GREEN STEM MODEL FOR STUDENT TRAINING

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Co-funded by the European Union

This Programme is funded by the European Union
Erasmus+ KA220-HED - Cooperation partnerships
in higher education Call 2022 Round 1 KA2

TABLE OF CONTENTS

I. ANNOTATION

This cutting-edge course in Green STEM explores innovative teaching approaches tailored for natural sciences and sustainability. The curriculum 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, modeling for ecological systems, experiments integrating augmented reality, and other forward-thinking methods.

Key Objectives

Exploration of Modern Teaching Approaches in Natural Sciences

Students will gain insight into contemporary teaching methodologies specifically designed for natural science education.

Establishing Proficiency in Innovative Teaching Approaches

Building foundational knowledge of new and inventive teaching techniques relevant to Green STEM.

Analysis of Diverse Innovative Approaches

Examining and assessing various green STEM innovative pedagogical methods essential for comprehending and engaging with natural sciences.

01

Program Objective

This introductory course aims to equip students with 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.

Prerequisites

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

Program Duration:
45 classroom hours of which 30 hours lectures and 15 hours exercises/ seminars/.

ECTS: 3 credit points.

II. 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

Module Objective: This module aims to introduce students to effective teaching methodologies specifically tailored for natural sciences within the objective of Green STEM, fostering scientific literacy in the human-nature relationship.

Module A1

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

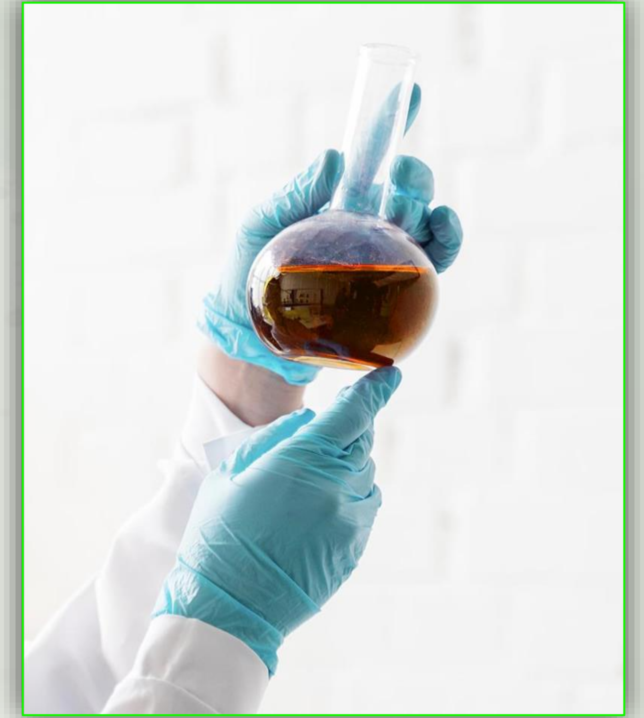
Exploring elements and structures of teaching methods for natural sciences within Green STEM. Various types and classifications of methods applicable to natural sciences. Indirect investigation methods relevant to Green STEM. Modeling methods for sustainability and environmental sciences within Green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

4 hours

Module A1

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

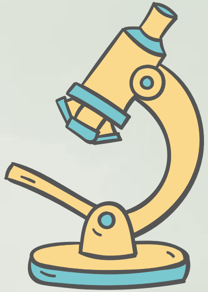
Supplementary: 1, 2, 3, 4, 5, 6

Midterm exam №1

1 hour

Module A2:
ADVANCED TECHNIQUES IN GREEN STEM EDUCATION

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



Module A2

A2.1. 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

Module A2

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

Module A2

A2.5. PRACTICAL ACTIVITY METHODS FOR GREEN STEM EDUCATION

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

Module A2

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

Module A2

A2.9. GREEN SCIENCE INTO STEM CURRICULUM 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

II. CONTENT OF THE EDUCATIONAL PROGRAM

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

B) EXERCISES/ SEMINARS/ Conducting Green experiments and projects

EXERCISES/ SEMINARS/ Conducting green experiments and projects

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

EXERCISES/ SEMINARS/ Conducting green experiments and projects

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

EXERCISES/ SEMINARS/ Conducting green experiments and projects

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

EXERCISES/ SEMINARS/ Conducting green experiments and projects

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

EXERCISES/ SEMINARS/ Conducting green experiments and projects

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.

