Co-funded by the European Union

Teaching Requirements Guide

for Chemistry Teachers in Vocational Secondary Schools in Bosnia and Herzegovina

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Banja Luka, 2024

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Electronic edition

Erasmus+ Project**:**

Improvement the quality of chemistry teaching in VET in Bosnia and Herzegovina

101129417-ERASMUS-EDU-2023-CB-VET

Publisher:

University of Banja Luka, Faculty of Natural Sciences and Mathematics

Banja Luka, Univerzitetski grad, Bulevar vojvode Petra Bojovića 1 A

FOREWORD

This manual was developed within the framework of the Erasmus+ project **"Improving the Quality of Chemistry Teaching in Vocational Education in Bosnia and Herzegovina – ChemTeach"** (101129417-ERASMUS-EDU-2023-CB-VET). The main aim of the project is to strengthen the capacities of chemistry teachers and related subjects in vocational secondary schools, enabling them to apply modern teaching approaches and effectively integrate multimedia and digital content, while connecting theory with practice.

The manual is based on the experiences of a five-day teacher training held at the **Faculty of Natural Sciences and Mathematics, University of Banja Luka**, covering topics such as the modern chemistry curriculum, active learning methods, learning outcomes design, experimental teaching, and digital skills. A particularly significant part of the training was the **round table with employers**, which included representatives from public institutions, laboratories, enterprises, and universities. This dialogue allowed teachers to better understand the concrete needs of the labor market, gain insight into the knowledge and skills students need to develop, and ensure the practical relevance of teaching content.

The manual provides practical guidance for creating teaching materials that promote competency development, scientific literacy, and critical thinking among students. It also emphasizes the importance of collaboration between **schools – universities – employers** and continuous professional development of teachers, along with the implementation of innovative teaching methods and multimedia tools.

This manual lays the foundation for the further development of teacher handbooks, including **"Modern Chemistry Teaching"** and **"Multimedia in Chemistry Teaching"**, aiming to improve the quality of chemistry education in vocational secondary schools and strengthen the connection between education and real labor market needs.

Banja Luka, April 2024

PREDGOVOR

Ovaj vodič razvijen je u okviru Erasmus+ projekta **„Unapređenje kvaliteta nastave hemije u srednjem stručnom obrazovanju u Bosni i Hercegovini – ChemTeach“** (101129417-ERASMUS-EDU-2023-CB-VET). Cilj projekta je jačanje kapaciteta nastavnika hemije i srodnih predmeta u srednjim stručnim školama, kako bi primjenjivali savremene metode nastave i efikasno koristili multimedijalne i digitalne sadržaje, uz povezivanje teorije i prakse.

Vodič se zasniva na iskustvima petodnevne obuke nastavnika na **Prirodno-matematičkom fakultetu Univerziteta u Banjoj Luci**, koja je uključivala predavanja o savremenom kurikulumu hemije, metodama aktivnog učenja, kreiranju ishoda učenja, eksperimentalnoj nastavi i digitalnim vještinama. Posebno značajan segment obuke bio je **okrugli sto sa poslodavcima**, na kojem su učestvovali predstavnici javnih institucija, laboratorija, preduzeća i fakulteta. Ovaj dijalog omogućio je nastavnicima da bolje razumiju konkretne potrebe tržišta rada, steknu uvid u znanja i vještine koje učenici treba da razviju, te osiguraju praktičnu relevantnost nastavnih sadržaja.

Vodič pruža praktične preporuke za kreiranje nastavnih materijala koji omogućavaju razvoj kompetencija, naučne pismenosti i kritičkog mišljenja kod učenika. Takođe, naglašava važnost saradnje **škola – univerziteta – poslodavaca** i kontinuiranog profesionalnog razvoja nastavnika, uz primjenu inovativnih nastavnih metoda i multimedijalnih alata.

Ovaj vodič predstavlja temelj za dalji razvoj priručnika za nastavnike, uključujući **„Savremena nastava hemije“** i **„Multimedija u nastavi hemije“**, sa ciljem unapređenja kvaliteta nastave hemije u srednjim stručnim školama i jačanja veze obrazovanja sa realnim potrebama tržišta rada.

Banja Luka, April 2024

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INTRODUCTION

How was the *"Manual for Creating Teaching Materials for Chemistry Teachers in Secondary Vocational Education in Bosnia and Herzegovina"* developed?

The document titled *"Manual for Creating Teaching Materials for Chemistry Teachers in Secondary Vocational Education in Bosnia and Herzegovina"* was developed within the Erasmus+ project *Improving the Quality of Chemistry Teaching in VET in Bosnia and Herzegovina – ChemTeach* as a result of activities under Work Package 2 (Building Capacities for Chemistry Teachers in Secondary Vocational Schools). It serves as a guide intended for chemistry teachers and related scientific disciplines, as well as for other stakeholders involved in the educational process across various chemistry-related fields.

