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ChemTeach REPORT

SUMMER SCHOOL FOR STUDENTS IN SLOVAKIA ON COSMETICS CHEMISTRY, FOOD CHEMISTRY, PHARMACEUTICAL CHEMISTRY

Stredná odborná škola chemická, Vlčie Hrdlo, Bratislava, Slovakia

Bratislava, August 26–30, 2024

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WP4: CHEMISTRY GAMES FOR STUDENTS

Activity: Summer school for students in slovakia on cosmetics chemistry, food chemistry, pharmaceutical chemistry

Report prepared by: Stredná odborná škola chemická, Vlčie Hrdlo, Bratislava, Slovakia

Erasmus+ Project

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

101129417-ERASMUS-EDU-2023-CB-VET

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Activities

The Summer School program held in Bratislava from August 25 to 31, 2024, provided an enriching and comprehensive educational experience designed to elevate the knowledge, skills, and intercultural competence of both students and teachers in the field of chemistry. This intensive week-long event seamlessly combined rigorous scientific training with cultural immersion and professional development, fostering an environment of collaboration and innovation.

The program commenced with the arrival of participants, where organizers prioritized a smooth onboarding process. This included the installation of mobile applications to facilitate seamless communication and support throughout the event. These technological tools laid the groundwork for effective collaboration and real-time information sharing among participants and staff during the Summer School.

On the **first day**, students were deeply engaged in **food chemistry** through a series of carefully arranged analytical laboratory experiments. They applied techniques such as spectrophotometry to quantify sucrose levels in various soft drinks, refractometry to measure sodium chloride concentration in brine, titration methods to evaluate the buffering capacity of beverages, and iodometric analysis to determine the sulphur dioxide content in wines. This hands-on approach not only enhanced their understanding of food chemistry principles but also equipped them with practical skills in precision analysis and data interpretation. During this time, teachers participated in a workshop centered on **chemical information literacy**. This session encouraged educators to exchange best practices and explore a range of educational resources to enhance their teaching acumen and better support student learning in chemistry.

The **second day** shifted the students' focus toward **pharmaceutical**

chemistry. Through laboratory experiments, they examined active components in commonly used pharmaceuticals, including salicylic acid in aspirin, boric acid, ibuprofen, and ethanol content. Analytical techniques such as spectrophotometry, titration, and refractometry were employed to foster a thorough grasp of pharmaceutical quality control and analysis. Following the laboratory work, a guided walking tour of Bratislava enriched the students' cultural perspectives, offering insights into the city's historical and architectural heritage. Meanwhile, teachers engaged in a workshop dedicated to the integration of state-of-the-art **sensor technology** into chemistry education. Practical demonstrations involved CMA sensors, VinciLab 2 software, and COACH—all tools designed to enhance student interaction and data collection accuracy in laboratory settings. This workshop prepared teachers to adopt innovative, technology-driven teaching methods to increase student engagement and comprehension.

Cosmetic chemistry was the focal point on the **third day**. Students synthesized key compounds integral to the cosmetics and personal care industry, such as dibenzalacetone, commonly used in sunscreen formulations, and 2-ethoxynaphthalene, a fragrance component identified as nerolin. They also performed the isolation of chamazulene from chamomile extracts, followed by refractive index measurements of the isolated components. These experiments provided students with exposure to natural product chemistry, synthetic organic methodology, and quantitative analysis techniques. Beyond laboratory activities, participants had access to cultural and sports activities around Bratislava, encouraging them to further immerse themselves in the local environment. Teachers simultaneously explored advancements in educational technology by engaging in a workshop focused on deploying **AI-powered chatbots in classroom** settings. The goal was to facilitate personalized learning experiences, increase student participation, and make chemistry education more dynamic and interactive through innovative digital tools.