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

III. LITERATURE FOR THE COURSE

Primary:

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

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

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

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

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

III. LITERATURE FOR THE COURSE

Primary:

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

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.*

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

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.

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

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

III. LITERATURE FOR THE COURSE

Additional literature:

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

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

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

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

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

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

IV. ORGANIZATION OF TRAINING

IV.1 Classroom Engagement: *Lectures*

The process of delivering lecture material is associated with the use of visual aids - graphical images, presentations, STEM modeling, simulations, 3D scenes, AI technologies, VR tools, sensors, etc.

IV.2 Extra-curricular Engagement

Students' extracurricular preparation primarily involves work in the library, internet research, individual and group consultations to prepare for theoretical aspects, and gaining knowledge for ongoing assessments and examinations.

IV.3 Ongoing Assessment

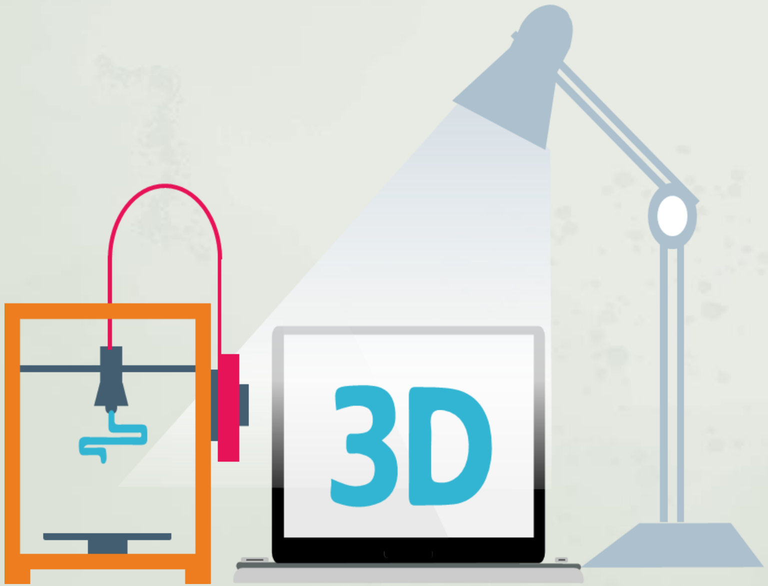
Ongoing assessment occurs during semester classes through two tests (at the end of each module), project and exercises/ seminars/ works based on a specific point system:

Ongoing control assessment:	Weight (in %)
Midterm exams (2 tests)	2 x 10
Project portfolio and presentation	20
Exercises/ seminars assessment	20
Total	**60**

V. ORGANIZATION OF CREDIT ACCUMULATION AND STUDENT ASSESSMENT

The total ECTS credits for the discipline are 3.0, of which 1.5 credit is earned from classroom engagement and 1.5 credits from independent (extra-curricular) work.

V.1 Organization of Assessment and ECTS Credit Accumulation from Ongoing Assessment



The grade from the ongoing assessment consists 60% of the final grade for the discipline.
The test questions are open-ended and multiple choice covering the material from the two modules. To receive an excellent grade, complete and correct answers to the questions are necessary.
Minimum grades from the ongoing control allowing students to be eligible for the semester exam are average (3).
Note: Failure to meet the conditions for an average grade (3) may require students to pass additional individual experimental and/or theoretical tasks to be eligible for the semester exam.

V.2 Organization of Semester Exam Preparation

There will be three exams including one final exam.

A: 80 - 100%
B: 60 - 79.99%
C: 40 - 59.99%
D: 30 - 39.99%
F: below 30%

The semester exam is 40% of the final grade. The rest of the grade (60%) comes from the ongoing assessment.

STEM EDUCATION

THANK YOU FOR THE ATTENTION!