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ELEMENTOS DE INVESTIGACIÓN EN CURRÍCULOS DE FORMACIÓN DOCENTE EN BRASIL Y PORTUGAL

Elements of research in teacher training curricula in Brazil and Portugal

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Resumen:

Este estudio tuvo como objetivo identificar, en las materias de cursos del área de formación docente de Educación Básica, aspectos relacionados con la investigación científica para la formación de estudiantes de pregrado. Se trata de un estudio cualitativo y documental. Los documentos analizados fueron las matrices curriculares de las carreras de Licenciatura en Ciencias Naturales de la Universidad Federal de Integración Latinoamericana - UNILA - Brasil y la formación de profesores de Educación Básica de la Universidad de Trás-os-Montes y Alto Douro - UTAD - Portugal. En la UNILA se analizaron 44 disciplinas y en la UTAD 45. En ambas se identificaron 7 disciplinas con aspectos relacionados con la investigación científica. A partir de los registros seleccionados en cada disciplina, fue posible establecer 3 categorías relativas a elementos relacionados con la producción de conocimiento, la comprensión de la construcción del conocimiento científico y las habilidades y competencias investigativas. Se observó que en la UTAD predominan elementos relacionados con la producción de conocimiento y en la UNILA con habilidades y competencias investigativas.

Palabras clave: **educación científica; formación docente; organización curricular.**

Abstract:

This study aimed to identify subjects from courses in the area of teacher training for Basic Education and aspects related to scientific research for the training of the licentiate. This is a qualitative and documentary study. The documents analyzed were the curricular matrices of the Degree in Natural Sciences at the Federal University of Latin American Integration-UNILA-Brasil and teacher training for basic education at the University of Trás os Montes e Alto Douro - UTAD-Portugal. At UNILA, subjects were analyzed in forty-four disciplines, and at UTAD 45. In both, 7 subjects were identified with aspects related to scientific research. From the records selected in each discipline, it was possible to establish 3 categories called elements referring to the production of knowledge, understanding the construction of scientific knowledge, and investigative skills and competencies. It was observed that in UTAD elements related to knowledge production predominate and in UNILA, to investigative skills and competencies.

Key Words: **Curriculum organization; science education; teacher education.**

1. Introduction

Constant changes and advances in science and technology influence contemporary society. These changes, as well as driving the transformations taking place worldwide, are also reflected in education, especially in the area of natural sciences, which is concerned with student education. The outlook for science teaching has therefore changed over time. Current proposals for teaching natural science subjects, such as Framework K-12 (European Comission, 2007; Ministério da Educação, 2018; National Research Council [NRC], 2012), emphasize the need for students to learn beyond the concepts and declaratory knowledge of the area, in other words, they stress the importance of also understanding the processes and procedures involved in the production of science (Duschl, 2008; Osborne, 2014), in order to promote student literacy. In this context, scientific literacy consists of the ability to understand and interpret the world (natural, social, and technological) and to be able to transform it based on the theoretical and procedural contributions of the sciences (Ministério da Educação, 2018).

As advocated by Unesco Brasil (2003), educational institutions should encourage students to participate in decisions relating to education and research. The same document indicates that governments should prioritize science education improvement at all levels, sensitizing and making the population aware of the relevance of science and encouraging its popularization. Especially for developing countries, it calls for measures to be taken to promote the professional development of science teachers and educators, enabling them to cope with the changes.

In the case of Portugal, higher education courses have been restructured over time to significantly improve the scientific training and professional skills of future educators and teachers. In this sense, the research component has been included in the syllabus of teacher training courses in order to train interventionist specialists who are aware of the value and potential of their area of training and who have the potential to base their choices on contact with the pedagogical reality in future professional contexts (Pereira, 2011). The importance of taking these guidelines into account is reinforced by various authors, including Pires (2018), who states that it is essential to include scientific research in the syllabuses of courses aimed at training future teachers because it allows students to prioritize the development of research into teaching and work contexts. Conducting investigative practices during lessons, as well as academic work, will enable students to develop various investigative skills and acquire professional knowledge, demonstrating that teachers play an important role as researchers (Linhares & Cavadas, 2012). Higher education institutions should; therefore, train students to regulate their practices in line with the research produced in their contexts of work and help them to master specific tools and technical aspects of research processes (Roldão, 2008).

