to be very deep so that the person wants to understand why they have to understand math if they have calculator software that does it all by itself (Representative, 2023).

Techniques, according to Chevallard (1999), are often evaluated for their pragmatic value, i.e., their productive potential. They also have epistemic value, contribute to understanding the object they involve, and are a source of questions about mathematical knowledge. However, for reasons of efficiency, the advancement of knowledge requires the routinization of some of them, and this process results in the weakening of the associated theory and the naturalization of knowledge (Artigue, 2002). Chevallard (1999) explains that this is the result of a particular institution choosing a technique, or a group of them, in such a way that subjects exclude, ignore, or criticize other existing techniques. Although this is commonplace in institutions, it can be dangerous because, according to Artigue (2002, p. 5):

> A technique that has become routine in an institution thus tends to become "dematerialized" for the members of that institution. It is important to be aware of this process because, through it, techniques lose their mathematical "nobility" and become simple acts. Thus, in mathematical work, what is finally considered mathematical is reduced to being the tip of the iceberg of real mathematical activity (Artigue, 2002, p. 5).

On the other hand, if the mathematical activity is associated only with the "tip of the iceberg", without considering the importance of the technical work, it will be difficult to see the need to reconstruct the theoretical discourse underlying the content taught and to understand the mathematical meaning that has been lost in the routinization (Artigue, 2002).

During the analysis stage, we found that the use of calculators was rarely reported. With this in mind, we contacted the interviewees again to clarify its use during manual calculations. According to them, the calculator is widely used and is present in activities and assessments, as can be seen in the excerpts below:

> E: When I had the calculator at the time of the activities, I used it to do the calculations manually because I trusted the calculator more because I thought it was safer (Student, 2021).
> D: Yes, we use a calculator, or Excel, or whatever we have at the time. In the test, I asked for a calculator. In class, I also do it; I ask for a calculator, and, eventually, in the lab, we do it in Excel, so it's quicker (Teacher, 2021).
> Researcher: Did you use a calculator or did you do it manually?
> E: I used a scientific calculator (Student, 2021).

The use of the calculator was reported as support for solving problems and exercises, especially in subjects that involve calculating diets, such as Dietary Inquiries, Nutrition and Dietetics II, Sports Nutrition, Maternal, Child and Adolescent Nutrition II, Pathology of Nutrition and Diet Therapy I and II and Vegetarianism. It is also used in other subjects, such as Sensory Analysis, Nutritional Assessment, Bromatology, Biostatistics, Economics, Management of Food and Nutrition Units, Planning of Food and Nutrition Units, Theoretical Organic Chemistry, Experimental Organic Chemistry and Theoretical General Chemistry.

Simple calculators are used, including in the form of a smartphone app, and scientific calculators. The latter are necessary for calculating logarithms, coefficients of variation, arithmetic and geometric means, population standard deviation, factorials, radications, exponentiation, and 1st and 2nd degree equations, while the former are used for basic arithmetic calculations and sample standard deviation, which is not provided by the scientific calculator.

The calculator, as a portable computer technology, has many everyday applications and is a recent aid to calculation. The debate on the advantages and disadvantages of using calculators in mathematics teaching has given rise to various discussions about their possibilities and restrictions, which reflect the teaching concept adopted (Monaghan, 2016). In addition, Pepin and Gueudet (2014) point out that the way students and teachers use calculators depends on their prior knowledge of the tool and their mathematical knowledge.

In a work environment, restrictions on its use are rare, however, when it comes to the learning space, there may be greater control and imposition of limitations due to the different understandings of each teacher about the potential of using this tool. We observed the defense that its use in certain contexts can save the time and effort needed to understand the key concepts of the subjects. This means that the tool is not seen as detrimental to the ability to abstract.

Monaghan (2016) analyzed research on the use of calculators in the classroom, and the results pointed to a greater use of mental strategies by students. According to the author (Monaghan, 2016, p. 312):

> From my position as someone with a particular interest in the use of tools in mathematics, this result is interesting because it shows that familiarity with a mathematical tool (a calculator) does not necessarily lead to dependence on this tool when solving problems.

In this sense, we can't really say that the skills of solving research problems and performing mental calculations are hampered by calculators. Considering this, we found that, in general, in the nutrition course analyzed, there are no limitations to its use in the classroom and laboratories, except for the use of smartphones during assessments.

Mathematics is usually associated solely with arithmetic calculations, although these are not its essence. In 1987, Ponte pointed out that "calculation is only one facet of mathematics, and far from the richest and most important. Calculation is everything that can easily be programmed into a computer" (Ponte, 1987, p. 5). For the author, computational execution can be easily implemented, since the greatest complexity lies in choosing the data, the calculations, evaluating the results and combining them with existing knowledge.

Advances in technology are helping to reduce the importance of the mechanistic domain, allowing the understanding of concepts to take the place of training technical skills and tedious calculations. Bizelli (2003, p. 39) points out that:

> Computers can free users from a lot of mechanical work related to learning mathematics (memorizing and executing algorithms), but they also require imagination, creativity, and critical faculties (algorithm design, stability, sensitivity to initial conditions, error detection, control, and exploitation of results).

