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ARTICLE

Teaching Internship: a look at didactic modalities in botany teaching

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ABSTRACT:

This article investigates the influence of the teaching methods used by higher education botany professors on the teaching practices of undergraduates in schools. It is based on the premise that pedagogical approaches, which are often theoretical and content-centered, are reproduced by future educators and contribute to perpetuating botanical imperceptions in society. The aim was to survey the teaching methods used by Biological Sciences undergraduates during their teaching internship to teach botany. Documentary analysis was carried out on the texts of high school internship reports. Content Analysis revealed a predominance of expository-dialogue classes, solving exercises and practical activities, with a preference for the use of playful resources and scientific texts. The creativity of the interns stood out, showing a tendency to propose more interactive and contextualized teaching strategies, breaking with traditional teaching.

Keywords:
Botany education; teacher training; high school.

Pasantía Docente: una mirada a las modalidades didácticas en la enseñanza de la botánica

RESUMEN:

Este artículo investiga la influencia de los métodos de enseñanza utilizados por los profesores de botánica de la educación superior en las prácticas pedagógicas de los estudiantes universitarios en las escuelas. Se basa en la premisa de que los enfoques pedagógicos, a menudo teóricos y centrados en el contenido, son reproducidos por los futuros educadores y contribuyen a perpetuar las impercepciones botánicas en la sociedad. El objetivo fue sondear las modalidades didácticas utilizadas por los estudiantes de Ciencias Biológicas durante su pasantía curricular para enseñar botánica. Se realizó un análisis documental de los textos de los informes de su pasantía curricular. El Análisis de Contenido reveló un predominio de clases expositivas-dialógicas, resolución de ejercicios y actividades prácticas, con preferencia por el uso de recursos lúdicos y textos de divulgación científica. Destacó la creatividad de los pasantes, que mostraron una tendencia a proponer estrategias de enseñanza más interactivas y contextualizadas, rompiendo con la enseñanza tradicional.

Palabras-clave:
Educación botánica; estrategias de ensenãnza, material didácticos

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Estágio de Docência: um olhar sobre as modalidades didáticas no ensino de botânica

RESUMO:

Este artigo investiga a influência das modalidades didáticas utilizadas por professores de botânica do ensino superior nas práticas pedagógicas dos licenciandos nas escolas. Parte-se da premissa de que as abordagens pedagógicas, muitas vezes teóricas e centradas em conteúdo, são reproduzidas pelos futuros educadores e contribuem para perpetuação da impercepção botânica na sociedade. O objetivo foi fazer um levantamento das modalidades didáticas utilizadas por licenciandos em Ciências Biológicas durante o estágio de docência para o ensino de botânica. A análise documental foi realizada nos textos dos relatórios de estágio no Ensino Médio. A Análise do Conteúdo revelou um predomínio de aulas expositivas-dialogadas, resolução de exercícios e atividades práticas, com uma preferência pelo uso de recursos lúdicos e textos de divulgação científica. Destacou-se a criatividade dos estagiários, evidenciando uma tendência em propor estratégias pedagógicas mais interativas e contextualizadas, rompendo com o ensino tradicional.

Palavras-chave:
Estratégia didática,
Material Didático;
Educação Básica.

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INTRODUCTION

Historically, botany has played a crucial role in science, but in the 1990s evidence emerged that there was less interest among students, teachers and researchers in this area of knowledge (Allen, 2003; Darley, 1990; Hershey, 1996; 2002; Wandersee & Schussler, 1999). Although Brazil is a country with great plant biodiversity, lack of interest in botany has also been recorded at all levels of education (Cruz et al., 2021; Melo et al., 2012; Oliveira & Liesenfeld, 2020; Salatino, 2001; Salatino & Buckeride, 2016; Silva et al., 2022). This tendency could result in a future society that does not understand the role of plants in maintaining life on our planet, an essential aspect for understanding the current climate crisis situation. Therefore, it is important to investigate the causes in order to develop effective measures to reverse this situation. Several researchers have listed factors that may be perpetuating the lack of interest in plants, such as the difficult scientific terminology in the academy, the lack of scientific knowledge of basic education teachers, zoochauvinism, the lack of up-to-date teaching material and the persistence of traditional teaching methodologies (Barbosa et al., 2020; Salatino, 2001; Salatino & Buckeride, 2016; Ursi et al., 2018; Vasques et al., 2021).

In this context, it has been noted that the lack of interest in botany has entered a cyclic movement, in universities and schools, on the part of students and teachers (Salatino & Buckeridge, 2016; Ursi et al., 2018). Some countries have already stated that society's lack of knowledge about flora has had a direct impact on research funding and also on practices that threaten conservation and environmental preservation (Balding & Williams, 2016; Havens et al., 2014; Margulies et al., 2019).

Recently, it has become clear that the Base Nacional Comum Curricular (BNCC) neglects the importance of studying plants in its text (Freitas et al., 2021; Prestes et al., 2023). According to the analysis by Freitas et al. (2021), the term “plant(s)” is mentioned in only one skill in the 2nd year of high school and one in the 8th year of elementary school, both in the Thematic Unit “Life and Evolution”. In secondary school, there is no mention of the term “plant(s)” or “vegetable(s)”. These authors point out that the gradual reduction of botany content in the guiding documents for education, both in the curriculum and in the classroom approach, is evidence of the devaluation of the area.