What is the Purpose of the Guide?

The purpose of this Guide is to provide an overview of the findings and recommendations arising from the initial project activities, including trainings, roundtable discussions, and visits to foreign educational institutions. The content is designed to assist teachers in applying modern didactic approaches, active learning, multimedia tools, and in better aligning teaching with the needs of the labor market.

Who is the Guide intended for?

The document is primarily intended for:

- Chemistry teachers and teachers of related subjects in vocational secondary schools,
- School management,
- Representatives of employers from the chemical industry and the public sector,
- University lecturers who train future teachers,
- Education policy makers.

How to Use the Guide?

The content of the document can serve as:

- a reference for planning and modernizing chemistry teaching,
- support in designing a curriculum aligned with modern educational approaches,
- a starting point for strengthening cooperation between schools, universities, and industry.

CHALLENGES AND RATIONALE FOR CREATING THE GUIDE

Demographic and Educational Trends

- In recent years, Bosnia and Herzegovina has experienced a continuous decline in the number of students choosing education in chemistry-related fields and natural sciences in general.
- This trend is partly due to unfavorable demographic developments, as well as an underdeveloped labor market and a gap between the quality and style of education compared to developed European Union countries.

Potential and Importance of Chemistry

Furthermore, chemistry, as a school subject based on a fundamental natural science, has significant potential to contribute to the development of scientific literacy, critical thinking, and the competencies required for various professions in both the private sector and public services.

Shortcomings in Current Practice

- The analysis of curricula in partner schools shows that, although the formal goals and objectives of chemistry teaching are set ambitiously, the teaching approach remains traditional, particularly in lower grades.
- Teaching is often focused on acquiring basic disciplinary knowledge, with limited application of active learning methods and insufficient connection of the subject matter to everyday life and work contexts.

Limitations of Didactic Guidelines

- There are certain didactic guidelines for teachers, but they mainly provide a general overview of methods and teaching tools, without offering a broader professional context or a clear connection to the real needs of the labor market.
- A clear methodological framework is missing for the development of generic competences, the formation of students' attitudes and values, as well as for encouraging the application of the scientific approach and critical thinking.

The Role of the ChemTeach Project

The **ChemTeach** project was launched precisely to address these challenges by strengthening the capacities of chemistry teachers and related subject teachers in vocational secondary schools. One of the key steps is the development of this Guide, which summarizes the experiences and findings from project activities and lays the foundation for the preparation of two comprehensive manuals:

- ***Modern Chemistry Teaching – A Manual for Chemistry Teachers,***
- ***Multimedia in Chemistry Teaching.***

Connecting Different Stakeholders

This Guide connects the results achieved so far in the project with concrete recommendations for practice, building on the cooperation of three key stakeholders in the educational process:

VOCATIONAL SECONDARY SCHOOLS – UNIVERSITIES – EMPLOYERS

OBJECTIVES OF THE GUIDE

- To provide chemistry teachers and teachers of related subjects with **clear guidelines** for improving teaching in vocational secondary schools in BiH.
- To encourage the use of **modern didactic approaches**, **active learning**, and **digital technologies** in chemistry education.
- To strengthen **cooperation between schools, universities, and employers** in creating relevant and high-quality education.
- To define the expected **level of students' knowledge and skills**, with a clear distinction between general and vocational education.
- To establish a foundation for **the development of comprehensive guides** intended for chemistry teachers.

ACTIVITIES

The development of this manual is based on the results of a series of activities carried out within the ChemTeach project. These activities were designed to enable the collection of relevant information, the exchange of experiences, and the identification of best practices that can be applied in chemistry teaching in vocational secondary schools in Bosnia and Herzegovina.

Training for Chemistry Teachers

A multi-day training was organized, attended by chemistry teachers from the partner schools. During the training:

- Examples of modern teaching methods from EU practice were presented,
- The use of multimedia tools and experimental teaching methods was demonstrated,
- Challenges in linking theoretical content with practical work and industrial contexts were analyzed.

Roundtable with Employers

Participants included representatives from the chemical industry, public enterprises, educational institutions, and teaching staff. The aim of the roundtable was to:

- identify the skills and knowledge that employers expect from students graduating from vocational secondary schools,
- define ways to better align the educational process with labor market requirements,
- exchange experiences and proposals for improving practical training.

Visits to Educational Institutions

Teacher and university delegations visited partner educational institutions in Slovakia and the Czech Republic. During these visits:

- curricula and teaching methodologies in chemistry were analyzed,
- models for integrating theoretical and practical teaching were presented,
- examples of good practices in the use of digital technologies and laboratory exercises were collected.