As a result, in 1987, Ponte observed that it was becoming increasingly difficult to convince students of the need or importance of memorizing mathematical techniques for solving exercises that they knew could be easily solved with software, as was also observed by the CFN representative in her classes:

> Researcher: How do you perform calculations in your professional practice? How do nutritionists perform their calculations daily? Do they do it manually or using calculators, software, devices?
> A: [...] This is one of the issues that made mathematics gradually drop out of the curriculum too because when I teach a Nutritional Assessment class, I teach calculation by calculation, how to do it, you know, estimate weight, estimate height, estimate I don't know what, there's a lot of software that does it nowadays, so the student says: - I'm not going to do it, I don't need to understand it because the software will do it (Representative, 2023).

Despite the recurrence of manual calculations carried out using calculators during the course, the interviewees emphasize that in clinical professional practice, in activities such as diet planning, the main calculation tools used by nutritionists are software, as highlighted below:

> A: There are many, many calculations that we do manually today, when you graduate, nobody does them. Nobody is going to do manual calculations for a lot of these things, including the ones I teach, because there's software for that. So this also leads to people distancing themselves from math throughout their training because they think they won't need it (Representative, 2023).
> E: In professional practice, it turns out that we don't need to use a calculator because [...] nutritional software calculates everything, right? (Student, 2021).
> D: I think calculating the diet in the software is much quicker (Teacher, 2021).

Just as arithmetic calculation is one of the nutritionist's recurring working tools, the computer tools used to carry it out are part of the professional practice in its different areas, constituting new ways of representing and exploring mathematics. Thus, in addition to calculations with pencil, paper and calculator, we identified the subcategory of "software", presented below.

5.1.2 Softwares

Mathematics was one of the first subjects to introduce computers into the classroom and contributed to their first appearance as calculating machines. As it evolved and became part of the classroom, different perspectives on the use of technology and the mathematics curriculum began to emerge, such as arguments that it should be included in the existing matrix or used to present complex ideas that would have been previously inaccessible (Sutherland; Rojano, 2014).

Several studies have questioned the effectiveness of using computers to teach differential and integral calculus. However, Rezende (2004) shows that this question has been extended to other areas of mathematics education and needs to be analyzed with serenity and balance, considering the technical and pedagogical limitations of computers. When working with computers, it is necessary to keep in mind the precise notion of their purpose, their potential and their limitations, scaling these variables to an objective outside their use: the knowledge to be taught. Thus, the question to be studied is not whether to use computers in the classroom, but rather how and when to use them.

The existence of software is not ignored by the respondents. However, its use in the course is not mentioned as a recurring theme, since, as already mentioned, manual calculations of formula applications given with the calculator predominate.

Various software programs are part of the professional practice of nutritionists, such as DietWin®, Avanutri® and the WorldFood Dietary Assessment System®, which allow them to formulate diets more accurately, make dietary prescriptions, monitor clinical progress, perform clinical, nutritional, anthropometric and laboratory assessments, among other functions (Trindade et al., 2018). However, its use for course calculations was identified as insufficient in the interviews:

> E: I think we could have some experience with the software too because that's what we're going to use in practice (Student, 2021).
> D: They don't use the program either, they just interpret (Teacher, 2021).

Trindade et al. (2018) point out that nutrition software offers practicality to nutritionists and researchers, being a safe and fast way to analyze diets, integrating food composition tables and formulas for calculations, such as energy expenditure and fat percentage. According to the authors (Trindade et al., 2018, p. 309):

> Among the advantages of using a computerized system are the reliability of the calculations, time savings, ease of searching for information, storage of the work for later consultation and the possibility of altering the analyses carried out.

According to the student interviewed, Avanutri® is the only one used in the course, provided by the institution, but she points out that the use of all its features is unsatisfactory:

> E: They make Avanutri available, right, so we only have Avanutri, but it's very basic, you know, you go there and put in the record, you go there and put in the plan. You don't know what else the software can bring you, you know, information, calculations. If you put all the patient's data in there, what can the software do to provide me with data? (Student, 2021)

In addition to nutrition software, statistical programs are used in most quantitative research, such as R®, SPSS®, Stata® and EpiInfo®. They allow descriptive and inferential statistical analysis to be carried out by providing measures of central tendency and dispersion, frequency tables, graphs, and the application of various tests, such as t-Student, Kolmogorov-Smirnov, ANOVA, chi-square, Pearson's r, among others, and it is up to the student to know the type of analysis that needs to be carried out and the correct interpretation of the results. However, during the Biostatistics course, these programs are not used, and all calculations are carried out manually, as shown below, which would be unfeasible when it comes to real research with extensive databases:

> Researcher: You don't have any contact with statistical software, such as Epinfo or Stata?
> E: No.
> Researcher: Everything manually when you have Biostatistics?
> E: Yes (Student, 2021).