Within the Biological Sciences, the teaching of botany is considered to be the most associated with traditional teaching methodologies because it is mostly based on memorizing terms and concepts. One of the explanations for the reproduction of traditional practices is pointed out by Marchioretto & Moço (2024), who observed that amongst young teachers, they searched their memories for models of teachers who were remarkable in their student life, and ended up reproducing their practices. In addition, it is well known that public tenders for professors at public universities place more value on research output than on pedagogical training (Dias & Branco, 2023). Marchioretto & Moço (2024) found that professors selected for their scientific

production end up teaching biological aspects that are relevant to their work as a researcher, with the aim of engaging new students in research projects and continuing their studies in graduate school, rather than thinking about training for teaching in Basic Education. Although many of these faculty members teach courses in both the bachelor's and teacher education programs, their primary focus is research in botany. However, research and educational practice should be integrated into the teaching and learning process.

Undergraduates recognize university professors of botany as a source of inspiration and examples to be followed (Silva & Sano, 2011). Thus, these authors conclude that the teaching methodology of undergraduate professors directly influences the way in which future teachers transpose botany content to their students. In the same vein, Marchioretto & Moço (2024) found that many botany professors with no pedagogical training do not adapt their didactic strategies to the training of undergraduate students, and therefore do not focus on the challenges of future professional performance in Science/Biology teaching.

The hypothesis of this work is that undergraduates will reproduce the same didactic strategies they experienced as students in their botany classes at school and university when they take on the role of teacher. To prove or disprove this hypothesis, we analyzed the experience reports of biology interns who taught botany classes in high school. In the situation of a curricular teaching internship, even though it is supervised, undergraduates have the opportunity to plan their lessons with autonomy and to practice in real teaching contexts, but the information in the reports ends up being lost over time because few reports are published. These reports are rich sources of information, as they record and reflect on the teaching practice of undergraduate students (Silva, 2013).

By understanding the importance of in-service teacher education and the curriculum of undergraduate courses for improving botany teaching, the aim of this study was to survey the teaching methods used by Biological Sciences undergraduates during their teaching internship to teach botany.

The systematization elements that make up the sections of this article are organized with this introduction, which describes the problem of teaching botany at the various levels of education. The theoretical framework sets out the factors that feed the cyclical lack of interest in teaching botany at all educational levels and contextualizes the teaching of botany in teacher training in Brazil, justifying the aim of the research. The methodology presents a qualitative documentary analysis of the Biology Teaching Internship reports from the Biological Sciences Licenciate degree course. In the Results and Discussion section, the Content Analysis highlights two categories: didactic modalities and didactic resources, thus enabling a dialog with the literature and the implications for the teaching practice of interns in training. The final considerations section lists the main conclusions that met the objectives, why the initial hypothesis was refuted and highlights the research's contribution to future studies. Finally, there are the references, with a complete list of the sources cited in the text.

THEORETICAL FRAMEWORK

The current state of botany teaching is a reflection of a number of factors. The main one, according to Parsley (2020), is the fact that humans do not perceive plants in the environment in the same way that they perceive animals. The author states that there is an asymmetry in our visual perception, which tends to be more stimulated by beings that move or have striking color patterns. In addition to this, there has historically been a zoochauvinistic view of teachers, who prioritize the use of animal examples over plants when teaching biology (Darley, 1990). The term zoochauvinism or animal chauvinism was defined and disseminated in academic circles in the 1990s (Hershey, 1996) and is still used in more recent work as it is identified as one of the causes of the neglect of plants in biology teaching (Brito et al., 2024; Piassa 2022).

Such issues related to the way humans perceive plants have been the subject of study by various researchers. Wandersee & Schussler (1999) proposed the term “plant blindness” to characterize the human inability to see or notice plants in their environment, to recognize the importance of plants in the biosphere and in human affairs, and to appreciate the aesthetics and unique biological characteristics of plants.

Recently, this term has come under criticism from the scientific community for alluding to ableism (Mackenzie et al., 2019). For this reason, Parsley (2020) proposed changing the term to "plant awareness disparity", recognizing that there is an inequality in the attention paid to animals and plants in society, with a possible impact on the production of knowledge. This discussion also took place in Brazil and was addressed by Ursi and Salatino (2022), where they brought up the use of the expression "*impercepção botânica*" as an alternative translation into Portuguese.

Studies looking into the reasons for this disparity in botanical awareness have found that the problem is partly due to the botanists themselves (Hershey, 2002). Historically, the teaching of botany in universities has been very descriptive, stuck in a vast nomenclature that becomes memorized and tedious (Hershey, 1996). Even more severely, the teaching of botany in higher education sometimes neglects the particularities of a curriculum aimed at teacher training, and is approached in a traditional, excessively theoretical manner and disconnected from the local reality (Fonseca & Ramos, 2017; 2018; Marchioretto & Moço, 2024; Silva & Sano, 2011; Silveira et al., 2019).

These aspects make up a vicious cycle that perpetuates decontextualized botany teaching in basic education, based on traditional methods inherited from in-service teacher education (Fonseca & Ramos, 2017; Macedo et al., 2012; Santos et al., 2021). To break this cycle, it is recommended that botany teaching includes more practical classes, contextualization with the local flora, the use of fun activities, active methodologies and interdisciplinary work (Pedrini & Ursi, 2022; Prestes et al., 2023; Reis et al., 2024, Santos et al., 2021; Towata et al., 2010).