On the **fourth day**, the program emphasized cultural exchange and team-building through the “Sing & Dance Around Europe” event. This activity encouraged students from various countries to collaborate, fostering intercultural understanding and social skills. Students also prepared **presentations detailing their Summer School experiences**, further sharpening their communication, reflection, and critical thinking skills. Teachers concentrated on **dissemination activities** designed to share the program’s outcomes with a broader educational community. This included formulating strategies and project ideas aligned with Erasmus program priorities, enhancing the prospects for future international collaboration. Planning also began for the Culture Quest activity, an intercultural challenge tailored to promote engagement and solidarity among participants. Optional recreational activities provided additional opportunities for informal interaction and relaxation.

The **fifth day** allowed students to consolidate their learning by **finalizing their presentations and sharing insights with peers and instructors**. Participation in Culture Quest and the culminating “Sing & Dance Around Europe” event highlighted the importance of respecting diversity and working collaboratively. These experiences reinforced the program’s intercultural objectives and celebrated the rich variety of cultural backgrounds represented. **Final self-assessment exercises** encouraged students to reflect on their educational journey and personal development throughout the Summer School. Teachers explored potential **Erasmus cooperation opportunities** to sustain and expand cross-border educational initiatives, ensuring a lasting impact of the program.

The final day marked the departure of participants, concluding an intense and rewarding week. The Summer School succeeded not only in imparting advanced chemical knowledge and practical skills but also in fostering a strong international network of educators and learners committed to excellence and cooperation.

Throughout the week, students gained significant hands-on experience in analytical techniques applicable to food, pharmaceutical, and cosmetic chemistry. They improved competencies in data analysis, teamwork, and the effective communication of scientific results. The rich schedule of cultural activities further bolstered their intercultural competence and global outlook. Teachers enhanced their professional capacity by exploring modern pedagogical tools such as sensor technologies and AI chatbots. They engaged deeply in dissemination, project integration within Erasmus frameworks, and strategic planning for future international educational collaborations.

The Summer School fostered an inclusive and collaborative environment where participants engaged in meaningful exchanges of expertise and culture—a model for holistic chemistry education that bridges scientific rigor with cultural enrichment and pedagogical innovation. Regular self-assessment provided crucial feedback loops that encouraged continuous personal and professional growth, maximizing the program’s long-term benefit for both students and teachers.

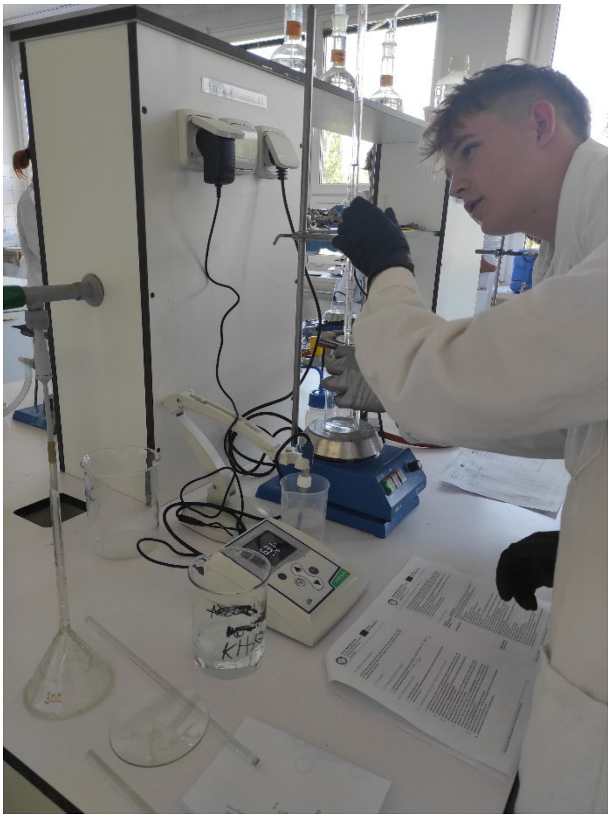

Figure 1 Determination of buffering capacity of drink by potentiometric titration – preparation for experiment

Figure 2 Determination of buffering capacity in orange juice by potentiometric titration

