



Module 10



LESSON PLANNING II FOCUS TO METHODS



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General overview and aim

Module O10: Lesson Planning – Focus to Methods supports future mathematics teachers in designing SSI lessons based on the nature of SSI and particular features of SSI as dealt with in modules O1 – O6 (Module 1: The Nature of Socio-scientific-issues; Module 2: Reasoning, Argumentation and Critical thinking; Module 3: Collecting Data; Module 4: Analysing Big Data; Module 5: Decision-making; Module 6: Negotiating Social, Political or Ethical Dimension in SSI). The aim of module O10 is on enabling future mathematics teachers to support their pupils and students in developing scientific competencies, transversal skills like creativity, critical thinking and reasoning and in taking into account the social, ethical and cultural aspects related to SSI when designing mathematics lessons in context with environmental socio-scientific issues.

Future mathematics teachers will learn methods how to redesign existing lessons or projects dealing with SSI and also how to find suitable and motivating topics for designing their own, original lesson accompanied by modern methods for promoting the importance of mathematics competency.

Transversal skills like critical thinking, reasoning and creativity can be enhanced in students by selecting controversial topics which promote these transversal skills and by choosing appropriate pedagogical methods, which allow for reasoning, critical thinking and creativity. Examples are: plenary discussions, debates, group work and cafe sharing methods. Module 10 includes three homeworks; two of them could be completed in small groups and the final one, the essay, is completed individually.

Prospective teachers will learn to choose active teaching and learning methods in relation to the specific aims of the lesson and in order to support transversal skills of their pupils and students.

The final assessment is based on the individual presentation of designed lesson and experience with its teaching and on the feedback to the Module 10, written by individual student in form of essay. The colloquium is suggested as the close up format of the Module 10 activity.

Module O10 focuses on the following topics:

- STEM lessons dealing with socio-scientific issues with focus to interdisciplinary contexts of mathematics and ecology, lessons redesign and design
- Active methods of teaching and learning mathematics in socio-scientific ecological contexts
- Outdoor mathematics lessons with active usage digital platforms, applications and devices
- Active peer collaboration and feedback to performing activities, which supports creativity, critical thinking and reasoning
- Small groups creative work principles in relation to importance and usefulness of mathematics and science knowledge and competencies for being active citizens
- Life-long-learning principles
- Formative assessment principles

This module is part of:

- **LEARNING:** Developing competences in dealing with environmental SSI themselves
- **TEACHING:** Acquiring teaching skills to supporting their students in developing these competences



Relevant topics

In this module the set on environmental socio-scientific issues is accompanied by challenges of active methods for teaching and learning. The methods and their specific features are introducing, repeating or adapting with the focus to mathematics and interdisciplinary contexts. Methods are based on modern pedagogies principles, such is inquiry based learning with strong digital resources and mobile devices support (tablets, mobile phones). Students not only repeat their knowledge and experience from the first, introductory, project ENSITE modules, especially what socio-scientific issues (SSI) are and how to deal with them, but they are also confronted with a palette of new or innovative pedagogical methods. Then students connect topics dealing on SSI with focus to environmental topics and adapt contexts with appropriate methods in mathematics lesson. The aim of the Module 10 is to enrich mathematics education of future mathematics teachers by exploiting SSI topics and be familiar with such pedagogical methods, which are the flexible sources for supporting the key competence concept published by the European Commission (COM 2019) of lifelong learning.

Then students continue in their deeper insight where to find, how to deal and in how to include SSI with environmental focus into their mathematics lessons. They work on examples that can be dealt with at the student level and plan lessons with selected examples and accompanied the topics by innovative methods and active pedagogies.



Learning Outcomes

Students will acquire

- Experience with reflection and critical analysis on existing specific environmental socio-scientific issues and interdisciplinary approach in mathematics lessons (Activities 1.1., 1.2 and 1.3)
- Knowledge that dealing with environmental socio-scientific issues includes transversal skills like critical thinking, ethical, social, economic and moral issues as well as country or nation specific cultural, political or historical features (Activity 1.4)
- Knowledge on the features of environmental socio-scientific issues and see that these are different to “traditional” mathematics tasks, project or activities on mathematics lessons (Activity 1.5)
- Skills on how to deal with environmental socio-scientific topics in an appropriate way and how to redesign the existing models of mathematics lesson into more active and flexible activities for mathematics education (Activity 1.6)
- Skills on how to deal with environmental socio-scientific topics in an appropriate way and how to design own attractive and motivating mathematics lesson (Activity 2.1)
- Knowledge how to adapt principles of key competencies framework to tasks, project or activities suitable for outdoor mathematics education (Activity 2.2)
- Awareness about outdoor mathematics activities that dealing with environmental socio-scientific issues (Activity 2.3)