At this point, we highlight the importance of the teaching internship in building the teacher's identity and proposing pedagogical practices centered on the student's learning process. As a compulsory curricular component of undergraduate courses, the internship offers future teachers the opportunity to experience and reflect on the various contexts of professional activity (Pimenta & Lima, 2006). During this experience at school, undergraduates can integrate biological and pedagogical knowledge (Bizzo, 2012). According to Pimenta (2013), the internship should not be seen only as the practical part of the course, because teaching is a theoretical-practical activity (praxis), which involves reflections on "what to teach", "how to teach", "to whom", "for what" and "in what circumstances". Thus, the experiences of undergraduates as students directly influence their praxis when planning lessons and using the different resources and didactic modalities that exist (Oliveira & Gianotto, 2020; Orlandi, 2015; Schmitt & Silvério, 2020).

Considering teaching practice and the scope of this work, we recognize didactic modalities as the different ways of organizing educational work so that specific educational objectives are achieved, including the teacher-student relationship, the space for implementation and the didactic resources available (Díaz, 2005, Krasilchik, 2011). The modalities can be lectures, practical classes, debates, excursions, case studies, exercise and problem-solving, problem-based learning, project-oriented learning, cooperative learning, individualized instruction (developing studies independently), among others. In turn, didactic resources correspond to all the material used in the teaching-learning-evaluation process, including physical and digital instruments. Therefore, the material itself and the way it is used in the classroom by teachers and students directly influences the didactic modality.

METHODOLOGY

This research consists of a qualitative Documental Analysis of the Biology Teaching Internship reports from the Biological Sciences Licentiate degree course. These documents report on the students' experiences during their high school internship. The sample covers the years 2016 to 2019, the period before the Covid-19 pandemic, in order to include only the planning and development of classroom lessons. In total, 89 reports were accessed, of which 30 presented reports of classes on botany content. We considered botany lessons to be those that covered the structure of the plant cell, including chloroplasts, vacuoles and cell wall; any photosynthesizing eukaryotic organism; or morphological, taxonomic, ecological and/or physiological aspects of plants.

The project was submitted to and approved by the Research Ethics Committee (CAAE 52078121.2.0000.5347). The invitation to take part in the research was sent via e-mail by the course coordinator to the undergraduate students who had submitted the 30 selected reports. A total of 18 graduates consented to

having their reports analyzed by signing the Informed Consent Form (ICF). As some interns wrote their reports in pairs, a total of 14 Teaching Internship reports were analyzed. To ensure anonymity, the reports will be identified by the letter "R" followed by a number (e.g. R01, R02...).

In order to achieve the objectives, a Content Analysis was carried out according to Bardin's method (2011), organized into three stages: 1) pre-analysis, 2) material exploration, and 3) results treatment, inference and interpretation. The pre-analysis stage included a "floating reading" to check whether the texts described didactic modalities and resources and formed the corpus of the analysis. One of the reports was eliminated at this stage because the description was too brief and lacked sufficient information. This stage also included formulating hypotheses and creating categories and subcategories in the codebook. In the case of category 1, didactic modality, the seven subcategories established before analysis were: a) expository lesson, b) expository-dialogued lesson, c) dialogued lesson, d) experimental practical class, e) demonstrative practical class, f) exercises and problems solving, and g) case study. In category 2, didactic resources, six subcategories were established prior to analysis: a) textbook, b) videos, c) science communication texts, d) teacher-authored texts, e) playful resources and f) experiments.

With the subcategories established, three randomly selected reports were analyzed independently by two researchers. During this preliminary analysis, the researchers identified passages from the text of the reports (recording units) and grouped them in the analysis matrix. The matrix with the raw data was constructed in a spreadsheet file (.xlsx), where the vertical axis corresponds to the categories and subcategories and the horizontal axis to the reports. This pre-testing procedure was used to check the effectiveness of the categorization criteria.

In the stage of exploring the material, a careful reading was made in search of indicators. In addition, after reading the material, two new subcategories emerged in the didactic modality: h) project-based learning and i) non-formal spaces. Among the didactic resources, the following subcategories emerged: g) debate, h) interview, i) news and j) food. In this part, the analysis matrix with the final results of the 13 reports was analyzed by all the researchers to confirm the recording units. These units were selected solely on the basis of the descriptions in the reports, in order to understand how the interns conducted the lessons and how the students interacted with them, with each other and with the information presented. The recording units were enumeration and counting the frequency of appearance. Some units were explicit as key words mentioned in the text, while in others we tried to understand the context. The reports include descriptions of several didactic sequences applied on different days, and each sequence consists of more than one activity. The results processing stage included inference and interpretations of the frequency analysis, the presence, absence and co-occurrence of the recording units.

RESULTS AND DISCUSSION

The results were organized into two categories: didactic modalities and didactic resources. The interpretations and inferences that emerged during the processing of the results will be presented below.

Didactic Modality

The information on the nine subcategories of didactic modalities is shown in Table 1. Analyzing the results, it can be seen that the expository-dialogued lesson was the most explored by the interns, appearing in 11 of the reports analyzed (84.6%). This lesson, according to Anastasiou and Alves (2005), is characterized by an exposition of the content interspersed with active student participation, with dialogue being a key tool in this method. To promote dialogue and stimulate students in this modality, the interns used a variety of strategies, such as reading summaries of the content, instigating questions, discussions about everyday life and oral explanations interspersed with dialogues.

The expository-dialogued lesson is an alternative to the traditional expository lesson, as it takes into account and values the students' prior knowledge, complementing the purely expository lesson (Anastasiou & Alves, 2005). The authors described that the expository-dialogued lesson is characterized by an exposition of the content interspersed with the active participation of the students, with dialogue being a key tool in this

method. In these types of lessons, when carried out by the research participants, care was taken to explain the meaning of Greek and Latin prefixes and suffixes in botanical terms, comparing them with other everyday words that use the same radicals, such as autotroph and automobile, which share the same prefix “auto” of Greek origin meaning “oneself” or “own”.