Teacher training in Portugal follows a structured model that combines theoretical training, pedagogical practice, and specialization in subject areas. In general, teacher training courses include 3 years in specific areas of knowledge (such as Mathematics, Languages, or Science), which make up the bachelor's degree, and in addition, a further 2 years of specialization, corresponding to the master's degree, combining pedagogical subjects, didactics, and supervised teaching practice (usually called Internship). In the case of basic education teachers (1st and 2nd cycles) who are qualified to instruct children aged 3 to 12, the training is more generalist, while for secondary education, the training is specialized according to the subject area. The internship is conducted in public or private schools and allows future teachers to apply the knowledge acquired at university in real teaching contexts. During this phase, students work under the guidance of an experienced professor, who helps them develop practical skills such as classroom management, lesson planning, and student assessment. This practical experience is a mandatory requirement for obtaining a professional teaching qualification. In addition to initial training, Portugal also promotes continuous teacher training as a way of ensuring professional development throughout their careers.

The degree in Basic Education is the result of the requirements to adapt to the Bologna Process (Decree-Law 43/2007 of February 22). At the end of the 1st

Bologna Cycle (180 ECTS - 3 academic years), this degree allows students to choose the specializations that qualify them to work as kindergarten teachers, 1st Cycle Primary School teachers, and 2nd Cycle Primary School teachers, for a total of 120 ECTS each.

In Brazil, in 2019, the National Education Council drew up Resolution CNE/CP No. 2 of December 20, 2019, which was designed to promote reflections, solutions, and improvements to teacher training. It defined the National Guidelines for the Initial Training of Teachers for Basic Education and established the Common National Base for the Initial Training of Basic Education Teachers (BNC-Formação) in line with the National Common Curricular Base for Basic Education (BNCC) (Schwartz et al., 2022). These documents have led to the reformulation of course plans to meet the guidelines which, according to Schwartz et al. (2022), aim to develop competencies related to knowledge, practice, and professional engagement. In the BNC- Formação, the proposal to develop teaching competencies for research is evidenced among the general competencies for teacher training, highlighting 'developing arguments based on scientific facts, data, and information to formulate, negotiate, defend ideas, points of view, and common decisions' and the ability to 'recognize current scientific evidence from different areas of knowledge' (Ministério da Educação, 2018).

UNILA's degree course in Natural Sciences, which involves Biology, Chemistry, and Physics, aims to train teachers for Basic Education in the area of Natural Sciences, enabling graduates to develop educational standards that meet the demands of the 21st century. The course lasts four years and enables graduates to work in elementary school (6th to 9th grades) and high school in the components of the natural sciences. The Political Curriculum Project is structured around a set of subjects and activities from the beginning of the course, which provide the graduate with contact with pedagogical issues relating to the reality of the school institution, as well as the specific objects of knowledge in the area of Natural Sciences. The set of theoretical and practical didactic activities included in the course's curriculum allows the student to perceive the complexity of the modern social and technological context, providing them with opportunities to reflect on the role of the future teacher in the school environment. The course proposes interventions in schools, by carrying out and participating in expository activities, lectures, and practical classes, as well as responding to requests for support in the use of teaching materials or computerized materials. The degree course in Natural Sciences offers theoretical and practical training based on a curriculum structured as follows: a - Core of Basic Content (comprising curricular units aimed at developing teaching skills in the area of Natural Sciences, including knowledge of Biology, Physics, and Chemistry); b- Core of Deepening Content and Professional Practice (comprising Basic Knowledge of Education that underpins the pedagogical training of teachers for Basic Education); c- Integrating Core (articulates the curriculum through practical activities that promote the development of skills with a view to learning and integrating different types of knowledge. There are courses on 'experimental science laboratories,' so that undergraduates receive training focused on preparing practical lessons.