Such software is only used in postgraduate courses, where there are subjects aimed at teaching its functionalities and reviewing the underlying statistical principles, as reported by the former nutritionist:

> N: When, in Biostatistics, when you see it in graduate school, eh, it's not biostatistics like what we see in undergrad. The biostatistics we see in graduate school is more focused on the calculation itself, within a program (Nutritionist, 2023).

The report Guidelines for Assessment and Instruction in Statistics Education - GAISE (Carver et al., 2016) notes that an increasing number of students are studying statistics in their higher education courses, in curricula that include a significant amount of statistical concepts and methods, enabling them to interpret categorical and quantitative data, make inferences, and justify conclusions. Among the recommendations for statistical literacy, the report includes the use of technology to explore concepts and analyze data, so that students can interpret the results of the output from statistical software. Although there is value in performing some calculations manually, it is unrealistic to analyze data without the help of a computer, except for smaller databases.

The text (Carver et al., 2016, p. 11) notes that "ideally, students should be given numerous opportunities to analyze data using the best available technology," and that regardless of the tools used, technology should be seen as a way to explore concepts and improve learning, not just to produce statistical results. However, the former nutritionist notes the difficulty that new graduates have in analyzing the results generated by the programs:

> N: I think it helps; I think it would help a lot to know the calculations because you have a much broader view. So, today, if you talk to a younger professional, sometimes they look at you like this. [...] When you put it into the program, it's easy, but what about when it comes to analyzing it? The analysis of what you've collected, often the person is like that, you know? [...] Because of the program, it gives you beautiful things, but what about when it comes to analyzing? (Nutritionist, 2023).

Statistics is a mathematical science and is very much present in the nutrition course at UFG, in the subject of Biostatistics, or in other subjects, in scientific research programs and, generally, in the development of course conclusion papers (Priebe; Alvarenga, 2022b). Thus, the lack of presentation and use of statistical programs represents a contradiction in relation to real academic and professional needs.

The interviewees also reported that some teachers prepare and make available Excel spreadsheets with the formulas used during the courses, leaving it up to the students just to include the data, interpret the results, and, in some cases, construct curve graphs, similarly to nutritional software. However, the student found it difficult to use, due to the lack of an introductory course on the use of this resource, according to the excerpts below:

> E: So, I don't have any facility with Excel, and here, we don't have a subject for this that teaches it, so I had a hard time putting the curve together [...].
> E: So, in this part, we had a hard time, because we didn't know how to work with Excel, for example (Student, 2021).

Digital spreadsheets allow for the creation and manipulation of data, providing resources for calculations, data analysis, graphing, and other functions. Sousa, Pinargote and Pereira (2018, p. 282) point out that "the use of the Excel program by students in the classroom, for the analysis and solution of problems close to the reality of business and work, will enable them to acquire the skills needed in the world of work".

The use of spreadsheets in the classroom contributes to the development of skills in the organization and presentation of information, qualitative and quantitative interpretation, communication, problem-solving, decision-making, control, and report writing (Raviolo; Alvarez; Aguilar, 2011). The interviewees revealed the use of this tool in the subjects of Management of Food and Nutrition Units, Internship in Food and Nutrition, Bromatology and Sensory Analysis of Food.

The student emphasizes that the course doesn't offer any prior training on how to use the application, which makes it difficult for those who don't know its basic functions and limits the possibility for teachers to explore advanced features. However, the teacher interviewed said that if she noticed that the class was having difficulty using the spreadsheets, she would teach them how to use them first.

The support provided by new technologies has been a driving force behind the recent growth in the use of mathematics in the professions, facilitating the application of methods and statistical analysis and stimulating the development of approaches (Guin; Ruthven; Trouche, 2005). In this sense, Pinto and Silva (2012) found that 75.5% of the nutritionists analyzed in their survey used software in clinical practice to help calculate menus, with the aim of reducing the time needed to perform calculations and the risk of errors. However, formulas such as the FAO/WHO/UNU[1] formula and the Harris-Benedict formula are still used to calculate estimated energy expenditure. The use of software in professional practice was observed by the student during her internship and differs from the manual calculations performed in her academic experience:

> E: When, for example, I worked with the clinical nutritionist in the office, she has software that does everything for her, she just has to put in the patient's data, and the software calculates everything. Now, when we learn Nutrition and Dietetics 2, we have to do it, we have to know how to do the calculations, and we do everything manually. [...]
> E: But I think it would also be interesting for us to work with this software, to work with this data because it's what we use in practice, right? (Student, 2021).

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[1] Food and Agriculture Organization of the United Nations; World Health Organization; United Nations University.

Considering the need to master different techniques and technologies for professional practice, teaching needs to be adapted to this demand, training students in the rational use of computer tools, both manual and digital. However, each institution and its teachers may have a different conception of the importance of one technology over another. From this perspective, Sutherland and Rojano (2014, p. 603) point out that:

> There is an ongoing debate about the relative importance of pencil-and-paper versus computer-based mathematics in terms of developing mathematical knowledge and understanding, with many people arguing that digital technologies for mathematics do not replace pencil-and-paper technologies.