Table 1. Quantification and frequency of didactic modalities used in the reports.

Didactic modality (Category 1)	Number of reports [a]		Mention frequency in reports [b]
	Number	*%*	
Expository-dialogued lesson	11	84,6	29
Demonstrative practical class	8	61,5	12
Exercises and problems solving	8	61,5	16
Expository lesson	7	53,8	18
Dialogued lesson	6	46,2	14
Experimental practical class	5	38,5	10
Case study	3	23,1	3
Non-formal spaces [c]	2	15,4	2
Project-based learning [c]	1	7,7	1

Note. [a] N = 13. [b] The mention frequency in the reports was measured by the number of times each report mentioned the use of each resource. [c] Subcategories that emerged from the analysis.
Source: Survey data, 2025.

Other modalities explored included demonstrative practices and problem-solving exercises, corresponding to eight reports (61.5%) each. Practice lessons in general were well explored, with demonstrative ones being used more than experimental ones. It should be noted that the former is linked to observation and verification of results, with pre-established scripts, and does not characterize an investigative practice lesson, which involves the student's participation in solving a problem using the scientific method. In demonstrations, the student loses the opportunity to manipulate the material and make mistakes. Errors also play a pedagogical role and should be used for questioning, critical thinking and hypothesis testing in the scientific method.

The choice of demonstrative practices may be related to the need for interns themselves to provide materials for practical classes in public schools, without financial support, leading many to obtain only what is necessary for demonstrations. The lack of a laboratory, the time it takes to draw up the protocol to be followed and the lack of help in cleaning the space before and after the activity also need to be considered. In addition, it was also reported that the time available for Biology lessons, which is one period a week and in some situations can be reduced, also made it difficult for each student to carry out the activities. In any case, practice classes, even demonstrative ones, brought an important aspect of interaction with botanical material, whether in natura, on histological slides, or as herbarium specimens. This modality is also the one that appears most frequently in works aimed at proposing interventions in botany classes (Reis et al., 2024, Santos Júnior et al., 2021)

The use of practice lessons in the laboratory is widely used by Biological Sciences undergraduates, as it is considered a motivational factor for both the student and the intern, as well as being recommended by teachers/mentors (Kirsch et al., 2021). All the reports that used experiments obtained good results in terms of student participation and engagement, as well as understanding of the content. The intern reports in R06 that "*After that, the explanation of Angiosperms began, which included a diagram on the board, a practice lesson and an activity sheet. [...] Most of the class welcomed the activity. [...] Everything went smoothly and the class, which previously didn't seem to be very well-integrated, was relaxed and comfortable when answering the questions*" (our translation). Thus, even when they don't go according to plan, there is always something to be learned. With regard to these aspects, Pinheiro and Cardoso (2020) state that

> Experimentation is proposed to complement science teaching, as it is an interesting educational practice that stimulates students' creativity in solving problems, allows them to develop a scientific attitude, creates a pleasant atmosphere in the classroom, and helps to promote an understanding of the scientific and technological foundations of production processes, relating theory to practice in the teaching of the subject in question (p. 70. Our translation).

In the case of the subcategory exercises and problems solving, it was noted that they were accompanied by discussions, engaging students with questions that required them to recognize and select alternative answers. There were also questions that made it possible to build relationships between information through the correlation of columns, tables to be filled in, graphs and timelines to be interpreted or completed, etc. As a strategy to encourage the interpretation of texts, gaps were also included, usually at the end of sentences, about central concepts. It is worth noting the occurrence of schematic representations to be subtitled and proposals to create concept maps or schematic representations based on texts and videos. Finally, questions requiring the formulation of responses through open-ended discussions were also observed. In this last type of question, there were often relationships with everyday situations, which allowed students to mobilize knowledge from their experience.

There were seven reports using expository lessons (53.8%) and six dialogued lessons (46.2%). The expository lesson, according to Ribeiro (2007), is the oldest technique present in higher education at universities and is characterized by the transmission of knowledge from the teacher to the student (unidirectional). This modality is the one that appears most frequently in botany classes in higher education (Marchioretto & Moço, 2024). The authors emphasized that, at this level of education, practice classes serve to illustrate theoretical explanations. Criticism of the traditional teaching system has increased in recent decades, but it still prevails in basic education schools (Rosa, 2004; Theodoro et al., 2015). In the reports from R02 and R04, the undergraduates stated that they had faced problems during classes, such as side conversations about other subjects, something that may be linked to this chosen modality. Godoy (2000) points out that the purely expository method does not develop more complex skills on the part of the students, where there is an excessive appreciation of information and its memorization for reproduction in exercises and tests.

Although just over half of the reports had some experience of using expository lessons, it should be noted that the pre-service teachers of R05 were the ones who used this modality the most throughout the internship. However, despite this predominance, they also used aids such as posters, drawings, models, copies of texts and comparative tables. These resources may have helped to diversify the sources of information, encouraging greater student interaction through oral expression in large groups. Godoy (2000) points out that an expository lesson can be conducted in different ways by the teacher, from reading notes (exposition of concepts) to interacting with the students through questions to keep their attention. In this type, audiovisual resources are also included, as well as summaries on the board and schematic drawings made by the teacher during the lesson, so that students can also take notes in their notebooks for study at home.

