METHODOLOGICAL APPROACHES TO TEACHING GRAPH COLORING WITH ONLINE TOOLS

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Modern education is increasingly based on the use of digital resources, which not only make it possible to present material in a visual form, but also ensure the active involvement of students in the learning process. In the academic discipline «Discrete Mathematics», a special place is occupied by graph theory, since it provides future specialists with fundamental skills in modeling and analyzing structures that are in demand in information technology, applied mathematics, and engineering.

Graph coloring is one of the key sections of graph theory, which has both theoretical and practical significance. Examples of its application include timetable construction, resource allocation, and logistics tasks.

For students, the topic of graph coloring often proves challenging: abstract definitions and proofs are difficult to perceive, while the operation of algorithms remains hidden. In this situation, a useful methodological approach is the use of online tools that allow students to construct graphs, apply various coloring algorithms, and immediately observe the results. Such services make it possible to trace the execution of an algorithm step by step, compare the performance of different methods, and consolidate theoretical material through concrete examples [1].

The aim of this work is to develop and substantiate methodological techniques aimed at effective teaching of the topic Graph Coloring with the use of online tools.

Material and methods. The research materials include professional educational resources for graph visualization, in particular the Graph Online service. The research methods are analysis of sources and existing tools, as well as the study and synthesis of information.

Results and their discussion. The learning process is based on a combination of traditional presentation of theoretical material and the use of online services for constructing and coloring graphs. As an example, the Graph Online service can be highlighted, which provides opportunities to create graphs of various structures, apply coloring algorithms, and visually observe the results.

It is advisable to organize the learning process step by step:

- **Theoretical section.** Basic concepts are introduced: vertex, edge, vertex degree, chromatic number.
- **Examples.** Different cases of graph coloring are demonstrated (complete, bipartite, and others).
- **Algorithm study stage.** The greedy algorithm, sequential coloring algorithm, and heuristic approaches are examined.
- **Practical part.** Students independently construct graphs using the Graph Online service, apply various algorithms, and compare the results.
- **Analysis and discussion.** The outcomes are reviewed collectively, patterns are identified, and conclusions are formulated [2].

Thus, the following key methodological approaches can be distinguished:

- **Visualization.** Graphical representation makes the coloring process more clear and comprehensible.
- **Interactivity.** Online services engage students in active participation and stimulate interest.

• **Step-by-step learning.** Material is introduced gradually: from simple examples to algorithms.

• **Comparison of theory and practice.** Theoretical statements are verified on specific graphs.

• **Research skills.** Students formulate hypotheses and test them experimentally.

• **Digital environment.** Online tools make it possible to organize learning both in the classroom and in a distance format.

The use of the Graph Online service in studying the topic of graph coloring enhances the effectiveness of learning. Visualization of algorithms contributes to a better understanding of their logic, while the opportunity to experiment with different graphs develops skills of independent analysis. Moreover, the use of online services fosters the development of students' critical thinking: they learn to compare the results of different algorithms, analyze their efficiency, and draw conclusions about the applicability of particular methods.

Conclusion. The use of the Graph Online service in studying the topic of graph coloring makes the learning process more visual, interactive, and effective. The combination of theoretical material with practical tasks contributes to a better understanding of key concepts, the development of research skills, and the formation of a sustained interest in the academic discipline «Discrete Mathematics».

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2. Levin, O. Discrete Mathematics. An Open Introduction. 4th Edition / O. Levin – University of Northern Colorado, 2024. – 549 p.

METHODS FOR DETERMINING FAT CONTENT IN FEEDS WITH CONSIDERATION OF MEASUREMENT UNCERTAINTY

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Keywords. Raw fat content, GOST 32905-2014, measurement uncertainty, metrology, Soxhlet method, NIR spectroscopy, repeatability and reproducibility, Type A and Type B uncertainty.

Objective of the Research. The determination of raw fat content in animal feeds, compound feeds, and feed raw materials represents a critical aspect of quality control in agricultural production. Accurate measurement of fat content is essential for ensuring nutritional value, compliance with regulatory standards, and product safety. However, existing methodologies often lack comprehensive consideration of measurement uncertainty, which can lead to significant errors in analytical results.

This research aims to develop and validate a systematic approach for determining raw fat content in feeds while accounting for all sources of measurement uncertainty. Specifically, the study focuses on:

1. analysing and comparing established methods for raw fat content determination according to GOST 32905-2014 (ISO 6492:1999).

2. developing a mathematical framework for incorporating measurement uncertainty into fat content calculations.

3. validating the proposed methodology through comparative analysis with reference values and inter-laboratory test data.

4. implementing a computational algorithm for automated calculation of fat content with uncertainty estimation.