RESULTS

Training for Chemistry Teachers

- Teachers recognize the need for greater application of **active learning** and inquiry-based methodologies.
- There is significant room for **improvement in teachers' digital competencies**, particularly in the use of multimedia and interactive tools.
- Experimental teaching is often limited due to a **lack of equipment, consumables, and safety conditions**.

Roundtable with Employers

- Employers prefer to hire students with well-developed **practical skills, teamwork abilities, and knowledge of basic safety and work procedures**.
- Students often lack sufficient **work experience** gained through practical training and have limited understanding of industrial processes.
- It is necessary to strengthen **collaboration between schools and employers** through joint projects, mentoring, and professional visits.

Visits to Educational Institutions

- Curricula in partner EU countries are **more flexible**, allowing adaptation of teaching content to local industry needs.
- A strong emphasis is placed on **integrating theory and practice** within the same teaching units.
- Multimedia and digital platforms are used **systematically**, not merely as an addition, but as an integral part of the teaching

RECOMMENDATIONS FOR TEACHERS AND SCHOOLS

The recommendations are based on the activities carried out and the analysis of the current state of chemistry teaching in vocational secondary schools. Their purpose is to serve as guidelines for improving the teaching process, taking into account available resources and the local context.

Teaching Methodology and Approach

- Use **active learning methods** (experiments, project-based tasks, group work, inquiry-based activities) to increase student engagement.
- Connect the curriculum content with **real-life situations and industrial contexts**, enabling students to understand the practical application of chemistry.
- Gradually introduce **interdisciplinary topics** that link chemistry with biology, physics, ecology, and technology.

Use of Digital Tools and Multimedia

- Use multimedia materials (videos, animations, simulations) as an **integral part of teaching**, not just as a supplement to lectures.
- Incorporate **online laboratory simulations** when live experiments cannot be conducted.
- Develop **teachers' digital competencies** through continuous training and exchange of best practices.

Improving Practical Teaching

- Plan and implement **student projects** in collaboration with local companies and laboratories.
- Organize **field visits** to chemical plants and relevant institutions.
- Ensure that students acquire basic **laboratory safety skills**, including the use of protective equipment and chemical handling protocols.

Collaboration with Employers and Universities

- Establish **partnership agreements** that enable joint projects, mentoring, and professional internships.
- Involve employers in the process of **updating curricula** to ensure programs meet labor market needs.
- Leverage collaboration with universities for **teacher professional development** and the creation of new teaching materials.

Continuous Professional Development of Teachers

- Regularly participate in **seminars, workshops, and professional gatherings** focused on modern chemistry teaching.
- Develop **teacher networks** for exchanging materials, ideas, and experiences.
- Keep up with **new trends and innovations** in chemistry education at the international level.

CONCLUSION AND NEXT STEPS

This manual represents the first step toward the systematic improvement of chemistry teaching in vocational secondary schools in Bosnia and Herzegovina. It combines and summarizes experiences from the ChemTeach project activities, insights into good practices from abroad, and recommendations from teachers, employers, and education experts.

The key message of this manual is that high-quality chemistry teaching cannot rely solely on the transmission of knowledge; it requires a broader and more dynamic approach. Effective teaching is built through the continuous connection of theoretical content with practical experiences and examples from everyday life and work. Such teaching implies openness to innovations and a willingness to apply new technologies that enrich the learning process.

Equally important is the collaboration between schools, universities, and employers, as only joint efforts can align the educational process with the real needs of society and the labor market.

Finally, quality is maintained and enhanced through the continuous professional development of teachers, who are the key drivers of change and innovation in the classroom.

Key Messages

- **Chemistry is a subject essential for developing scientific literacy** and preparing students for modern society and the labor market.
- **The curriculum must be modern, flexible, and aligned with professional needs**, integrating both theoretical and practical knowledge.
- Active learning, **real-life connections, and multimedia** significantly enhance student motivation and engagement.
- **Collaboration with employers** enables teachers to better understand the competencies required for student employment.
- **Continuous professional development of teachers** is crucial for high-quality teaching and sustainable development of chemistry-related professions.

Next Steps

Naredni koraci uključuju:

The **next steps** include:

- Developing **comprehensive teacher manuals** with examples of lesson units, experiments, and digital resources,
- Organizing **workshops** for students and teachers to exchange experiences and materials,
- Establishing an **online platform** for collaborative creation and sharing of teaching content,
- **Monitoring and evaluating** the implementation of the guide's recommendations in practice.

In this way, the guide will serve not only as a document but also as a starting point for the continuous improvement of chemistry education in Bosnia and Herzegovina.