Even though they used the expository method in some lessons, the authors of R01 and R02 also used dialogued lessons on other occasions. In these cases, they combined them with activities such as solving questions, discussing texts and everyday issues and using playful materials. According to Ribeiro (2007), the mere presentation of content can be detrimental to the acquisition of more complex intellectual skills. In this sense, the initiative to diversify the auxiliary resources was very positive, as highlighted in R02's report: "*In fact, they were distant, but not uninterested: as soon as I took the materials out of the bag, especially the lighter and candles, they all switched on the 220v instantly. Their participation in the class was extremely satisfactory, at every moment someone would make a guess about what was going on, even if they doubted what I had said was the explanation (which I thought was great)*" (our translation).

In contrast, the dialogued class is characterized by Cunha (2015) as an active method and has dialogue as the mediator of the process, with the student as the center of the process, the teacher as a mediator, valuing the students' prior knowledge and contextualizing the subjects. In this study, for lessons to be considered dialogic, continuous interactions between the teacher and students, as well as among the students themselves, were required throughout the entire class, rather than occurring only in brief and isolated moments. Cunha (2015)

suggests that students write a synthesis of the topics covered, as the lack of a written systematization of information at the end of the lesson may result in limited engagement from some students.

It can be observed in the reports that dialogued lessons were more commonly used to revisit content already covered, discuss videos, review summaries of previous lessons, and correct activities. The lower frequency of these dialogued lessons in other contexts may indicate that this format still does not play a central role in the practices of teacher trainees. This result reflects the transitional role that the trainee has in the school, as they are dealing with the supervisor's class and do not have complete autonomy in their actions.

It is important to highlight that the analyzed reports refer to actions developed before the pandemic, when remote teaching and the popularization of digital platforms were not widely disseminated. It is believed that, currently, with the introduction of these new tools, teacher trainees have adopted and used these resources more frequently and effectively during lessons (Santos et al., 2023).

The case study strategy appeared in three reports. In one of them, an activity was proposed that presented true and false news for discussion in the classroom, encouraging students to reflect on the reliability of various sources of information. Regarding this activity, the intern, in R01, stated that *"[...] it was extremely effective and fun. Even students who almost never participated in class began to give their opinions, which was very positive"* (our translation). The case study also appeared in another report, where the interns provided jars containing organic matter to the students, allowing them to observe the changes over time caused by decomposition processes.

Another teaching approach that appeared in the reports during exploration of material was the use of non-formal spaces. This strategy was mentioned in reports R12 and R13. In both, the activity included a field trip aimed at bringing students closer to nature, and a visit to a paleontology museum. According to the reports from the interns in R12, the feedback was positive: *"It was very beautiful to see and hear the students' exclamations of pleasure and satisfaction upon arriving at the destination. Some simply remained silent, contemplating nature, immersed in their own reflections. Others, more expressive, shared their thoughts verbally"* (our translation).

According to Franquelino et al. (2020), "Field trips serve as an essential tool for the reading and understanding of geographic space and its dynamics, mainly because they integrate theory and practice" (p. 6, our translation). In this regard, Pinheiro and Cardoso (2020) argue that the use of non-formal spaces is fundamental:

> The teaching and learning processes occur throughout people's lives through education, whether in formal or non-formal settings. Many of our knowledge is not necessarily acquired in the school environment but in non-formal spaces. [...] Therefore, promoting non-formal education is beneficial because it proposes a process of socialization for individuals, empowering them to become more critical citizens, fostering an open relationship with knowledge about the world and the exercise of citizenship (p. 70, our translation).

In R12, the field trip was part of an Environmental Education project, which is why project-based learning was also recorded as an emerging subcategory. In this case, the intern in R02 reported carrying out an environmental education activity in a preserved area with native vegetation near the school, aiming to *"awaken in the students the idea of belonging to nature [...]"* (our translation) and to understand how this location is *"an important element in the maintenance of the region's ecosystem services [...]."* (our translation).

Project-based learning is a good opportunity for interns to promote interdisciplinarity, an approach that is still underexplored in school contexts. According to Fazenda (2008), school interdisciplinarity aims to enhance learning processes by valuing students' knowledge, their integration, and dialogue with various areas of knowledge. Prestes and Boff (2020) argue that, through the development of projects, teachers create new teaching procedures that integrate different resources into didactic-pedagogical activities, fostering improved teaching practices. To achieve this, it is necessary to consider the ideas and needs of the teachers involved in the development of the training proposal. Interdisciplinary projects require the availability of space and time for shared planning within the school, paid time for frequent pedagogical meetings, which is not typically available in public schools where most high school internships take place.

In the case of botany, Prestes et al. (2023) demonstrated that there are various topics that connect with other areas of knowledge, highlighting the possibility of an interdisciplinary approach. However, the implementation of this approach remains a challenge, as the guiding documents for educational practices do not explicitly outline the potential interfaces between disciplines and areas of knowledge, leaving it up to teachers to identify and plan for promoting dialogue. The authors further emphasize that future studies involving the initial training of science and biology teachers, with an emphasis on botany education, could contribute to shaping teachers who are more engaged with an interdisciplinary and contextualized approach. However, it is important to note that the implementation of interdisciplinary proposals also depends on the working conditions within school contexts.

