



## SOME ISSUES CONCERNING THE USE OF DIDACTICS OF BIOLOGY

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Teaching biology is interesting and challenging, at the same time, it is also a dilemma because new and new advances are being made in biological science: biodiversity is changing - new species are being discovered while others are threatened with extinction, and unprecedented genetically modified organisms are being created. Teachers find it difficult to keep up with all the latest developments, especially in cell and molecular biology (Tunnicliffe & Ueckert, 2007). Biology is a unique science that studies living things. The discipline of biology differs from other fields of science (e.g. physics and chemistry) in the breadth and complexity of its knowledge content and the interconnectedness of knowledge at many different levels (Wandersee et al., 2000). Regarding the use of different research methods, biology is also involved in exploring both the micro-world through microscopy, experimental work in the laboratory or in field studies of the macro-world.

Biological knowledge encompasses a range of concepts with varying degrees of complexity, abstraction and meaning (Zogza, 2016), so the level of background knowledge of learners is important (Birzina et al., 2019; Cedere et al., 2022; Sorgo & Siling, 2017; Machar et al., 2014). Successful learning in biology requires the use of diverse teaching/learning methods not only for understanding the natural world, but also for learners' successful engagement in today's labour market through project-based learning, critical thinking, problem solving, civic engagement, research and digital skills (Birzina et al., 2021; Cedere et al., 2020; Mård & Hilli, 2022). There are so many new developments in life sciences that nowadays previous theoretical constructs - theories, laws and models - need to be revisited and mastered at the school level. In these new circumstances, the highest priority should be given to improving the didactics of biology so that students can acquire biological knowledge and understand biology as a science, avoid misconceptions, learn according to the digital age and use an interdisciplinary approach in their learning (Tsybulsky, 2020).

While biology and natural sciences share many aspects, the focus of biology on life creates unique philosophical, methodological and ethical preconditions for understanding biology (Kloser, 2012). This means that the study of the teaching and learning process in the biological sciences is a pressing issue and this area of research is called 'biology didactics' and aims to highlight and facilitate the process of teaching and learning about the biological world. Since the biological world is part of the natural world and biological sciences are part of the natural sciences, then 'biology didactics' can only be considered as part of the research area of 'science didactics' (Zogza, 2016, cited in Lewis, 2008).

To understand the nature of the didactics of biology, it is necessary to clarify its place in education. There are two didactic approaches known: the Anglo-American and the European (Meyer, 2012; Ligozat & Almqvist, 2018). In Anglo-American education, the view of pedagogy as a science, often borrowed from Herbart, spread in the late 19th century (Hamilton, 1999). In the Anglo-American approach, the laws of psychology ground the teaching,



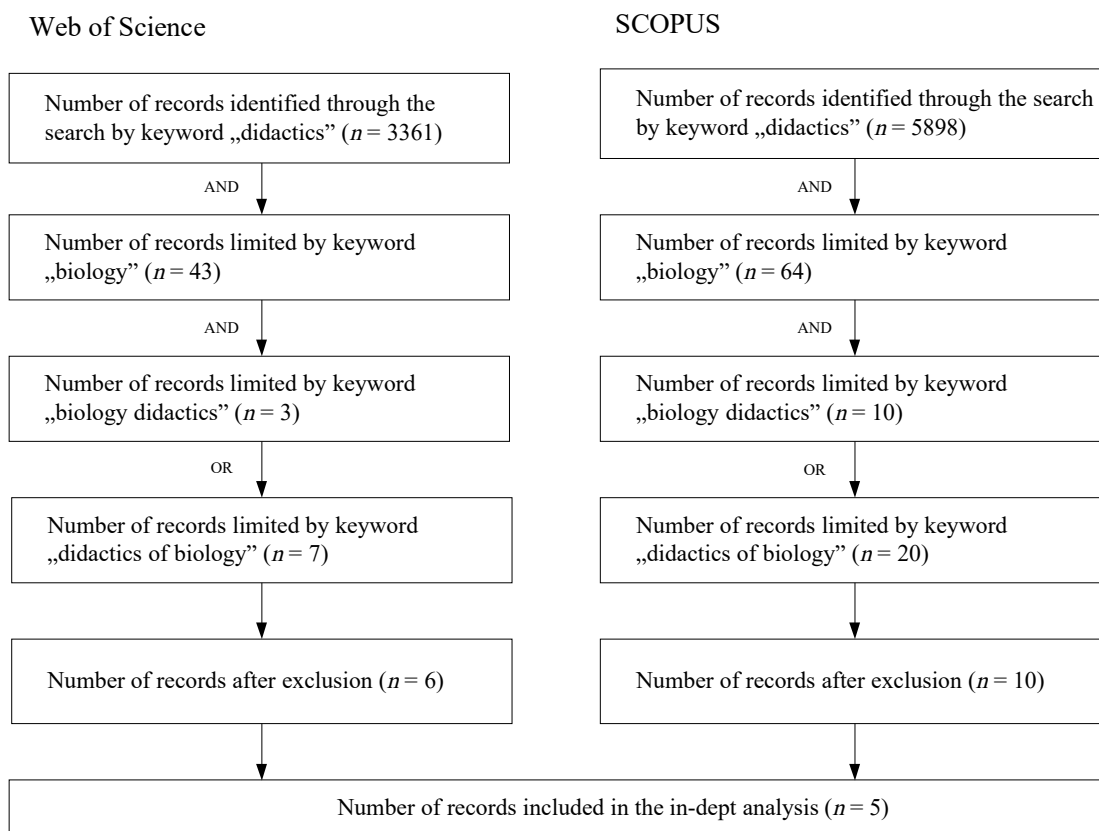
while teaching methods are primarily a matter of subject-teaching strategy. In the European approach, didactics develops as a theory and methodology of education and learning and is part of pedagogy (Zogla, 2001), which focuses more on strategies, methods and different approaches to teaching and learning.