Learning manual calculation procedures can be considered an important prerequisite for using computer resources, allowing results to be understood and inconsistencies generated by programs to be seen. However, it can be seen that, outside the classroom, computers have social legitimacy in their inclusion in everyday life and in most professional sectors. As a result, the excessive emphasis on calculations with pencil, paper, and calculator and the little use of software in the course point to a contradiction between professional needs and the training offered.

Guin, Ruthven and Trouche (2005) state that, in the commercial world, computer tools have eliminated pencil and paper calculations in all professions that involve manipulating numbers, so that many professionals, such as auditors and managers, have specific software at their disposal for calculations linked to professional practice. The authors (2005, p. 12 and 13) point out that:

> The emergence of new tools changes not only computing techniques, but also the relationship with numbers themselves. On the one hand, performing calculations with a machine increases the user's distance from the numbers; on the other, performing marginal tasks (for example, giving change) is connected to computing practices that involve counting concrete objects. Technological evolution drastically changes social relations with mathematical objects.

Diet and menu planning using linear programming is a successful example of the use of computers and mathematics in the field of nutrition. Such calculations were difficult to perform without the use of a computer because the traditional method of designing diets was based on trial and error, i.e., an iterative approach in which different combinations of foods are made repeatedly until an optimal solution is found. This situation has changed radically with easy access to computers and powerful software for solving such problems. However, although linear programming is a valuable tool for health professionals, its use can be hampered by a lack of familiarity with it (Briend et al., 2003).

As a result, educational institutions are confronted with society's broad acceptance of the incorporation of technology into everyday life and professional practice, and the need to revise the curriculum in relation to the new relationship between students and mathematics with the mediation of software. Thus, the social need to master these technologies can be seen as legitimizing mathematics in curricula (Guin; Ruthven; Trouche, 2005).

D'Ambrósio (2009, p. 68) briefly defines curriculum as "the strategy for educational action" and identifies its structure based on three integrated components: content, objectives, and methods. According to the author, the difficulties of introducing computers and calculators in the classroom are due to the maintenance of traditional content and objectives, which need to be reformulated to make the implementation of these tools feasible, so that modern content can be included, which could not be covered without these technologies.

Therefore, to make better use of existing technologies for the calculations performed in the course and to adapt the training offered to professional needs, changes are needed, starting from the teaching methodology adopted by teachers and the official matrix, so that mathematics is recognized as a necessary and non-limiting tool, capable of opening the way to new possibilities of articulating concepts with application to real situations and of breaking down the distance between academia and the labor market.

6 Reflections and suggestions

Calculation software, whether nutritional or statistical, although offering greater practicality and accuracy of results, can also contribute to the perpetuation of the mechanistic approach to mathematics. Their inclusion in the classroom does not imply an improvement in the quality of education, since they are not good or bad in themselves, but depend on the methodological teaching strategy used by teachers (Raviolo; Alvarez; Aguilar, 2011).

Barzel, Ball and Klinger (2019, p. 76 and 77) state that "procedural skills in doing mathematics are important, but they must be developed through flexible and productive exercises in order to learn and understand the mathematical structure behind them". Thus, there is no significant gain in mathematical learning by simply substituting data manually using a calculator or software.

In this sense, Pepin and Gueudet (2014, p. 133) support the idea that there is a need to change the way mathematics is used in teaching because "it is crucial to provide frequent opportunities for students to engage in dynamic mathematical activities based on rich and valuable tasks".

To this end, teachers can promote learning situations that do not limit students' knowledge to technical or routine activities and propose activities in different registers of representation of the mathematical[2] object so that they acquire a broad understanding of the concepts (Bianchini; Puga, 2006). In this way, teachers need to be creative in showing the richness and power of mathematics, helping to achieve conceptual mastery of basic ideas and

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[2] Semiotic representation registers are defined by Duval (1995) as the different ways of representing a mathematical object. The author refers to four types of register: algebraic, numerical, graphical and mother tongue.

flexibility in their applications, and presenting problem situations that require resourcefulness and exploration so that students learn various solution methods (Siegel, 1987).

One way to reconcile the manual technique with the digital technology of software would be to propose thought-provoking and non-standard exercises and problems, including the use of mathematical modeling, that allow students to deduce the formulas or understand their fundamentals, leaving the more technical calculations to the computer. This allows them to transform and adapt the procedures to different contexts and situations, an important characteristic for the exercise of the profession. In this sense, Libâneo (2004) points out that professional knowledge and skills must be acquired through the confrontation of experiences, in work situations and their context, and cannot be limited to technical skills and abilities.

As new possibilities, the computer illustrates concepts, performs experiments, and aids memory, replacing technical virtuosity and freeing users from much of the mechanical work involved in learning mathematics, such as memorizing and executing algorithms. On the other hand, there is a demand for more creativity, imagination, and criticality, as users need to know what to ask the computer and how to interpret the results, and should have more diverse knowledge at their fingertips (Bizelli, 2003; Howson et al., 1987). This requires teachers to be up-to-date and willing to experiment with new possibilities, in a scientific and pedagogical effort to make mathematics education truly relevant.