A specific issue for all UNILA undergraduate programs is the offer of a Common Cycle of curricular components whose main themes are Latin America, the Teaching of Spanish and Portuguese, and Introduction to Scientific Thought and Ethics.

When it comes to scientific education, Constantinou et al. (2018) see research as an intentional process to diagnose situations, formulate questions, propose, and test hypotheses, build models, and debate with partners using evidence, and representations to propose coherent arguments.

Azevedo (2006) defends in his studies the investigative elements necessary for research activities, such as proposing a problem in the form of a question that stimulates the student's scientific curiosity; raising hypotheses, which should be issued by the students through discussions; collecting data; analyzing the data, using graphs, texts, so that the students can explain the data and the conclusion in which the students formulate answers to the initial problem, based on the data obtained and analyzed.

Teaching by Inquiry is a proposal that meets the training needs of students in science education, as it presents the elements necessary for an investigation. Studies show that this teaching approach enables students to learn scientific concepts and procedures, as well as develop various cognitive skills (Gouvêa & Suart, 2014; Zoller et al., 2002). In this sense, the National Research Council (NRC, 2000, 2012), and Carvalho (2006) point out some elements that are inherent to inquiry teaching, such as the proposition of a problem, the issuing and confrontation of hypotheses by students, the collection and interpretation of data, the conclusion and the communication of results. Concerning inquiry teaching, these elements are essential characteristics of investigative practices, according to Bybee (2006).

Teaching by Inquiry, also called ‘inquiry’ in English-speaking countries and ‘Indagación’ in Spanish-speaking countries, emerged at the end of the 19th century with the ideas of philosopher and biologist Herbert Spencer and chemist Charles Eliot (Deboer, 2006). At the beginning of the 20th century, it was greatly influenced by the ideas of Dewey and Joseph Schwab in the 1950s and 1960s and is still growing today, presenting different approaches. Since the 1990s, it has been widely disseminated following the publication of the National Science Education Standards (NRC, 1996). Thus, many curriculum documents for the area of Natural Sciences propose Science Teaching by Investigation as a practice to be developed in the classroom with students.

The literature review carried out by Pauletti & Morais (2022) on the last ten years of publications on Inquiry Teaching provided enough information to highlight the positive results of this practice not only for teacher training but also for pedagogical practices. Some of these benefits include enhancing lesson quality and supporting conceptual understanding of science. Thus, the authors defend the need for undergraduate and continuing education courses to provide teachers with access

to investigative practices so that they have contact with the elements of a scientific investigation (Cunha, 2020).

This was also pointed out by Anderson (2002) and Cardoso (2018) when they emphasized that it is essential that training programs offer support to teachers so that they have access to knowledge related to inquiry teaching and can deal with the difficulties presented in their work context.

This study is part of a larger study investigating the curriculum for teacher training at two universities that have partnered to develop projects in the area of teacher training for subjects in the field of natural sciences. This study presents the data obtained from the analysis of the curricular matrices of UNILA (Federal University of Latin American Integration-Brazil) and UTAD (University of Trás-os-Montes and Alto Douro-Portugal), which are part of this project. Considering the importance of contact with investigative practices during initial teacher training, this study aims to identify subjects in teacher training courses for basic education that present aspects of scientific research, i.e. investigative elements. These elements can be identified in the syllabus or objectives of the subjects, such as proposing a problem, issuing, and confronting hypotheses by the students, collecting and interpreting data, concluding, communicating, and socializing the results, or whether the subject provides opportunities for practices related to scientific research, such as preparing scientific papers and scientific articles.

2. Methodology

The research conducted is qualitative and is classified in terms of its procedures as documentary research. According to Marconi & Lakatos (2003), the main characteristic of documentary research is that the source of data collection is restricted to documents, whether written or not, which constitute what is known as primary sources and therefore, have no analytical treatment. According to Fonseca (2002), documents, which are the sources for the study, can be statistical tables, newspapers, magazines, reports, official documents, letters, films, photographs, and others.