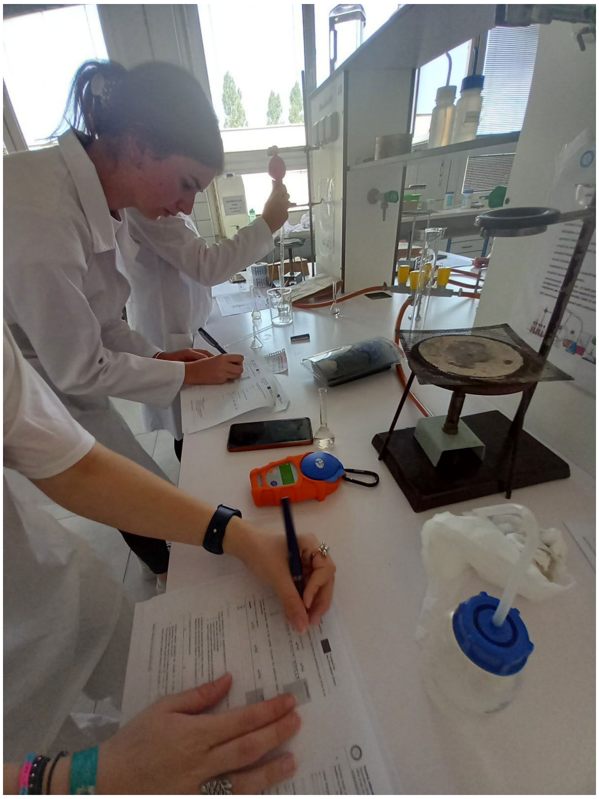

Figure 3 Determination of ethanol in mixture by refractometry

Figure 4 Synthesis of nerolin

Figure 5 Presentation of team 1

Figure 6 Presentation of team 2

Figure 7 Presentation of team 3

Figure 8 Presentation of team 4

Materials

The provided **lab manual** and **worksheet** documents, supplemented by an Excel table for each laboratory exercise, together form a comprehensive educational toolkit designed to facilitate effective chemistry teaching and learning. Below is a detailed description of the structure and usage of both the lab manual and the worksheet, as well as their practical application for teachers and students.

Lab Manual Description:

The lab manual serves as the primary instructional guide for conducting the laboratory experiment. It is organized into clear sections, each contributing essential information for a successful experiment. Typically, the manual includes:

1. **Introduction:** This section provides the scientific background and contextual relevance of the experiment. For example, it explains the significance of determining sodium chloride concentration in brine used for cheese salting, highlighting its preservative role and impact on food quality.

2. **Chemical and Equipment Information:** Detailed information about chemicals, including safety data, chemical properties (molecular formula, molar mass, CAS number), and handling instructions, is presented. Additionally, equipment descriptions and technical specifics, such as the function and setup of a refractometer, are included to familiarize users with the tools required.

3. **Procedure:** Step-by-step instructions guide users through the laboratory processes, such as preparing standard solutions, measuring refractive indexes at a controlled temperature, conducting calibrations, and sample analyses. This portion

ensures that students and teachers can reproduce the experiment accurately.

4. **Data and Calculations:** The manual often incorporates explanatory content on key analytical techniques and mathematical approaches (e.g., linear interpolation, calibration curve construction) necessary for interpreting experimental data.

5. **Safety Information:** Clear guidance on safe laboratory practices and chemical hazards, if any, to ensure the well-being of all participants.

Teachers can use the lab manual to prepare and plan their lessons, ensuring they understand the scientific concepts and practical steps thoroughly. The manual helps them explain the theory behind the experiment and supervise the laboratory work safely and effectively. It also serves as a reliable reference during the lab to assist students if they encounter difficulties or questions.

Students rely on the lab manual to familiarize themselves with the experiment's goals, methods, and safety considerations before and during the laboratory session. It acts as a structured guide that supports autonomous work, encouraging students to understand both the theoretical and practical aspects of the task.