Based on the results obtained in this category, there was a noticeable resistance from the interns to reproduce the same expository lessons they experienced during their undergraduate studies. Although the expository method was recorded, it was accompanied by activities that fostered interaction with the students, with the teacher acting as a mediator of learning. This indicates a shift in attitude among these future teachers. The report in R01 exemplifies this concern in the change of attitude in the classroom: "*Because providing a dynamic that involved everyone's active participation (which sometimes doesn't happen when group work is given in which research or a review is requested), made the students move and leave a static position, of 'just' receiving knowledge.*" (our translation). The way of working with content in a more dynamic and engaging manner for students aligns with the principles of active teaching methodologies. Despite various studies showing the benefits of active methodologies, these approaches are not widely applied by higher education instructors (Blasko et al., 2021). Therefore, a structural change in the training curriculum is needed, one that is focused on active learning pedagogy. That is, a pedagogy that understands learning as an active effort from the student, requiring complex thinking for analysis, synthesis, and evaluation (Assemany & Gonçalves, 2022). Teacher training programs can no longer focus solely on providing ready-made strategies, as schools are places that embrace diversity, prioritize inclusion, and accept that each student is unique (Miranda et al., 2023, Souza & Santos, 2021).

Didactic Resources

The results organized in Table 2 show the diversity of teaching resources used throughout the Teaching Internship to address the contents of botany. According to Souza (2007), these resources should not be used indiscriminately; planning by the teacher is necessary to ensure that the objectives are achieved. Therefore, it is important to select teaching resources with creativity and innovation.

Table 2 - Quantification and frequency of didactic resources used in the reports.

Resources (Category 2)	Number of reports [a]		Mention frequency in reports [b]
	Number	%	
Playful resource	13	100	44
Science communication texts	10	76,9	20
Teacher-authored texts	9	69,2	13
Experiments	9	69,2	22
Textbook	4	30,8	6
Videos	7	53,8	11
Foods [c]	3	30,8	6
Debate [c]	1	7,7	1
News [c]	1	7,7	1
Interview [c]	1	7,7	1

Note. [a] N = 13. [b] The mention frequency in the reports was measured by the number of times each report mentioned the use of each resource. [c] Subcategories that emerged from the analysis.
Source: Survey data, 2025.

According to Gil-Pérez and Carvalho (2011), the formative needs of science teachers are linked to the rupture they must have with simplistic views of what teaching science means. The authors discuss what the teacher should "know" and "know how to do" in order to transform students' spontaneous thinking, proposing the idea of learning as the construction of knowledge with the characteristics of scientific research. Theodore et al. (2015) questioned science teachers about the objectives of teaching science, and the results revealed that 23.2% stated it is to provide an understanding of the phenomena and transformations occurring in nature, 21.5% emphasized that it is to relate scientific content to students' everyday lives, while 55.3% did not respond. The choice of teaching resources depends on clear objectives that must be achieved; otherwise, students are unable to make more complex connections between biological, chemical, and physical phenomena, reinforcing a memoristic learning process.

The resources classified as playful were the most used, appearing in all reports. The term “playful” is polysemic, as it is attributed with many concepts and meanings (Silva, 2021). However, the Latin origin of the term “*ludus*” refers to play, games, and imagination, also including simulations, make-believe, competitions, recreation, and all artistic representations. In the educational context, play is learning because it stimulates intelligence, creativity, symbolism, emotion, and imagination (Fortuna, 2018). The interns in this study reported the use of teaching models, modeling clay, games, cards and posters, group dynamics, and the preparation of exsiccates. Recently, the publication of teaching strategies using teaching models and games for botany education has increased (Reis et al., 2024; Santos Júnior et al., 2021). Soares and Mesquita (2021) state that educational games are effective for learning scientific content. Similarly, teaching models help in visualizing aspects considered abstract or difficult in botany (Santos Júnior et al., 2021).

The variety of types and the frequency analysis from Table 2, regarding the use of playful materials, demonstrate the concern of all the interns in seeking novelty in their lessons. As a consequence, it was also significant the reports of active student participation while interacting with the playful material, as reported in R05 "*Once the theoretical explanation was over - a little later than expected - we moved on to the second part of the lesson, which was the memory game involving the subjects of photosynthesis, algae, bryophytes, pteridophytes and gymnosperms. [...] When the game began, both groups were a little apprehensive, as they didn't know exactly how they were going to proceed with the activity. However, as the game went on, the students began to show a lot of interest and willingness, since it instigated both an understanding of the content being worked on and curiosity about the images*" (our translation). This scenario demonstrates the positive dialectical relationship established between the interns and their students, as they noticed the care in keeping the educational space light and enjoyable for learning. However, this fact contrasts with the findings by Tramontini (2010) in the internship reports in Science and Biology, where descriptions of attempts to propose alternative methodologies appeared. The author found reports of resistance from students in Basic Education in participating in these types of activities, especially those that were not part of their daily routine, probably due to insecurity and fear of not being able to perform the activity.

This scenario of student receptivity, combined with the concern of the interns, highlights the importance of using playful resources in the didactic-methodological process to introduce a scientific language that is difficult to understand, as emphasized by Pinheiro and Cardoso (2020):

> [...] games can provide discussions in which there is interaction between the language of the teacher and that of the students, which facilitates the establishment of a common meaning for both, contributing to a meaningful learning of the scientific concepts addressed in the game (p. 69, our translation).