Document analysis involves a sequence of systematic steps, generally based on the following phases: Definition of the research problem; Selection of documents, inclusion and exclusion criteria must be defined to ensure relevance, reliability, and representativeness of sources; Classification and Organization, documents are organized based on thematic or chronological categories to facilitate analysis; Content or Discourse Analysis; Validation, cross-checking information with other sources or methods to verify the consistency of interpretations (Souza & Giacomoni, 2021).

In this study, the documents analyzed were the curricular matrices of the Biological Sciences courses at the Federal University of Latin American Integration-

UNILA (2014) and Basic Education at the University of Trás-os-Montes and Alto Douro in Portugal-UTAD, for the 2021/2022 academic year.

The convenience study sample was chosen because some of the authors were professors at the institutions under study, which allowed for greater accessibility and availability for data collection. In other words, this option has some advantages: data collection is quicker, less expensive, and allows the use of samples available in the researcher's environment, although it does not offer representativeness for broader generalizations. The use of convenience sampling in this study is because it allows information to be collected more efficiently and there is easier access to teaching platforms to obtain data from the higher education institutions to which the researchers involved in this study belong.

The items analyzed in the UNILA curriculum matrix were the syllabuses for each subject and, in UTAD, the objectives proposed for each subject, considering that in the UTAD curriculum matrix, there is no mention of the term syllabus, but objectives, which we believe to be compatible with the UNILA syllabuses. In order to meet the objectives, set out in this study, a comparison was made between the syllabuses and objectives of these curricular matrices. The subjects were selected after detailed reading and analysis of the UNILA Syllabus, and the UNILA Objectives, to identify their investigative elements. After this identification, the excerpts containing the investigative aspects of each syllabus were extracted for later analysis.

From UNILA, the data was obtained from the 2014 Pedagogical Project of the Degree Course in Natural Sciences: Biology, Physics, and Chemistry, which contains 44 compulsory subjects spread over 8 semesters and 28 elective subjects, 7 of which were selected for their investigative element. This course trains teachers to teach science classes in basic education for ages 11 to 14. From UTAD, the data was obtained from the Curricular Unit sheets available online on the Basic Education Degree course website: Teaching Information and Support System (SIDE) for the 2021/2022 academic year, which contains 45 subjects spread over 6 semesters, 4 of which are elective subjects, from which 7 subjects were selected that have aspects relating to scientific research. We believe that the course offered by UTAD is similar to Pedagogy courses in Brazil but, at UTAD, graduates are required to obtain a master's degree to be qualified to teach Science to students aged 6 to 11.

3. Data presentation and analysis

Once the subjects had been selected, the investigative elements present in each were analyzed. Therefore, only the subjects for which at least one of the investigative elements was identified, under the aim of this study, are presented. The data was analyzed using content analysis, according to Gomes (2009), based on the breakdown and treatment of the content obtained. According to the author, it is necessary to break down the material to be analyzed into parts to establish the

recording units; distribute the parts into categories; describe the results of the categorization, explaining the findings of the analysis; make interferences with the results and interpret the results obtained with the help of the theoretical basis adopted.

Table 1.
Lists the subjects in the Basic Education course at the University of Trás-os-Montes - UTAD, Portugal.

Discipline/Objectives	Investigative elements
Physics/Chemistry: the aim is to develop skills in using concepts and establish relationships between concepts and laboratory skills, recording observations, analyzing results, and drawing conclusions.	- Recording observations - Analyzing results - Drawing conclusions.
Dramatic Expression III: developing a spirit of research and creativity. - Developing habits of analyzing problems in real situations, formulating hypotheses, investigating, testing, and planning to find appropriate responses.	- Formulate hypotheses - Investigating - Testing - Planning.
History of Science: identify some researchers, learn about their main contributions, and place them in a historical context. - Acquire temporal notions related to important scientific events. - Refer to lines of research in the area of the History of Science. - Conduct scientific work and present it to the class. - Research and select information.	- Referring to lines of research - Carrying out scientific work - Searching for and selecting information.
Health Promotion: acquire knowledge in the area of Health Education; discuss, from a current and critical perspective, themes in Health Education; build an integrative and interdisciplinary vision in Health Education; know how to write reports and summaries and prepare a scientific article.	- Prepare a scientific article.
Human Development: analyzing theoretical knowledge related to research and practice.	- Analyzing theoretical knowledge related to research.
Research Methodology: know the main characteristics of scientific research. - Identify the main scientific research methods / Describe the stages of the scientific research process. - Know the structure of a research project. /Correctly formulate research problems. - Develop practical scientific research skills. /Prepare a scientific article. /Mobilize scientific and technological knowledge. - Research, select, and organize information to transform it into actionable knowledge.	- Know the main characteristics of scientific research. - Identifying the main scientific research methods. - Correctly formulate research problems. - Develop practical scientific research skills. - Searching, selecting, and organizing information.
Teaching Natural Sciences: understanding the importance of science education in pre-school education and primary and secondary education. - Apply teaching, learning, and assessment methods, and techniques when planning activities in the area of natural sciences.	- Understand the importance of science education.

