Co-funded by the European Union

Green STEM

COURSE SYLLABUS	
Course title:	Innovative STEM methods in GREEN STEM for student training

Study programme and level	Study field	Academic year	Semester
Educational chemistry, Bachelor degree	**1.3.**	**2024**	**2nd**

Course type	Elective
University course code:	

Lectures	Seminar/ Exercise	Tutorial	work		Individ. work	ECTS
30	**15**				**45**	**3**

Lecturer:	**Assist. Prof. Dr. Damyana Grancharova**

Languages:	**Lectures:**	English
	Tutorial:	English

Prerequisits:

Basic familiarity with the teaching methodologies in chemistry and the interconnectedness of humanity and nature will enhance the successful comprehension of course material.

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

Key Objectives of Syllabus:

This cutting-edge course in Green STEM explores innovative teaching approaches tailored for natural sciences and sustainability.

The syllabus is structured into the following modules: "STEM Teaching Methods for Natural Sciences" and "Advanced Techniques in Green STEM Education". Topics covered include the essence of natural science, sustainable observation methodologies, modelling for ecological systems, experiments integrating augmented reality, and other forward-thinking methods.

Key Objectives:

1. Exploration of Modern Teaching Approaches in Natural Sciences: Students will gain insight into contemporary teaching methodologies specifically designed for natural science education.

2. Establishing Proficiency in Innovative Teaching Approaches: Building foundational knowledge of new and inventive teaching techniques relevant to Green STEM.

3. Analysis of Diverse Innovative Approaches: Examining and assessing various green STEM innovative pedagogical methods essential for comprehending and engaging with natural sciences.

Objectives and competences:

Objectives students will be able to:

Earn fundamental pedagogical knowledge while utilizing modern teaching tools and methodologies. Active student participation is encouraged to facilitate a deeper understanding of Green STEM concepts.

Expected Outcomes:

- **Knowledge Acquisition:** Students are expected to gain foundational knowledge, enabling them to further specialize in Green STEM disciplines.
- **Expansion of Teaching Methodologies:** The course aims to broaden and deepen understanding of contemporary teaching methods specifically applicable to natural sciences.

Intended learning outcomes:

Students learn about effective teaching methodologies specifically tailored for natural sciences within the realm of Green STEM, fostering scientific literacy in the human-nature relationship.

To familiarize students with advanced principles and methodologies vital for Green STEM education, emphasizing innovative approaches and sustainability in environmental and natural sciences.

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

Learning and teaching methods:

Lectures, seminars/ labwork.

Assessment:	Weight (%)
Midterm exams (2 tests)	**2 x 10**
Project presentation	**20**
Exercises/ seminars assessment	**20**
Total	**60**

CONTENT OF THE EDUCATIONAL PROGRAM

The Course Program “Innovative course in Green STEM for student training” includes lectures and seminar exercises.

A) LECTURES

The lecture course is structured into 2 modules with a total duration of 30 study hours.

Module A1:

STEM TEACHING METHODS FOR NATURAL SCIENCES IN GREEN STEM

A1.1. TEACHING METHODS FOR GREEN STEM

Understanding the essence and characteristics of the concept of "teaching method" in the context of Green STEM. Methodological approaches specific to natural sciences. Classification of teaching methods. Types of competencies and scientific literacy within Green STEM. Teaching environmental sciences and fostering scientific literacy in Green STEM.

5 hours

A1.2. TEACHING METHODS IN NATURAL SCIENCES FOR GREEN STEM

Exploring elements and structures of teaching methods for natural sciences within Green STEM. Various types and classifications of methods applicable to natural sciences. Indirect investigation methods relevant to Green STEM. Modeling methods for sustainability and environmental sciences within Green STEM.

4 hours

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

Expected Results. Students will acquire knowledge about teaching methods in natural sciences within Green STEM, grasp the essence of science in an environmental context, and develop skills in scientific research related to sustainability and the natural world.

References: *Primary*: 1, 2, 3, 4, 5, 6, 7,8,9,10,11
Supplementary: 1, 2, 3, 4, 5, 6

Midterm exam №1 **1 hour**

Module A2:

ADVANCED TECHNIQUES IN GREEN STEM EDUCATIONA2.1. OBSERVATION IN GREEN STEM NATURAL SCIENCES

Understanding observation and its application in teaching natural sciences within the context of Green STEM. Types of observation: spontaneous, independent, descriptive, systematic, teacher-guided, focusing on sustainability and environmental implications within Green STEM.