Integrating software into the classroom can raise questions about how best to use it. In 1987, Howson et al. pointed out that the ideal way to work with some types of calculations is to make students familiar with their assumptions so that they can understand their origins and use programs to replace hand calculations, which they considered a "waste of time". They point out that, thanks to the development of computers, students today need to understand mathematics in order to assimilate concepts, not techniques. A single example, well analyzed and properly presented, would be sufficiently more instructive than a list of repetitive exercises, allowing the time saved to be used to familiarize students with the basic concepts.

Three types of software were mentioned in the interviews: statistical, nutritional, and spreadsheet. The first two are fundamental for academic and professional practice, but their use in the nutrition course is insufficient or non-existent. The Excel spreadsheet was the most frequently observed, but the main problem reported was the students' lack of prior knowledge of the program.

Considering the importance of knowing the functionalities of statistical programs, we must keep in mind that in some cases the institution may have financial and structural limitations regarding the availability of computers for all students or the purchase of licenses for use. As a free alternative, you can use free software such as R for statistical applications or LibreOffice Calc for spreadsheets.

The GAISE report (Carver et al., 2016) recommends that the experience with computers should include a brief introduction to a statistical package, a demonstration of its use by an instructor, or the reading of a generic output of results with questions to probe the class's understanding.

These recommendations can also be adapted to nutrition software to provide a presentation of the main features of those used in nutritionist practice, such as Avanutri®, DietWin® and the WorldFood Dietary Assessment System®. The ideal training would include experience close to the reality of the workplace, but the methodological teaching alternatives recommended in the GAISE report can be applied to minimize the damage caused by a total lack of contact with these programs.

As far as Excel is concerned, the students' lack of knowledge of how to use it affects the progress of the lessons, in the sense that the time that the teachers devote to introducing its basic functions could be better used to explore the content of the subject and to solve problems. As an alternative to this problem, the institution could offer complementary practical courses on Excel, teaching the main functionalities needed for use during the undergraduate course and others applicable to nutrition, such as supplements and extensions for carrying out linear programming of diets and statistical analysis in research.

7 Final considerations

The analysis of the data from the interviews made it possible to identify coherence and inconsistencies between the training and professional needs of nutritionists and revealed two subcategories of technological tools used to perform calculations in the nutrition course: "pencil, paper, and calculator" and “software”. The results indicated a mechanistic teaching perspective, based on the emphasis given to calculations performed with pencil, paper, and calculator, substituting data in formulas, and harming the use of software. This practice is justified by the need for autonomy with computer resources during professional practice and the development of technical mathematical skills. However, these skills cannot be developed by memorizing formulas and applying them in repetitive exercises, since the routinization of these techniques tends to de-mathematize them, and mechanization limits the exercise of creativity and does not contribute to the development of understanding of concepts and procedures.

We found that the predominance of manual calculations in the classroom is dissonant with the professional needs of dietitians, and that the incorporation of technology already present in the professional environment is an immediate necessity. However, although software offers greater practicality and reliability in performing calculations, its simple inclusion in the classroom does not guarantee an improvement in students' understanding of mathematics, and a change in teaching approach is needed to move away from the technical, tool-based and pragmatic conception of mathematics.

To make better use of the computer resources available, the mathematical activities carried out in the classroom can be dynamic and rich in context, exploring different registers of representation, allowing students to deduce formulas and understand their foundations, while the more technical calculations are carried out by the software.

As we have seen, teachers have an important role to play in this shift in pedagogy. However, we recognize that this responsibility should not be attributed to them alone, since the changes must begin with the official curriculum, which currently does not address this issue, and be permeated and implemented by the other educational spheres.

In short, we start from the idea that the goals of mathematics education should be to develop students' deeper understanding of concepts and procedures and to help them achieve greater flexibility in applying these concepts and procedures in different contexts and problems. Thus, the ideal way to solve the formulas used requires more than memorizing algorithms; it requires an understanding of the internal structure of each equation and the types of solutions expected, so that students can understand that algebraic equations can describe mathematical connections in general, that they cover more than one situation, and that they can serve as tools for modeling real-world situations (Barzel; Ball; Klinger, 2019). These skills cannot be developed through the mechanical repetition of algorithms, which is a recurring theme in the nutrition classes analyzed, but through systematic reflection on the principles of formulas, flexible and creative problem-solving, and modeling of real situations, leaving the mechanical tasks to the available technology.

References

ALDON, Gilles; TRGALOVÁ, Jana. **Technology in Mathematics Teaching**. Cham: Springer International Publishing, 2019. 325 p. Available on: https://doi. org/10.1007/978-3-030-19741-4. ISBN: 978-3-030-19741-4 (*eBook*). Acess on: 04 mar. 2022.

ARTIGUE, Michèle. Learning Mathematics in a Cas Environment: the Genesis of a Reflection about Instrumentation and the Dialectics between Technical and Conceptual Work. **International Journal of Computers for Mathematical Learning**, v. 7, p. 245-274, 2002.