Source: Study plan for the Degree in Basic Education at the University of Trás-os-Montes e Alto Douro - Portugal-2021/2022.

In Table 1, we can see that 18 investigative elements were identified in the 7 disciplines of UTAD's Basic Education course, the most frequently mentioned of which was 'researching and selecting information.' We also found that writing a scientific paper was included in 2 of the 7 subjects.

Table 2 shows the subjects in the Biological Sciences course at the Federal University of Latin American Integration (UNILA).

Table 2.
Results referring to the investigative elements found in the subjects of the Biological Sciences course at the Federal University of Latin American Integration, UNILA (Brazil)1

Discipline/Summary	Investigative Elements
Biology Elements: Epistemological and conceptual study of Life, Sciences, and Biological Sciences. Study of the learning criteria and indicators proposed for teaching Biology in Curriculum Parameters. Understanding the process of acquiring basic attitudes, skills, and competencies in the process of systemic and rational construction of scientific knowledge, as well as the teaching-learning process in Life Sciences.	- Understanding the process of acquiring basic attitudes, skills, and competencies in the systemic and rational construction of scientific knowledge.
Introduction to Biology I: Cytology and Genetics: cells and their organelles. Metabolism, physiology, and cell metabolism. Theoretical-practical interdisciplinary teaching and learning of cytology and genetics are aimed at teacher training. At the end of the course, the student will have an idea of the fundamental topics of cytology and its research tools, which use principles of chemistry, and physics, and the necessary resources (equipment, microscopes) for teaching this content. Development of skills and tools for critical and autonomous thinking.	- An understanding of the fundamental topics of cytology and its research tools, which use principles of chemistry, physics, and the necessary resources (equipment, microscopes) to teach this content. - Development of skills and tools for critical and autonomous thinking.
Introduction to Biology II: Biological Morphologies - a study of the different histological, anatomical, morphological, and functional patterns in different groups of living beings (animals and plants). The use/development of different teaching resources aimed at improving scientific skills in observation, recording, analysis, and communication. By the end of the course, the student should have a systemic view of the similarities and antonyms of various tissues, organs, and systems, as well as the morphological differences of organisms in different taxonomic groups.	- Improve scientific observation, recording, analysis, and communication skills.
Introduction to Biology III: Biodiversity - the importance of classifying biological diversity. The history of taxonomy and the systematics of living beings. Methodologies for establishing taxonomic groups. The five kingdoms of living beings. Introduction to concepts of biogeography. The fossil records. Earth's geological eras. Biological diversity in the different geological eras. Dynamic elaboration of questions and assumptions about scientific information on geological history and the current systematics of living beings and proposing research strategies to find solutions. The use of educational teaching collections in science teaching.	- Developing questions and assumptions about scientific information. - Research strategies for finding solutions.