Worksheet Description:

The worksheet complements the lab manual by providing a structured format for students to record, organize, and analyze their experimental data. Key elements of the worksheet include:

1. **Identification Fields:** Spaces for participant names, group information, instructor details, and date are provided to maintain clear documentation.

2. **Experimental Data Tables:** These sections are designed for inputting measured values such as refractive indexes, solution concentrations, and sample descriptions. The tables promote systematic data collection during the experiment.

3. **Calculations and Data Analysis:** The worksheet prompts students to perform necessary calculations, including the preparation of calibration curves using regression analysis and the application of linear interpolation for data evaluation. It may also require sample calculations to reinforce understanding of the analytical procedures.

4. **Questions and Theoretical Tasks:** Conceptual questions related to refractive index principles, measurement techniques, and the scientific rationale behind the experiment encourage students to actively engage with the material and reflect on their learning.

5. **Applied Informatics and Additional Exercises:** Some worksheets incorporate tasks involving chemical informatics tools, such as molecular structure downloads or software use, integrating digital skills with laboratory science.

Teachers can employ the worksheet to guide students through data collection and analysis systematically. It helps facilitate assessment by providing a clear record of student work and understanding. Additionally, completed worksheets serve as valuable evidence of student learning outcomes and can be used for grading or feedback.

For students, the worksheet functions as an interactive workbook that structures their laboratory notes, calculations, and reflections. It encourages thorough engagement with both experimental practice and theoretical comprehension, fostering critical thinking and analytical skills.

Excel Tables:

The accompanying Excel spreadsheets provide digital aids for data processing. They often include **templates for calibration curves**, **automatic calculations of concentrations** from refractive indexes, and **visualization tools**. Teachers can use these to demonstrate data analysis methods or automate grading. Students can apply Excel sheets to process their data efficiently, visualize results graphically, and gain proficiency in scientific data handling software.

In summary, the lab manual and worksheet together constitute a cohesive instructional package. The manual delivers comprehensive scientific and procedural knowledge, while the worksheet structures practical application and data management. Both are invaluable assets for teachers aiming to deliver high-quality, interactive chemistry education and for students striving to achieve a deep understanding of laboratory techniques and analytical reasoning. The integration of these materials with Excel tools enhances learning by combining theoretical knowledge, hands-on practice, and digital competence.

Evaluation

The surveys included in the Summer School program serve as an essential component of the overall assessment and evaluation strategy for both students and teachers. Daily self-assessment surveys for students and teachers promote ongoing reflection, personal growth, and the continuous improvement of learning and teaching practices throughout the event. Additionally, specialized surveys—such as those exploring AI integration, sensor use in chemistry lessons, ideas for future programs, and Erasmus cooperation—allow educators to systematically evaluate the effectiveness, relevance, and impact of both laboratory activities and professional workshops.

By gathering feedback on learning outcomes, professional development, collaborative experiences, and innovative approaches (like AI and sensors), these surveys provide organizers with actionable insights to fine-tune future Summer School content and methods. They also foster a culture of self-reflection and shared responsibility, ensuring that both students and teachers actively contribute to enhancing educational quality, maximizing program benefits, and aligning future projects with the evolving needs of the international educational community.

The **daily student self-assessment survey** are designed to help participants reflect on their learning, collaboration, and progress following each day's Summer School lab or activity. Its goals are to encourage students to identify new concepts or techniques learned, assess their confidence in applying them, and evaluate how effectively they communicated and contributed to their team. By providing structured questions about achievements, challenges, and remaining questions, the survey supports ongoing self-awareness and personal development.

Evaluation

The **daily teacher self-assessment survey** is designed to promote reflection on professional growth, teaching effectiveness, and collaboration during each day of the Summer School program. Its goals include helping teachers evaluate their observation of student activities, assess student engagement and learning outcomes, and reflect on their participation and skill development in workshops. By responding thoughtfully to structured questions, teachers contribute to the continuous improvement of the program and gain insights for integrating new practices into their own teaching.