ARTIGUE, Michèle. Innovative technologies and approaches to mathematics education: old and new challenges. *In:* ALDON, Gilles; TRGALOVÁ, Jana. **Technology in mathematics teaching**. Cham: Springer International Publishing, 2019, p. 93-97. 325 p. Available on: https://doi. org/10.1007/978-3-030-19741-4. ISBN: 978-3-030-19741-4 (*eBook*). Acess on: 4 mar. 2022.

BARDIN, Laurence. **Análise de conteúdo**. Trad, de Luís Antero Reto e Augusto Pinheiro. São Paulo: Edições 70, 2016. 279 p. ISBN: 978-85-62938-04-7.

BARZEL, Bärbel; BALL, Lynda; KLINGER, Marcel. Students’ Self-Awareness of Their Mathematical Thinking: Can Self-Assessment Be Supported Tthrough CAS-Integrated

Learning Apps on Smartphones? *In:* ALDON, Gilles; TRGALOVÁ, Jana. **Technology in Mathematics Teaching**. Cham: Springer International Publishing, 2019, p. 75-91. 325 p. Available on: https://doi. org/10.1007/978-3-030-19741-4. ISBN: 978-3-030-19741-4 (*eBook*). Acess on: 4 mar. 2022.

BIANCHINI, Bárbara Lutaif; PUGA, Leila Zardo. Equações e inequações: uma abordagem a partir da utilização de duas ferramentas tecnológicas. *In:* CONGRESSO INTERNACIONAL DE EDUCAÇÃO A DISTÂNCIA, 11, 2004, Salvador, **Anais...**, v. 1. p. 1-11.

BIANCHINI, Bárbara Lutaif; PUGA, Leila Zardo. O uso de tecnologias no ensino superior em um contexto matemático. **Plures**. Humanidades (Ribeirão Preto), n.7, p. 45-54, 2006.

BIZELLI, Maria Helena Sebastiana Sahão. **A matemática na formação do químico contemporâneo**. 2003. 209 f. Tese (Doutorado em Educação Matemática). Instituto de Geociências e Ciências Exatas, Universidade Estadual Paulista, 2003. Available on: http://hdl.handle.net/11449/102150. Acess on: 14 may 2020.

BRIEND, André *et al.* Linear Programming: a Mathematical Tool for Analyzing and Optimizing Children's Diets During the Complementary Feeding Period. **Journal of Pediatric Gastroenterology and Nutrition**, v. 36, n. 1, p. 12-22, 2003.

CARVER, Robert *et al.* **GAISE College Report ASA Revision Committee**, "Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report 2016". American Statistical Association, 2016. 141 p.

CHEVALLARD, Yves. L'analyse des pratiques enseignantes en théorie anthropologique du didactique. **Recherches en didactiques des mathématiques.** Grenoble: La pensée Sauvage Éditions, v. 19, p. 221-265, 1999.

D'AMBRÓSIO, Ubiratan. **Educação matemática**: da teoria à prática. 19. ed. Campinas: Papirus, 2009. 120 p. ISBN: 85-308-0410-4.

DINIZ, Leandro do Nascimento. **O papel das tecnologias da informação e comunicação nos projetos de modelagem matemática.** 2007. 118 f. Dissertação (mestrado) - Universidade Estadual Paulista, Instituto de Geociências e Ciências Exatas, 2007. Available on: http://hdl.handle.net/11449/91079. Acess on: 4 mar. 2021.

DOCENTE. **Entrevista concedida à pesquisadora.** Goiânia, 21 set. 2021.

DOMINGUES, Nilton Silveira. **O papel do vídeo nas aulas multimodais de matemática aplicada:** uma análise do ponto de vista dos alunos. 2014. 125 p. Dissertação - (mestrado) - Universidade Estadual Paulista, Instituto de Geociências e Ciências Exatas, 2014. Available on: http://hdl.handle.net/11449/91019. Acess on: 13 mar. 2021.

DUVAL, Raymond. **Sémiosis et pensée humaine:** registres sémiotiques et apprentissages intellectuels. Bern: Peter Lang, 1995. 395p. ISBN: 3-906754-32-4.

ESTUDANTE. **Entrevista concedida à pesquisadora.** Goiânia, 5 out. 2021.

FREIMAN, Viktor. Types of Technology in Mathematics Education. *In:* LERMAN Stephen. (ed.) **Encyclopedia of Mathematics Education**. Springer, Dordrecht, 2014, p. 623-629. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

GUIN, Dominique; RUTHVEN, Kenneth; TROUCHE, Luc. (Eds.). **The Didactical Challenge of Symbolic Calculators**: Turning a Computational Device into a Mathematical Instrument. Springer Science & Business Media, 2005. 304 p. ISBN: 0-387-23435-7 (*eBook*). Available on: https://link.springer.com/book/10.1007/b101602. Acess on: 20 apr. 2022.