1 Data obtained from the Pedagogical Project of the Bachelor's Degree Course in Natural Sciences: Biology, Physics, and Chemistry - Federal University of Latin American Integration (UNILA) - 2014

Methodology of Physics Teaching: motivation of Physics Teaching in Basic Education; Problematization and Contextualization in Physics Teaching; Epistemological and Pedagogical Obstacles in Physics Teaching; The role of experimentation in Physics Teaching; Problem-solving in Physics Teaching; Physics Curriculum: textbooks and teaching proposals; Skills and Competencies; Analysis of Physics and Science Teaching journals; Analysis of textbooks, Physics projects, and Physics and Science curriculum proposals; Scientific Dissemination; Scientific and Technological Literacy (ACT).	- Problematization and contextualization in physics teaching. - Experimentation in physics teaching. - Problem-solving.
Introduction to Scientific Thinking: critical and argumentative skills in the production of scientific knowledge. Relations between epistemology and methodology.	- Critical and argumentative skills.
Term Paper: Discusses methodology and method for investigating the research problem. Provides the conclusion and presentation of the research project to a panel.	- Discuss the methodology and method for investigating the research problem.

Source: Pedagogical Project for the degree course in Natural Sciences: Biology, Physics, and Chemistry - Federal University of Latin American Integration (UNILA) - 2014

Table 2 shows that out of the 7 disciplines that make up the UNILA Bachelor's Degree in Natural Sciences, we have distinguished 11 investigative elements in which skills for investigating and understanding aspects of the construction and understanding of scientific knowledge are indicated.

After a detailed analysis of the fragments obtained from each university's curriculum matrix, it was possible to establish three categories (Gomes, 2009). The categories were organized based on syntactic groupings, i.e., essential terms that appear in the objectives (UTAD) or syllabus (UNILA) that refer to scientific research, considered as recording units for the subsequent elaboration of the categories. In this way, it was possible to systematize three categories called elements referring to the production of knowledge, relating to the aspects that underpin scientific knowledge; elements referring to understanding the construction of scientific knowledge, in this case alluding to the undergraduates' understanding of scientific research; elements referring to investigative skills and competences, concerning the abilities expected of undergraduates to develop regarding scientific research. Table 3 shows the fragments extracted from the syllabus/objectives of each discipline selected, as well as the categories to which the fragments selected belong.

Table 3.
Categories established from the selected records.

Categories	UTAD Fragments	UNILA Fragments
1. Elements related to knowledge production	Recording observations. Analyzing results. Drawing conclusions. Formulating hypotheses. Investigate. Testing. Planning. Searching for and selecting information. Correctly formulate research problems. Search, select, and organize information.	- Investigation strategies for finding solutions. - Problematization and contextualization in physics teaching. - Discuss the methodology and method for investigating the research problem. - Problem-solving. - Experimentation in physics teaching. - Developing questions and assumptions about scientific information.
2 - Elements relating to understanding the construction of scientific knowledge	- Refer to lines of research. - Conduct scientific work. - Analyze theoretical knowledge related to research. - Know the main characteristics of scientific research. - Identify the main scientific research methods. - Understand the importance of scientific education.	- Systemic and rational construction of scientific knowledge. - Notions of the fundamental topics of cytology and its research tools.
3 - Elements relating to investigative skills and competencies	-Prepare a scientific article. - Develop practical scientific research skills.	- Developing skills and tools for critical and autonomous thinking. - Improving scientific observation, recording, analysis, and communication skills. - Critical and argumentative skills.

Source: Prepared by the authors.

In Table 3, it is possible to identify a total of 18 elements referring to scientific research in the selected subjects at UTAD and 11 at UNILA. In this sense, it can be inferred that the teacher training course offered by UTAD has a greater emphasis on investigative practices when compared to the Natural Sciences course offered by UNILA.

Regarding the categories in which these elements are classified at UTAD and UNILA, in both matrices those relating to the production of scientific knowledge predominate. At UTAD, the investigative elements classified under investigative skills and competencies appear in smaller numbers, while at UNILA they refer to the construction of scientific knowledge. We believe that investigative skills and competencies are necessary capacities for mobilizing knowledge in order to carry out investigative practices, just as investigative elements relating to the construction of scientific knowledge enable students to better understand the production of knowledge. In this sense, we believe that there is a need for a better balance in the

distribution of the two categories that make up these investigative elements to favor the students' comprehensive scientific training.