In addition to playful resources, science communication texts (SCT) emerged as the second most used didactic resource during the internships, as recorded by the undergraduates in R08: “*Text on ‘Adaptations to Life on Earth’, used as a hook to assemble a cladogram, on brown paper, with the main groups of current plants, relating them to the characteristics we believe are important*” (our translation). Moreover, SCT strengthen scientific literacy by promoting the development of skills such as searching for, evaluating, and using information sources to identify problems, explain phenomena, and draw conclusions based on scientific evidence (Souza et al., 2016). The use of this resource sparks students' interest in scientific issues and fosters

the formation of critical citizens, capable of understanding and making decisions about the world and its transformations. According to Albuquerque et al. (2022), SCT contribute to the human development of individuals through the democratization of knowledge historically produced by science. The authors emphasize that these types of texts bring scientific topics closer to students' everyday lives by using accessible language, with metaphors, images, and colloquial representations.

The use of teacher-authored texts was also extensively explored by the interns. This resource served various purposes: collective or individual reading, solving interpretation exercises that accompanied the texts, contextualizing local and national issues, among others. The most recurring text genres were summaries of the topics covered in class. R09's report makes it clear that "*summarizing the subjects of all our lessons and making them available in printed form would be a way for them to not only have auxiliary research material, since the content taught in the internship is not clear in the textbook, but also a way of arousing the interest of those who have committed themselves to the activities to go further within what we have covered.*" (our translation). These texts enable the interaction of each student with new information, as well as the development of reading and interpretation skills, in addition to the acquisition of a larger vocabulary.

The interns also explored the use of different types of experiments as a resource, but they all had simplicity in common. Most of the experiments were carried out in the school's classrooms and schoolyard, with everyday materials and few visits to the Science and Biology laboratory itself, which made it easier for the interns to use this resource. Examples include the use of potatoes and salt to demonstrate the process of osmosis; the use of sugar and rice to explain the formation of glucose and starch reserves and an experiment to show evapotranspiration. However, the report that stood out the most with the use of this resource was R08, which included experiments on fermentation, tropism, allelopathy and another on the function of leaf pigments. The feedback from the students was very positive, which shows that the use of this resource enriches the teaching and learning process, as reported in R08: "In general, the lesson was very productive, the class that participated the most was very curious about some discoveries and immediately asked about other close relationships between plants and animals" (our translation).

Regarding the textbook, there was no predominance in its use (30.8%), and when used, it functioned as a reference material, for reading a specific topic, interpreting drawings, or completing exercises. One of the reports mentioned issues due to students not bringing the textbook to school: *"[...] I asked if they had brought the textbook. Only one student had it [...]"* (R07, our translation). The study conducted by Theodore et al. (2015), for example, highlighted that the blackboard and the textbook were the most used resources by science and biology teachers, from middle school through high school. Nilles and Leite (2023) emphasize that in Brazil, there has been a historical dependency between the curriculum and the science textbook, which persists today, even after the implementation of the BNCC.

It is important to highlight that many public schools only have the textbook in the classroom; therefore, it is necessary to know how to mediate the use of the textbook with other resources, as clarified by Frison et al. (2009):

> Although the internet is used as an important research tool, the textbook still represents the primary, if not the only, source of printed material in many public schools' classrooms. [...] However, in addition to the textbook, it is essential for the teacher to use other pedagogical resources for lesson development, as no book, no matter how good it is, should be used without adaptations and supplements (pp. 8-9, our translation).

Videos were also used during the lessons, appearing in seven reports (53.8%). These videos, typically short, included news reports, articles, and lessons, animations of biological processes, living beings interacting within their ecosystems, and documentaries on socio-environmental conflicts, often used as a starting point for other activities. For example, report R09 described that after watching a video, a debate was held, which was well received by the students. In report R02, an interview with a nutritionist about food pyramids and nutrition was used as a trigger to start a productive classroom discussion.

Among the emerging subcategories, the use of food in lessons stood out. The interns from R06, R09, and R10 described practices using food tasting as a teaching method, allowing the stimulation of other senses, such as taste. In this activity, topics such as the carbon cycle, food pathways in the body, and decomposition were addressed, making learning more contextualized. In addition, both in R06 and R10, Non-Conventional Food Plants (PANCs) were mentioned, expanding the menu and bringing students closer to locally grown foods that have been neglected due to large-scale food production.

Sales et al. (2023) discuss the use of food in teaching as something essential for establishing connections with various fields of knowledge:

> Food also allows for the co-creation of various events, and these carry the potential to sprout rhizomes and germinate educational connections. [...] Biology is the field of study of life. Food, being made of organic, living beings in its materiality, also inhabits the territories explored by the study of biological sciences. [...] Thus, we believe that mobilizing scientific knowledge about food in education is to traverse biological fields, but also to break them, shatter their barriers that extend beyond the 'teaching of scientific knowledge,' and connect with transversal fields that surround knowledge, in rhizomes, in multiplicities (p. 1065, our translation).

Other emerging subcategories were debates, news, and interviews, which, together with videos, characterize the use of different languages to compose the teaching and learning process. According to Pinheiro and Cardoso (2020), "[...] language plays a crucial role in the development of concepts and, as such, is one of the main resources in the processes of acquiring new knowledge" (p. 68, our translation). As an example, we can cite R02's report: "*I planned a discussion on food pyramids and nutrition, using an interview with a nutritionist on the subject as a trigger.*" (our translation). In this sense, the diversity of these resources throughout the lessons allows for addressing the same theme from different perspectives, thereby increasing the opportunities for knowledge acquisition by students.

In conclusion, the data analysis showed that all the interns, in some way, attempted to use differentiated playful resources to engage students in the teaching and learning process of botany. Contradicting the initial hypothesis, these data reflect a desire among future teachers to break the paradigm of repetitive and monotonous botany lessons. The same engagement was recorded by Abreu et al. (2021) when biological sciences interns introduced a perspective of creating more dynamic, well-planned lessons, always grounded in the use of different didactic strategies. Unlike Lins and Moura (2019), who found that interns did not diversify their methodologies during their lessons, which resulted in a sense of frustration.