HEGEDUS, Stephen; MORENO-ARMELLA, Luis. Information and Communication Technology (ICT) Affordances in Mathematics Education. *In:* LERMAN Stephen. (ed.) **Encyclopedia of Mathematics Education**. Springer, Dordrecht, 2014, p. 295-299. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

HERNÁNDEZ SAMPIERI, Roberto; FERNÁNDEZ COLLADO, Carlos; BAPTISTA LUCIO, Pilar. **Metodologia de pesquisa**. Tradução de Daisy Vaz de Moraes. 5. ed. Porto Alegre: Penso, 2013. 600 p. ISBN: 978-1-4562-2396-0.

HOWSON, Geoffrey *et al.* (Eds.) **Mathematics as a Service Subject**, ICMI study series, Cambridge: Cambridge University Press, 1987. 89 p. ISBN: 978-0-521-35395-3.

LAJOIE, Susanne; LAVIGNE, Nancy. Mathematics Learning. Learning Tools. s.d. Available on: https://education.stateuniversity.com/pages/2202/Mathematics-Learning-LEARNING-TOOLS.html. Acess on: 28 nov. 2022.

LAVICZA, Zsolt. **A Comparative Analysis of Academic Mathematicians' Conceptions and Professional Use of Computer Algebra Systems in University Mathematics.** Unpublished Doctoral Dissertation. Faculty of Education, University of Cambridge, Cambridge, UK, 2008.

LIBÂNEO, José Carlos. **Organização e gestão da escola:** teoria e prática. 5. ed. Goiânia: Alternativa, 2004. 304 p. ISBN-10: 8567281008.

MONAGHAN, John. The Calculator Debate. *In:* MONAGHAN, John; TROUCHE, Luc; BORWEIN, Jonathan. **Tools and Mathematics**. Springer, Cham, 2016, cap. 13, p. 305-329. 483 p. Available on: https://doi.org/10.1007/978-3-319-02396-0. ISBN: 978-3-319-02396-0 (*eBook*). Acess on: 04 mar. 2022.

MONAGHAN, John; TROUCHE, Luc. Introduction to the Book. *In:* MONAGHAN, John; TROUCHE, Luc; BORWEIN, Jonathan. **Tools and Mathematics**. Springer, Cham, 2016, cap. 1, p. 3-12. 483 p. Available on: https://doi.org/10.1007/978-3-319-02396-0. ISBN: 978-3-319-02396-0 (*eBook*). Acess on: 04 mar. 2022.

MONAGHAN, John; TROUCHE, Luc; BORWEIN, Jonathan. **Tools and Mathematics**. Springer, Cham, 2016. 483 p. Available on: https://doi.org/10.1007/978-3-319-02396-0. ISBN: 978-3-319-02396-0 (*eBook*). Acess on: 04 mar. 2022.

NUNES, Terezinha. Learning Difficulties, Special Needs and Mathematics Learning. *In:* LERMAN Stephen. (ed.) **Encyclopedia of Mathematics Education**. Springer, Dordrecht, 2014, p. 343-348. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

NUTRICIONISTA. **Entrevista concedida à pesquisadora.** Goiânia, 10 jan. 2023.

O'NEILL, Geraldine. **Curriculum Design in Higher Education:** Theory to Practice. Dublin: UCD Teaching & Learning, 2015. 187 p. Available on: http://researchrepository.ucd.ie/handle/10197/7137. ISBN: 9781905254989. Acess on: 18 sept. 2021.

PALIS, Gilda de La Rocque. Pesquisa sobre a própria prática no ensino superior de matemática. **Educação matemática no ensino superior:** pesquisas e debates. Brasília: SBEM, p. 203-221, 2009.

PEPIN, Birgit; GUEUDET, Ghislaine. Curriculum Resources and Textbooks in Mathematics Education. *In:* LERMAN, Stephen (ed.). **Encyclopedia of Mathematics Education**. Springer: Dordrecht, 2014. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

PINTO, Maria Soraia; SILVA, Juliana de Araújo. Perfil do nutricionista clínico e sua atuação em consultórios na cidade de Fortaleza – Ceará. **Revista Brasileira em Promoção da Saúde**, vol. 25, núm. 2, abril-junho, 2012, p. 62-69.

PONTE, João Pedro. A matemática não é só cálculo e mal vão as reformas curriculares que a veem como simples disciplina de serviço. **Educação e Matemática**, p. 5-26, 1987.

PRIEBE, Débora Danielle Alves Moraes; ALVARENGA, Karly Barbosa. A matemática nos cursos superiores em saúde: mapear e conhecer. **Revista Sustinere**, Rio de Janeiro, v. 10, n. 1, p. 94-116, jan-jun, 2022a.

PRIEBE, Débora Danielle Alves Moraes; ALVARENGA, Karly Barbosa. A matemática no currículo de nutrição. **Educ. Matem. Pesq.** São Paulo, v. 24, n. 3, p. 279-322, 2022b.

RABELLO, Camila Vieira. **Uma investigação sobre o uso de ferramentas digitais do dia-a-dia para aprendizagem de Matemática**. 2012. 95 f. Dissertação (Mestrado Profissional em Educação Matemática) - Instituto de Ciências Exatas, Universidade Federal de Juiz de Fora, Juiz de Fora, 2012. Available on: https://repositorio.ufjf.br/jspui/bitstream/ufjf/1978/1/camilavieirarabello.pdf. Acess on: 4 mar. 2021.