One relevant fact worth mentioning is the target audience for the courses at both universities. Considering the age group that in Brazil corresponds to primary school, UTAD trains graduates to work in the subject of Sciences in basic education with students aged between 6 and 11, which in Brazil corresponds to the early years of primary school, and UNILA, for the same subject, but for students aged between 11 and 14, referring to the late years of primary school. It is important to note that both universities have subjects in their curricula that include scientific training for undergraduates, although there are more of these in UTAD's subjects. We believe that UTAD provides its undergraduates with a richer scientific education since they will be working on other subjects in the curriculum and not just Science.

We believe it is extremely important for students to have contact with investigative practices during their training. Galvão et al. (2018) corroborate these statements when they say that research helps to increase their learning, to amend their teaching practice, seeking answers to their own needs and to the problems they face in their daily lives. Contact with these investigative elements in training favors the development of competencies related to inquiry and critical thinking, both of which make up the scientific competencies needed to prepare teachers for teaching in basic education (Galaz & Weil, 2014).

In Portugal, the introduction of research components in teacher training is recommended by several authors (Pereira, 2011; Roldão, 2008). These components should be an integral part of the future teacher's initial training since this is the only way to 'help them understand the nature, problems, methods, and value of producing knowledge in these areas, enabling them to develop an investigative attitude, open to reflection and to deepening their knowledge' (Alarcão et al., 1997, p. 9).

In Brazil, investigative elements are present both in the normative document for Basic Education - Common National Curriculum Base and National Curriculum Base - Teacher Training ((Ministério da Educação, 2018, 2019).

3.1 Discussion and implications for teacher training

This section discusses the relationship between the data obtained from the curricular matrix of both universities and the normative documents for training students in basic education. In this sense, it is possible to see whether there is a correspondence between the investigative elements proposed in the course matrix for teacher training and what is expected for the scientific training of students in school, considering that teachers need to meet the demands of basic schooling in terms of scientific education, so there is a need for university curricula to offer these conditions.

The 'Pupil Profile' and the 'Core Competencies' are two of the main normative documents that shape what children are expected to achieve at the end of

compulsory schooling, and the commitment of the school and all those who work there is crucial to this.

The Student Profile document includes two competencies associated with the subject under study: Reasoning and problem solving, and critical thinking and creative thinking. In terms of reasoning and problem-solving, it is considered that students should be able to 'interpret information, plan and conduct research; manage projects and make decisions to solve problems; develop processes leading to the construction of products and knowledge, using diverse resources,' among others (Direção Geral de Educação [DGE], 2017, p. 23). The skills associated with critical thinking and creative thinking presuppose that students can think comprehensively and in-depth, logically, observe, analyze information, experiences, or ideas, argue using implicit or explicit criteria, with a view to taking a reasoned position; predict and evaluating the impact of their decisions; developing new ideas and solutions, imaginatively and innovatively, as a result of interaction with others or personal reflection, applying them to different contexts and areas of learning (DGE, 2017, p. 24).

About the Core Competencies in Sciences, it is clearly suggested that students should be offered the opportunity to carry out investigative activities that allow them to take ownership of scientific processes to build concepts and links between them to understand the phenomena and events observed and, in this way, contribute to better knowledge, understanding, and mastery of the world around them (DGE, 2018).

It should be added that at UTAD, the organization of the Study Plans for Teacher Training Courses takes into account the documents mentioned above, as well as the guidelines defined by the Legal Framework for Professional Qualification for Teaching (Decree-Law no. 112/2023, of November 29), which guides decision-making in the context of curriculum development, consistent with the vision of the future, i.e. which professionals we want to train. In this way, the investigative elements found in UTAD's subjects are, in our opinion, results of the requirements of the normative documents but also of the training of the teachers who teach them.

We also believe that integrating investigative elements into all the subjects on the course syllabus would be fundamental to fostering the all-round development of future teachers, stimulating creativity, problem-solving skills, and critical thinking in all areas of knowledge. In this sense, the requirements of the normative documents for training students in basic education in Portugal are aligned with the investigative elements present in the UTAD curriculum matrix, listed in the categories of knowledge production, understanding the construction of scientific knowledge, investigative skills, and competencies.

