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КРИТИЧНЕ МИСЛЕННЯ В АКАДЕМІЧНОМУ СЕРЕДОВИЩІ: ВІД ТЕОРІЇ ДО ПРАКТИКИ

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ПОЛЯКОВА Анастасія Сергіївна

CRITICAL INTERPRETATION OF EXPERIMENTAL DATA IN PLANT PHYSIOLOGY AS A BASIS FOR DEVELOPING STUDENTS' RESEARCH SKILLS

The ongoing transformation of biological education from a content-based to a research-oriented paradigm places increasing emphasis on the development of students' analytical and interpretative skills. In life sciences, this shift is particularly relevant due to the growing complexity and volume of experimental data, which require not only comprehension but also critical evaluation and meaningful integration into scientific reasoning.

Critical thinking is conceptualized as the ability to interpret empirical evidence, assess variability, and construct scientifically grounded conclusions. The study explores the potential of data analysis–oriented laboratory practices as a tool for developing students' research skills in plant physiology courses.

The implementation of problem-based learning and the scientific method enables students to engage in higher-order thinking processes, including hypothesis formulation, data interpretation, and argumentation. A structured framework linking stages of experimental work with specific types of thinking is proposed.

A laboratory case involving osmotic potential determination in plant cells illustrates the transition from descriptive reporting to critical interpretation. The findings confirm that engagement with authentic experimental data enhances analytical and research skills and supports evidence-based scientific reasoning.

The ongoing transformation of biological education from a content-based to a research-oriented paradigm places increasing emphasis on the development of students' analytical and interpretative skills. In life sciences, this shift is particularly relevant due to the growing complexity and volume of experimental data, which require not only comprehension but also critical evaluation and meaningful integration into scientific reasoning.

Within this context, critical thinking is regarded as a core competence that underpins the ability to interpret empirical evidence, assess variability, and formulate scientifically grounded conclusions (Kuhn, 2019; Facione, 2020; van Laar et al., 2020). Consequently, the ability to work with experimental data becomes a fundamental component of professional training in plant physiology and related disciplines.

Despite the recognized importance of these competencies, traditional laboratory practices often remain focused on procedural execution and descriptive reporting, limiting opportunities for deeper cognitive engagement. This creates the need to reconsider the methodological foundations of laboratory instruction and to integrate approaches that promote active data analysis and inquiry-based learning.

Against this background, the study explores the potential of data analysis–oriented laboratory practices as a tool for developing students' critical thinking and research skills in plant physiology courses.

In the natural sciences, critical thinking can be defined as a process of interpreting and explaining biological phenomena based on empirical evidence, established scientific principles, and reasoned argumentation. Research skills involve not only the reproduction of existing knowledge but also the ability to formulate hypotheses, analyze variability in results, and draw justified conclusions under conditions of uncertainty (Dunbar & Fugelsang, 2005).

Plant physiology courses provide substantial opportunities for developing these competencies, as they combine experimental work with the need to interpret quantitative data. A key methodological distinction should be made between reproductive "exercises" and research-oriented "problems." While exercises involve the application of predefined procedures to obtain expected results, problems require students to interpret data that may be variable or even contradictory.

The implementation of problem-based learning (PBL) transforms laboratory activities from illustrative tasks into inquiry-driven investigations. The effectiveness of this approach has been widely documented (Hmelo-Silver, 2004; Loyens et al., 2015) and remains relevant in contemporary student-centered STEM education (Bishop & Verleger, 2023). The study of stomatal conductance, photosynthetic activity, and mineral nutrition involves not only data collection but also their interpretation in relation to experimental conditions and potential sources of error.

The scientific method acts as a cognitive framework that structures students' analytical activity. The sequence "observation – question – hypothesis – experiment – conclusion" engages higher-order thinking at each stage (Handelsman et al., 2007; National Research Council, 2012). The formulation of predictions using the "if…, then…" structure plays a crucial role in establishing causal relationships. Recent studies confirm that structured engagement in scientific inquiry enhances both scientific and critical thinking skills (de los Santos et al., 2025).

Table 1. Stages of working with experimental data and their role in developing research skills

Stage	Student activity	Type of thinking	Developed skill
Observation	Recording results	Descriptive	Initial understanding
Data analysis	Interpreting data	Analytical	Working with data
Variability assessment	Comparing results	Critical	Identifying errors
Hypothesis formulation	Building explanations	Scientific	Causal reasoning
Interpretation	Argumentation	Reflective	Scientific reasoning

A representative example is the laboratory case of determining the osmotic potential of red onion epidermal cells. At the descriptive level, students record the

value corresponding to 50% plasmolysis. However, critical interpretation requires considering a broader dataset, including results obtained by different groups, which may vary significantly. Such variability reflects both biological diversity and methodological limitations inherent to experimental research (Goodman et al., 2016; Ioannidis, 2005).

The final stage in the development of research skills is the written interpretation of results. The "Discussion" section of a laboratory report requires students to evaluate reliability, identify limitations, and propose further research directions. Engagement with authentic experimental data significantly enhances analytical and research skills (Brownell & Kloser, 2015; Auchincloss et al., 2014; Dolan, 2021). Active learning approaches also improve student performance in science (Freeman et al., 2014).

In conclusion, the critical interpretation of experimental data in plant physiology is not a supplementary component but a central element of the learning process. The integration of problem-based learning and the scientific method enables students to interpret data under uncertainty and make evidence-based scientific decisions.

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ПРОНОЗА Інна Іванівна

THE ROLE OF CRITICAL THINKING IN THE FORMATION OF POLITICAL CULTURE OF STUDENT YOUTH IN THE CONTEXT OF DIGITALIZATION

The current stage of societal development is characterized by profound digital transformation, which encompasses all spheres of life, including the political domain. Digitalization is reshaping communication patterns, the formation of public opinion, and the mechanisms of political participation and influence, thereby significantly increasing the relevance of critical thinking as a key competence of the modern individual. In this context, student youth act not only as objects but also as active subjects of political processes, which necessitates a deeper understanding of the role of critical thinking in shaping their political culture.

The relevance of this study is driven by the intensification of information flows, the spread of disinformation, manipulative technologies, and hybrid influences within the digital environment. On the one hand, the digital space expands opportunities for citizens' participation in political life; on the other hand, it generates new risks related to information security and the quality of information perception. In this regard, critical thinking emerges as an essential tool for analyzing, evaluating, and interpreting information from various sources, as well as a mechanism for developing resilience to manipulation and propaganda [4].

The theoretical conceptualization of critical thinking in the context of digitalization is associated with its interpretation as an integrative capacity that includes cognitive, value-based, and behavioral components. It involves the ability to reflect, conduct reasoned analysis, assess the credibility of information, and form one's own position based on rational judgment. Contemporary research considers critical thinking a fundamental civic competence that ensures effective participation in democratic processes and contributes to the development of responsible political behavior [1].