RAVIOLO, Andrés; ALVAREZ, Marcelo; AGUILAR, Alfonso. La hoja de cálculo en la enseñanza de la Física: recreando simulaciones. **Revista de enseñanza de la física**, Vol. 24, n. 1, p. 97-107, 2011.

REPRESENTANTE. **Entrevista concedida à pesquisadora.** Goiânia, 3 jan. 2023.

REZENDE, Wanderley Moura. O ensino de Cálculo: um problema do ensino superior de matemática? *In:* ENCONTRO NACIONAL DE EDUCAÇÃO MATEMÁTICA, 8. 2004, Recife. **Anais**... Recife: Universidade Federal de Pernambuco, 2004. p. 21-33.

SANTOS, Anderson Anzai dos. **A construção do letramento estatístico em estratégias com o uso de tecnologias digitais em aulas de Estatística de cursos de graduação**. 2019. 134 f. Dissertação (Mestrado em Educação Matemática) - Pontifícia Universidade Católica de São Paulo, São Paulo, 2019. Available on: https://tede2.pucsp.br/bitstream/handle/22764/2/Anderson%20Anzai%20dos%20Santos.pdf Acess on: 4 mar. 2021.

SIEGEL, Martha. Teaching Mathematics as a Service Subject. *In:* HOWSON, Geoffrey *et al.* (ed.) **Mathematics as a Service Subject**, ICMI Study Series, Cambridge: Cambridge University Press, 1987. 89 p. ISBN: 978-0-521-35395-3.

SILVA, Mara Reis; FERREIRA, Carla Cristina da Conceição. **Nutrição humana**: da teoria à prática. São Paulo: Sarvier, 2020. 440 p. ISBN-10: 6556860042.

SINCLAIR, Nathalie; ROBUTTI, Ornella. Teaching Practices in Digital Environments. *In:* LERMAN Stephen. (ed.) **Encyclopedia of Mathematics Education**. Springer, Dordrecht, 2014, p. 598-601. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

SOUSA, Marlene; PINARGOTE, Angelica Guillen; PEREIRA, Isabel. O programa Excel como ferramenta para a formação dos profissionais de contabilidade. *In:* Investigação, Práticas e Contextos em Educação, VII, 2018, Leiria. **Livro de atas...** Escola Superior de Educação e Ciências Sociais, Instituto Politécnico de Leiria, 2018, p. 281-283.

SUTHERLAND, Rosamund.; ROJANO, Teresa. Technology and Curricula in Mathematics Education. *In:* LERMAN, Stephen (ed.). **Encyclopedia of Mathematics Education**. Springer: Dordrecht, 2014. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

TRINDADE, Daniella de Brito *et al.* Comparação entre softwares de cálculo nutricional de dietas. **DEMETRA**: Alimentação, Nutrição & Saúde, v. 13, n. 1, p. 307-322, 2018. Available on: https://www.e-publicacoes.uerj.br/index.php/demetra/article/view/29706/24219. Acess on: 23 mar. 2022.

TROUCHE, Luc. Managing the Complexity of Human/Machine Interactions in Computerized Learning Environments: Guiding Students’ Command Process Through Instrumental Orchestrations. **International Journal of Computers for Mathematical Learning**, n. 9, p. 281–307, 2004.

TROUCHE, Luc. Instrumentation in Mathematics Education. *In:* LERMAN Stephen. (ed.) **Encyclopedia of Mathematics Education**. Springer, Dordrecht, 2014, p. 307-313. 650 p. Available on: https://doi.org/10.1007/978-94-007-4978-8_40. ISBN: 978-94-007-4978-8 (*eBook*). Acess on: 12 apr. 2022.

TROUCHE, Luc. Integrating Tools as an Ordinary Component of the Curriculum in Mathematics Education. *In:* MONAGHAN, John; TROUCHE, Luc; BORWEIN, Jonathan.

Tools and Mathematics. Springer, Cham, 2016, cap. 12, p. 267-303. 483 p. Available on: https://doi.org/10.1007/978-3-319-02396-0. ISBN: 978-3-319-02396-0 (*eBook*). Acess on: 04 mar. 2022.

VYGOTSKY, Lev Semionovich. The Instrumental Method in Psychology. **The Concept of Activity in Soviet Psychology**, v. 2, n. 3, p. 135-143, 1981.

VYGOTSKY, Lev Semionovitch. **Thought and Language**. Cambridge, MA: MIT Press, 2012. ISBN: 978-0-262-51771-3.

WEYNE, Gastão Rúbio de Sá. **Obstáculos epistemológicos para a inclusão de disciplinas matemáticas nos currículos de medicina.** 2012. 210 f. Tese (Doutorado em Educação Matemática) - Pontifícia Universidade Católica de São Paulo, São Paulo, 2012. Available on: https://repositorio.pucsp.br/jspui/handle/handle/10932. Acess on: 4 mar. 2021.