2 hours

A2.2. EXPERIMENTATION AND AUGMENTED REALITY IN GREEN STEM EDUCATION

Utilizing augmented reality in experimentation and teaching for environmental sciences within Green STEM. Shifting virtual data (audio-visual and multimedia content) for environmental learning. Various experiment types focusing on sustainability within Green STEM.

2 hours

A2.3. GREEN STEM LABORATORY, PRACTICAL WORK, AND VIRTUAL ENVIRONMENTS

Implementing internet simulations, demonstrations, and virtual laboratory experiments specifically tailored for environmental sciences within Green STEM. Exploring the potential of virtual reality in teaching about the human-nature relationship, emphasizing sustainability and environmental literacy in Green STEM.

2 hours

A2.4. MODELLING METHODOLOGY FOR SUSTAINABILITY EDUCATION IN GREEN STEM

Exploration of different types of models and their application in sustainability education within Green STEM. Utilizing the research approach to study content related to sustainability and the environment, enhancing scientific literacy within Green STEM.

2 hours

A2.5. PRACTICAL ACTIVITY METHODS FOR GREEN STEM EDUCATION

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

Implementing situational methods (case studies) and research-oriented approaches in teaching about the human-nature relationship within Green STEM. Application of research approaches for environmental scientific literacy within Green STEM.

2 hours

A2.6. COMMUNICATION METHODS IN NATURAL SCIENCES WITHIN GREEN STEM

Dialogue (heuristic dialogue), narrative, explanation, and lecture strategies focusing on Green STEM contexts. Developing effective presentations aligned with environmental sciences within Green STEM.

2 hours

A2.7. GREEN STEM TEXTUAL ANALYSIS AND APPLICATION

Developing skills to work with diverse sources such as educational, reference, scientific-popular literature, internet articles, etc., specifically emphasizing environmental challenges and sustainability within Green STEM. Problem-based presentation of environmental science material within Green STEM contexts.

2 hours

A2.8. RESEARCH-BASED LEARNING IN SUSTAINABILITY EDUCATION FOR GREEN STEM

Active learning, problem-based learning, and the implementation of research-based methods ("learning through research") specifically designed for Green STEM education, emphasizing sustainability and environmental research.

2 hours

A2.9. GREEN SCIENCE INTO STEM SYLLABUS INTER-DISCIPLINARY APPROACHES TO GREEN STEM INTEGRATION

Brainstorming sessions focusing on sustainability and environmental challenges within Green STEM contexts. The connection of Green STEM with the public engagement and the environments industry.

2 hours

A2.10. RESULTS ANALYSIS AND MODELING FOR SUSTAINABILITY IN GREEN STEM

Building models, conducting simulations, and presenting scientific reports based on sustainability and environmental learning within the context of Green STEM education.

1 hour

Midterm exam №2 **1 hour**

B) EXERCISES/ SEMINARS/ Conducting green experiments and projects

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

1. Exploring *renewable energy sources*, sustainable energy technologies, and life cycle impact assessment through advanced computational tools within the realm of Green STEM.

1 hour

2. Analyzing corporate sustainability practices and their integration with social *responsibility in the context of Green STEM initiatives*.

1 hour

3. Understanding *Wind Power systems* and their integration into the methodologies of Green STEM for sustainable energy generation.

1 hour

4. Evaluating Concentrated *Solar Power* within the spectrum of Green STEM sustainability practices.

1 hour

5. Evaluating Concentrated *Solar Photovoltaic technologies* within the spectrum of Green STEM sustainability practices.

1 hour

6. Harnessing the potential and applications of *Bioenergy* within the framework of Green STEM principles.

1 hour

7. Harnessing the potential and applications of *Hydropower* within the framework of Green STEM principles.

1 hour

8. Delving into *Geothermal Energy* solutions through the lens of Green STEM sustainability practices.

1 hour

9. Exploring innovative *Energy Storage methods* in alignment with Green STEM sustainability frameworks.

1 hour

10. Understanding the role and implications of *Nuclear Power* within the purview of Green STEM practices.

1 hour

11. Investigating the *environmental pollution* harvesting technologies and their alignment with Green STEM sustainability frameworks.

1 hour

12. Exploring the *biodiversity* and their relevance within the spectrum of Green STEM initiatives.

1 hour

13. Understanding the implications of Green STEM among teachers and joint conduct of lesson units, hours of the full-day *organization of the study day, extracurricular activities, as well as activities in partnership with external organizations* (museums, libraries, observatories, research centers, etc.).