The use of playful activities is not part of the routine of university professors, nor is it included in teacher training (D'Ávila, 2014; Miranda et al., 2022). Thus, there are indications that the "knowledge derived from professional teacher education," as described by Tardif (2010), was not built through experiences in higher education. On the contrary, the interns sought ideas on how to use alternative resources, likely on their own initiative. Some studies show that playful materials are seen as a way to "infantilize" the university student (Veríssimo & Santos, 2016). On the other hand, the authors emphasize that such materials should be more widely used in higher education as a way to move away from slide presentations. Through playful activities, it is possible for an individual to experience various situations in a scenario different from reality. According to Hoppe and Kroeff (2014), when well-planned, playful experiences generate a framework of memory that can be accessed in other concrete situations, as they lead to learning. Including the production of playful materials for teaching botany in teacher education programs enhances the understanding of specific content, both for the future teachers and for their students in Basic Education (Almeida et al., 2018).

In their review of articles published in the Brazilian Journal of Science Education Research (RBPEC) between 2001 and 2018, Pinheiro and Cardoso (2020) found "[...] a small percentage of articles related to playful activities, suggesting that this theme is still underexplored as a research object in the field of science education" (p. 72, our translation). The internship experience represents only a fraction of the teaching profession, and despite the desire to innovate, several factors in daily school life, such as excessive workload, lack of collaborative planning, and insufficient support from school management, impact pedagogical practice. Interns also face other challenges, such as student indiscipline and lack of motivation (Kirsch et al., 2021; Marques et

al., 2019). Therefore, changing the teaching approach requires an effort from all spheres of education and society, not just the teacher.

Botany education presents many specific terminologies that are distant from students' reality. It is necessary to adopt a new approach to teaching and learning, one based on the connection between subjects in an interdisciplinary practice. Curricula and pedagogical practices used in botany education must be innovative and not merely a reproduction of the academic teaching that took place during the teachers' own education (Marchioretto & Moço, 2024; Prestes et al., 2023). It is a fact that many undergraduate programs in Biological Sciences still remain overshadowed by the bachelor's degree courses, where disciplinary knowledge prevails, while pedagogical knowledge is often neglected (Marques et al., 2019; Oliveira et al., 2022).

Therefore, outdated tools, old practices, and retrograde methodologies are no longer sufficient to meet the needs of students today, considering the current contemporary educational landscape. Pre-service teacher course requires a curriculum focused on practices and methodologies that facilitate the learning process in different educational settings. There must be a pedagogical team in schools, providing support to teachers so they can implement these changes. In these perspectives, both pre-service and in-service teacher education courses must always be critically assessed. The pre-service teaching course in undergraduate teacher education programs should place more emphasis on pedagogical content, highlighting the development of teaching skills, and encouraging methodologies and didactic modalities based on innovative resources and actions that facilitate the teaching and learning process for students.

FINAL CONSIDERATIONS

The research achieved its proposed objective by surveying the didactic modalities used by undergraduate students in Biological Sciences during their teaching internships for botany education. The study analyzed internship reports, as they provided free and reflective writing, incorporating the learnings that the interns were able to construct, linking their academic and school experiences. The analysis indicates a trend among the interns to use didactic modalities that prioritize student interaction and the teacher's role as a mediator of learning, as evidenced by the predominance of expository-dialogue classes and interactive lessons with practical activities and exercises. It is concluded that the interns make an effort to stimulate student engagement, moving away from traditional teaching methods and the use of textbooks.

The most prominent didactic resources in the reports were those classified as "playful," highlighting the concern of bringing scientific knowledge closer to Basic Education students without the burden of the stigma associated with technical terminology. This approach involved the use of games, modeling clay, exsiccates, and other means to make botany education more engaging and inviting. Playful resources, as tools or strategies that incorporate the concept of learning through enjoyment, play a crucial role in making lessons more appealing and stimulating the desire to learn.

Although traces of traditional teaching still persist, our initial hypothesis that the interns would replicate the traditional practices of their professors was not confirmed. Instead, the interns demonstrated diverse and creative approaches in their pursuit of participatory and innovative methodologies for teaching botany. This study has certain limitations, as it is a specific investigation of a group of undergraduate teaching students from a single university. However, the analysis suggests that a cultural shift may be occurring, in which interns take on the challenge of innovating and differentiating their teaching practices from their previous experiences. This shift indicates a break in the cycle of disinterest in botany by addressing its underlying causes, which include the use of playful activities, hands-on lessons with live botanical material, and scientific literacy through the incorporation of updated information from science communication texts.

Cultural, technological, and political transformations that society has recently undergone directly influence the educational context. However, there are still resistances to changes in teaching and learning methods, which are linked to various factors such as the devaluation of teachers, inadequate school infrastructure, family participation, and the persistent issue of social inequality, which affects both access to education and the quality of teaching.

In this regard, education serves as the foundation of all human development. Therefore, the tools employed in human development, which ensure comprehensive training for the exercise of citizenship, are essential in the teaching and learning process. Thus, exploring different didactic approaches through the diversification of teaching resources for botany education represents a significant opportunity within the evolving landscape of contemporary education. In this context, future research should focus on expanding data on the pre-service course of science and biology teachers to enhance the understanding of the effects of cultural changes in science education.

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