
CONFERENCE ARTICLE

**METHODOLOGY FOR GUIDING STUDENTS TOWARD SCIENTIFIC RESEARCH THROUGH AN
INDIVIDUAL APPROACH IN CHEMISTRY EDUCATION**

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ABSTRACT

The development of students' readiness for scientific research is an important task of modern chemistry education. Future chemistry teachers must be able not only to master theoretical knowledge and laboratory techniques, but also to organise inquiry, analyse scientific information and guide learners toward evidence-based thinking. This thesis examines the methodology for guiding students toward scientific research through an individual approach in chemistry education. The main attention is given to differentiated research tasks, inquiry-based laboratory activity, individual educational trajectories, formative assessment and reflective support. The thesis shows that an individual approach increases students' motivation, strengthens independent scientific thinking and creates favourable conditions for connecting chemical knowledge with research practice.

Keywords: Chemistry education, individual approach, scientific research, future chemistry teachers, inquiry-based learning, laboratory activity, research competence, scientific thinking.

INTRODUCTION

Chemistry education has a special role in preparing future teachers because it combines theoretical knowledge, experimental activity and scientific explanation. A future chemistry teacher should understand chemical laws and processes, but professional readiness also requires the ability to organise scientific inquiry. Students must learn how to formulate a problem, put forward a hypothesis, select appropriate methods, conduct experiments, process results and draw evidence-based conclusions. These skills are not formed automatically through traditional lectures or reproductive laboratory tasks. They require a purposeful methodology based on active participation and individual academic support.

The individual approach is important because students enter higher education with different levels of preparation, motivation, cognitive style and laboratory experience. Some students easily understand abstract chemical concepts, while others need more practical explanation and visualisation. Some are interested in environmental chemistry, others in analytical methods, organic synthesis or teaching methodology. If all students are given identical research tasks, their personal potential may remain insufficiently developed. Therefore, guiding students toward scientific research should be organised through individualised tasks, flexible support and gradual complication of academic activity.

The methodological basis of this thesis is formed by the competence-based, individual and inquiry-based approaches. The competence-based approach allows research activity to be interpreted as an integrated professional quality that includes knowledge, skills, motivation, responsibility and reflection. The individual approach focuses on the student's personal educational trajectory, taking into account abilities, interests and difficulties. The inquiry-based approach provides a methodological foundation for transforming chemistry learning into a process of scientific search.

The study is based on theoretical analysis of pedagogical and

methodological literature on differentiation, science learning, laboratory education and research-oriented teaching. Comparative analysis was used to distinguish traditional instruction from individually oriented research guidance. Generalisation made it possible to identify the main methodological conditions that support students' involvement in scientific work in chemistry education.

Guiding students toward scientific research through an individual approach begins with diagnostic study of their academic needs. The teacher should determine how well students understand basic chemical concepts, whether they can use laboratory equipment correctly, how they work with scientific texts and whether they are able to explain experimental results. Such diagnostics helps to design tasks that are neither too simple nor too difficult. When the level of difficulty corresponds to the student's real abilities, research activity becomes meaningful and motivating.

One of the central methodological conditions is the development of individual research tasks. In chemistry education, such tasks may be connected with the analysis of water quality, soil composition, food additives, reaction rate, acid-base balance or environmental pollution. The same general topic can be adapted to different students. A beginner may be asked to collect information and conduct a simple qualitative experiment, while a more prepared student may compare several methods, calculate quantitative indicators or interpret results using scientific literature. This differentiation allows each student to participate in research at an appropriate level.

Laboratory activity is the main environment for forming research skills in chemistry. However, laboratory work should not be limited to following ready-made instructions. In an individual approach, students are gradually guided from reproductive experiments to inquiry-based tasks. At first, they may repeat a known experiment in order to master safety rules and techniques. Later, they can modify conditions, compare

results, explain deviations and propose improvements. This gradual transition helps students understand the logic of scientific investigation and develops confidence in independent work.

The teacher's methodological support plays a decisive role. Individual guidance does not mean that students work without help. On the contrary, the teacher provides consultation, asks guiding questions, recommends sources, checks the research plan and helps students avoid methodological mistakes. At the same time, the teacher should not replace the student's own thinking. The aim of support is to create conditions in which students independently search for solutions and learn to justify their conclusions.

Work with scientific information is another important direction. Students should learn to find reliable sources, compare scientific opinions, identify key concepts and use references correctly. In chemistry education, this skill is especially significant because scientific knowledge develops rapidly. Future teachers must be able to update their knowledge and explain modern chemical achievements to pupils. Individual assignments such as preparing a short literature review, analysing an experimental method or summarising a scientific source help students develop academic independence.

Formative assessment strengthens the effectiveness of the individual approach. The assessment should focus not only on the final result, but also on the process of scientific inquiry. It is necessary to evaluate how the student formulates the problem, plans the experiment, observes safety requirements, analyses data and explains conclusions. Such assessment gives students clear feedback and helps them understand what must be improved. Reflection is also essential because it teaches students to evaluate their own research actions, identify errors and plan further development.

The individual approach also helps connect research activity with future teaching practice. Students who learn through scientific inquiry are better prepared to organise similar activities for school learners. They understand how to simplify a chemical problem without losing its scientific meaning, how to guide pupils during experiments and how to develop evidence-based reasoning. Thus, individual research guidance contributes not only to scientific competence, but also to pedagogical professionalism.

Guiding students toward scientific research through an individual approach in chemistry education is an effective methodological direction for preparing future chemistry teachers. This approach allows the teacher to consider students' abilities, interests and learning difficulties while organising research-oriented activity. It supports the development of independent thinking, laboratory culture, scientific information literacy and reflective skills.

The thesis shows that the main methodological conditions include diagnostics of students' needs, individual research tasks, inquiry-based laboratory work, teacher consultation, scientific source analysis, formative assessment and reflection. Through these conditions, students gradually move from passive learning to active scientific search. As a result, future chemistry teachers become more prepared to organise research-based learning in their professional practice.

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