1 hour

14. Researching the sustainable methods to optimize *transport infrastructure and reduce carbon emissions and the greenhouse effect* and its integration with Green STEM principles for sustainable practices.

1 hour

15. Exploring the implementation of *organic farming methods that use natural techniques for soil nutrition and pest control* within the framework of Green STEM practices.

1 hour

Project No: 2022-1-BG01-KA220-HED-000088567 with the financial support of the Erasmus+ programme

Lecturer's references:

Primary:

1) Casal-Otero, L., Catala, A., Fernández-Morante, C., et al. (2023). AI literacy in K-12: A systematic literature review. *International Journal of STEM Education, 10*(1), 29. https://doi.org/10.1186/s40594-023-00418-7

2) Darmawansah, D., Hwang, G. J., Chen, M. R. A., et al. (2023). Trends and research foci of robotics-based STEM education: A systematic review from diverse angles based on the technology-based learning model. *International Journal of STEM Education, 10*(1), 12. https://doi.org/10.1186/s40594-023-00400-3

3) Gravel, B. E., & Puckett, C. (2023). What shapes implementation of a school-based makerspace? Teachers as multilevel actors in STEM reforms. *International Journal of STEM Education, 10*(1), 7. https://doi.org/10.1186/s40594-023-00395-x

4) Martella, A. M., Martella, R. C., Yatcilla, J. K., et al. (2023). How rigorous is active learning research in STEM education? An examination of key internal validity controls in intervention studies. *Educational Psychology Review, 35*(1), 107. https://doi.org/10.1007/s10648-023-09826-1

5) Park, J., Teo, T. W., Teo, A., et al. (2023). Integrating artificial intelligence into science lessons: Teachers' experiences and views. *International Journal of STEM Education, 10*(1), 61. https://doi.org/10.1186/s40594-023-00454-3

6) Rosengrant, D. (2003). Physics in the real world. Teaching outside the textbook. *Techniques, Association for Career and Technical Education, 78*(2), 58-59.

7) Rosengrant, D. (2013, April). Using eye-trackers to study student attention in physical science classes. *CREATE for STEM Eye-Tracking mini conference proceedings at Michigan State University.*

8) Rosengrant, D., Hearrington, D., & O'Brien, J. (2020). Investigating student sustained attention in a guided inquiry lecture course using an eye tracker. *Educational Psychology Review.* https://doi.org/10.1007/s10648-020-09540-2

9) Rosengrant, D., Hensberry, K. K., Vernon-Jackson, S., & Gibson-Dee, K. (2019). Improving STEM education programs through the development of STEM education standards. *Journal of Mathematics Education, 12*(1), 123-140.

10) Rosenzweig, E. Q., & Chen, X. Y. (2023). Which STEM careers are most appealing? Examining high school students' preferences and motivational beliefs for different STEM career choices. *International Journal of STEM Education, 10*(1), 40. https://doi.org/10.1186/s40594-023-00427-6

11) Teplá, M., Teplý, P., & Šmejkal, P. (2022). Influence of 3D models and animations on students in natural subjects. *International Journal of STEM Education, 9*(1), 65. https://doi.org/10.1186/s40594-022-00382-8

Additional literature:

1. AlGerafi, M. A. M., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the Potential: A Comprehensive Evaluation of Augmented Reality and Virtual Reality in Education. *Electronics, 12*(18), 3953. https://doi.org/10.3390/electronics12183953

2. Kozhuharova, D., & Zhelyazkova, M. (2021). What Is STEM Education. *Pedagogical Forum, 9*. https://doi.org/10.15547/PF.2021.016

3. Li, Y., & Schoenfeld, A. H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education, 6*, 44. https://doi.org/10.1186/s40594-019-0197-9

4. Mawadah, N., Ikhsan, J., Suyanta, Nurohman, S., & Rejeki, S. (2023). 3D Visualization Trends in Science Learning: Content Analysis. *Jurnal Penelitian Pendidikan IPA, 9*, 397-403. https://doi.org/10.29303/jppipa.v9i8.3864

5. Sen, C., Ay, Z., & Kıray, S. (2018). STEM skills in 21st-century education. *Research Highlights in STEM Education*.

6. Thibaut, L., Knipprath, H., Dehaene, W., & Depaepe, F. (2018). The influence of teachers' attitudes and school context on instructional practices in integrated STEM education. *Teaching and Teacher Education, 71*, 190-205. https://doi.org/10.1016/j.tate.2017.12.014

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.