Two areas of didactics must be distinguished: general didactics and subject didactics. In European countries, there is a heterogeneous approach to understanding didactics and subject didactics: some subject didactics are considered subfields of general didactics (Krogh & Qvortrup, 2021) because of the relationship between general didactics and subject didactics. In Sweden, for example, the term general didactics was introduced in the late 1980s to make connections between general didactics and subject didactics (Ligozat et al., 2015) and pedagogy as an academic discipline has a strong influence on educational policy, while subject didactics is a relatively independent academic discipline. In Denmark, subject didactics is less developed than in Sweden or Norway (Zogla, 2001). In Spain, didactics is a scientific-pedagogical discipline that addresses each stage of the teaching and learning process (Vergara, 2015). In general, the term "subject didactics" is used in Scandinavian, German, Swiss, French, Spanish and other European countries. The term "general didactics" is used less frequently (in Finland, Norway, Denmark, and other countries). The use of didactics does not exist in the UK, although some aspects of didactics do appear, such as curriculum theory and research on the teaching/learning process (Meyer, 2012).

Since the 1980s, under the influence of globalisation and the importation of Anglo-American educational paradigms, the state of didactics and the relationship between general and disciplinary didactics has been an increasingly contentious issue in both the academic world and the field of teacher education (Ligozat & Almqvist, 2018). On the one hand, subject didactics claims the status of an independent science, while at the same time, it is part of general didactics and general didactics, in turn, is part of pedagogy. Thus, subject didactics integrates parts of the respective subject, curriculum, pedagogy, didactics, psychology, communication theory and practice, becoming an independent science within the system of pedagogical sciences (Zogla, 2001) including a highly structured and grounded approach to teaching and learning. The analysis of European understandings of didactics

**Figure 1**

*The Scheme of Performing the Systematic Review*



also shows that the understanding of didactics as a science is multi-coloured, multi-faceted and diffuse (Meyer, 2012). The relationship between teaching and research is often accepted and just as often ignored. In fact, research should and does influence teaching (and vice versa), but the gap between them sometimes is wide (Kubiátko, 2012). Ideally, didactics should simultaneously cover three levels: (1) the theoretical or research level, where didactics denotes the field of research; (2) the practical or implementation level, where didactics mainly involves teaching and learning, curriculum design and the school learning process; and (3) the discursive level, where didactics shapes the professional dialogue by discussing teaching and learning issues (Hopmann & Gundem, 1998).

In order to identify trends in the understanding of biology didactics in the scientific literature, a systematic review was performed by conducting quantitative and qualitative research on the use of biology didactics in the Web of Science and SCOPUS databases. The keywords "didactics", "biology" and "biology didactics" or "didactics of biology" were selected for the information search.