In Brazil, the National Common Core Curriculum - BNCC is the guiding document for basic education. Concerning students' education in the area of Natural Sciences, 'the investigative process must be understood as a central element in

students' education, and its development must be linked to didactic situations planned throughout Basic Education' (Ministério da Educação, 2018, p. 323).

The skills related to science education that students need to develop are observing the world around them and asking questions; proposing hypotheses, evaluating information (validity, coherence, and appropriateness to the problem formulated); developing explanations and/or models; associating explanations and/or models with the historical evolution of the scientific knowledge involved; Selecting and constructing arguments based on evidence, models and/or scientific knowledge; Systematically presenting data and research results; participating in scientific discussions with peers, teachers, family members, and the community in general (Ministério da Educação, 2018).

We believe that these expected skills are in line with the investigative elements present in the UNILA matrix, which are grouped into the categories of knowledge production, understanding the construction of scientific knowledge, investigative skills, and competencies.

Initial teacher training in Brazil, as well as continuing teacher training, is guided by the Common National Base - CNB Training (Ministério da Educação, 2019). According to Sodré & Zompero (2023), the investigative proposal is present in chapter III of the aforementioned document, which deals with the curricular organization of courses for the Initial Training of Teachers for Basic Education, and is in line with the learning prescribed in the National Common Core Curriculum for Basic Education, Article VIII and item II, which presupposes a commitment to new methodologies and other training activities that enable future teachers to learn in a meaningful way and that are relevant to their social context in a didactic-methodological approach related to the BNCC, aiming to improve teaching autonomy, problem-solving skills, in line with investigative and creative processes (Ministério da Educação, 2019).

The BNC-Training presents general competencies to be developed by teachers. In this case, competency two contains the investigative elements 'Research, investigate, reflect, carry out critical analysis, use creativity, and seek technological solutions to select, organize, and plan challenging, coherent, and meaningful teaching practices' (Ministério da Educação, 2019, p. 13). Competency seven also alludes to investigative elements 'Develop arguments based on facts, data, and scientific information to formulate, negotiate, and defend ideas, points of view and common decisions [...]' (Ministério da Educação, 2019, p. 13).

In this sense, the presence of subjects in the curriculum that allow contact with investigative practices is essential for teacher training, considering that this knowledge is necessary to work in basic education to contribute to students' scientific training.

On the other hand, some challenges pointed out by Vaillant (2019) emphasize that there is a gap between what is proposed in teacher training curricula, theories, practices, and school reality, especially in Latin American

countries. In this sense, the author mentions that in order to overcome fragmented and encyclopedic curricula, curricular reforms have been carried out to prepare teachers in training for the challenges of the 21st century.

Considering science education and research elements, it is necessary that science classrooms contemplate the processes and situations that occur in the social context so that they favor the participation of students in organizational processes of thought; the communication of ideas; the adoption of positions that are supported by good arguments; and respect for positions so that students develop the ability to use scientific knowledge to identify questions and formulate conclusions; the adoption of positions that are supported by good arguments; and respect for positions so that students develop the ability to use scientific knowledge to identify questions and formulate conclusions based on evidence that allow them to understand and make decisions about the natural world (Martín-Gámez, 2020). We admit that in order for students to have these elements in their training, it is necessary for teacher training courses to train teachers through practices based on curricula that have subjects providing opportunities for aspects of scientific research.

4. Concluding remarks

In this study, we have sought to identify aspects of scientific research in the courses offered by two universities - UTAD and UNILA. The investigative elements were identified in the curricular matrices of both universities, which are organized into three categories. It is important to mention that although the investigative elements were only identified in the syllabuses of UNILA's courses and the objectives of UTAD's courses, as proposed in this study, it is possible that other courses at these universities also include aspects of scientific investigation in their content, methodological proposals or assessment instruments.

Therefore, this study can be considered a preliminary one, which could be expanded in the future. We admit that research of this nature is relevant because it shows which aspects are prioritized in the scientific training of undergraduates to work in Basic Education, considering the demands and requirements of today's societies, allowing us to rethink and propose new directions for the initial training of teachers.

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