The limiting criteria were the publication period of the articles used in the systematic review (1990-2023), language (English), publication only in scientific journals, selected databases (Web of Science and SCOPUS), excluding articles that are in both databases ( $n = 5$ ) and full-text availability ( $n = 1$ ). Figure 1 illustrates the selection of articles.

As can be seen in Table 1, all the articles analysed have reached the research, practical and discursive levels of biology didactics. At the research level, a study is usually carried out and/or the scientific literature on the research question is systematised. At the practical level, research is carried out on the pupil's, student's or teacher's activity related to the use of a particular teaching method or technique. For example, the project method (Kubiátko & Vaculová, 2011), making vignettes (Sanders, 2022), identification of misconceptions and analysis of teaching/learning materials (Angosto Sanchez & Morcillo Ortega, 2022), developing word associations and exploring outdoor experiences (Schmäing & Grotjohann, 2021). For feedback and professional dialogue, there are workshops organised (Kubiátko & Vaculová, 2011), project work (Machar et al., 2014; Schmäing & Grotjohann, 2021), learning and sharing takes place in the form of different courses (Machar et al., 2014; Sanders, 2022), new methodological materials and learning models (Angosto Sanchez & Morcillo Ortega, 2022), and courses are developed (Machar et al., 2014). It should be noted that the didactic approach to the acquisition of biology is mostly seen in the context of cross-subject links and projects are usually more interdisciplinary, making links between biology and other science subjects of chemistry, physics and geography, at the same time also including social sciences, as well as environmental and health education.

**Table 1**  
*Research, Practical and Discursive Level in Understanding the Didactics of Biology*

Authors	Research level	Practical level	Discursive level
Angosto Sanchez & Morcillo Ortega, 2022 (Spain)	Questionnaires of students from four different academic levels gathering the ideas about plant nutrition and photosynthesis	Analysis of learning misconceptions and analysis of textbooks and university manuals	Suggestions on how to improve the teaching/ learning process are offered –a teaching model of plant nutrition and photosynthesis
Kubiátko & Vaculová, 2011 (Czech Republic)	Pupils' practical activities in the project are explored	Project-based learning, implementing the interdisciplinary approach takes place	Discussion between the teacher and pupils
Machar et al., 2014 (Czech Republic)	The survey of 119 graduates of Master's courses in Teacher Education in Biology to determine their opinions on the importance of biology and environmental education didactics during their pre-graduate studies	Evaluation of the content and benefit of the completed courses of biology and environmental education didactics in biology studies with respect to its significance for the current teaching practice	Discussion of the feedback received from participants in the context of current changes in the education system and discussion about subject-matter didactics of biological disciplines
Sanders, 2022 (Sweden)	Multimodal objects are considered as boundary objects that can facilitate learning conversations, both cognitive and affective	Three vignettes are used to make public an individual teacher's reflections on teaching situations in three courses	Practice-based reflective narratives on specific teaching moments with multimodal objects, which can support pupils' engagement in biology didactics and related classes



Authors	Research level	Practical level	Discursive level
Schmäing & Grotjohann, 2021 (Germany)	Guided interviews, documents such as concept maps can be analysed, questionnaires can be used, or field observations can be made	Pupils develop word associations using stimulus words "Wadden Sea", "mudflat hiking tour", and "tides". Collection and analysis of experiences (school, out-of-school with the class, and private)	It is implemented as a project of the biology didactics with the aim of implementing the studies of the biology didactics that have a concrete focus on the Wadden Sea as a place of learning

The selection of articles shows that the relationship between research and the teaching/learning process is interconnected: both research is linked to the teaching/learning process and the teaching/learning process is linked to research. Biology didactics provides a holistic view of the biology learning process, taking into account the key actors (teachers, pupils, students, teaching/learning objectives, the subject content and structure of biology) and their different relationships in the didactic triangle, thus incorporating the core principles of general didactics (Kubiátko, 2021; Lampiselkä et al., 2019). Overall, it can be concluded that in the context of the contemporary educational paradigm shift (Krogh & Qvortrup, 2021) and because of synergies with general didactics (Ligozat & Almqvist, 2018), the didactics of biology is becoming stronger and more visible, and it shows itself as "a dynamic discipline" (Kubiátko, 2021) and continues to develop as an independent science.

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