- Awareness about the necessity that teaching mathematics should not only include learning mathematics but also includes active citizenship in local, national, and global level of ecological and environmental issues (Activity 2.4 and 2.6)
- Awareness about methods how to link citizenship education to mathematics education activities, which are closely connected with global environmental and ecological issues (Activity 2.5)
- Knowledge and skills on how to deal with environmental socio-scientific issues in future teaching of mathematics and how to reflect own work as well as work of colleagues (Activity 3.1 and 3.2)



Flowchart and Module plan

This module involves three sections, all structured into several activities. It includes 545 minutes of sessions and three homework. It includes lecture parts, group discussions, group work, reflection debates and student presentations. The structure is as follows:

- Reflection and analysis on specific designs on SSI lessons: 135 min + Homework
- Lessons designs examples with focus to methods (outdoor lessons with environmental topics): 270 min + Homework
- Usefulness and effectiveness of STEM lessons in relation to SSI: Cafe sharing method 50 min + Essay as Homework
- Assessment and final colloquium 60 min
- Outlook on the other modules: 30 min

Reflection and analysis on specific designs on SSI lessons

- Activity 1.1: Two STEM lessons plans INTRODUCTION. Topics: Aircraft and Power of river water stream.
- Activity 1.2: Two STEM lessons plans ANALYSIS.
- Activity 1.3: Two STEM lessons plans DISCUSSION.
- Activity 1.4: Two STEM lessons plans SSI topics as OPEN END PROMLEMS
- Activity 1.5 Two STEM lessons plans HOMEWORK.
- Activity 1.6 Two STEM lessons plans HOMEWORK REFLECTION

Lesson designs examples with focus to methods

- Activity 2.1: Quiz. Topic: Tree
- Activity 2.2: Outdoor lesson introduction
- Activity 2.3: Outdoor lesson experience
- Activity 2.4: Outdoor mathematics lesson design
- Activity 2.5: Example lesson: Carbon footprint
- Activity 2.6: Desingning STEM lesson: Carboon footprint

Usefulness and effectiveness of STEM lessons in relation to SSI

- Activity 3.1: What ITE students have learnt about pedagogical concepts and methods for dealing with SSI?
- Activity 3.2: Essay: Authenic and personal feedback on Module 10 activities



1. Reflection and critical analysis on specific designs on STEM lessons (135 minutes + homework)

1.1. Two examples: Aircraft fuel consumption and Flow of fluids: River



Duration: 30 minutes

This is a “warm up” activity. The intention is to allow future teachers to gain first insights on environmental SSI and let them experience the character of existing STEM lessons. Additionally, the activity is the first reflection on the SSI and the first touch to existing lessons with focus to interdisciplinary context in mathematics education.

Teacher educator, lecturer, introduces the module using the ppt presentation [1] and then present the activity 1.1 to preservice teachers, future mathematics students. The two lessons materials are available online, but it is possible to hand on students printed version of lessons. Students can work in pairs, small groups.

This session contributes to the achievement of the following learning outcomes:

- Experience with reflection and critical analysis on existing specific environmental socio-scientific issues and interdisciplinary approach in mathematics lessons (Activity 1.1.)

1.2. Common and different features of materials and methods



Duration: 10 minutes

The intention of this activity is to give teachers insight into the different approach and various activities in mathematics lessons with interdisciplinary topics. Students inform their schoolmates about general features of existing lessons, about lesson plan, content, aims of the lessons with focus to suggested methods for gaining the aims. Students discuss also questions dealing with motivation of the topic for their intended teaching. Students also discuss socio-scientific dimensions in the examples of existing lessons and describe how strong is the particular lesson topic connected with personal life and prospective science research.

Teacher educator, lecturer, introduces the module using the ppt presentation [1] and then present the activity 1.2 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Experience with reflection and critical analysis on existing specific environmental socio-scientific issues and interdisciplinary approach in mathematics lessons (Activity 1.2.)

1.3. Two dimensions: citizenship and science dimensions of the two lessons



Duration: 10 minutes

The intention of this activity is to let future teachers reflect on the features of SSI in examples of existing interdisciplinary STEM lessons. They are supposed to discover how far relate such topics to STEM education. Student teachers of mathematics should be familiar with mathematics syllabus and answer the question about fitting the topics and interdisciplinary approach to mathematics lessons. At the end of the activity students, future teachers, are aware what is in existing lesson plans missing and how would they redesign the lesson plans towards deeper motivation and emphasis of SSI issues.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 1.3 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Experience with reflection and critical analysis on existing specific environmental socio-scientific issues and interdisciplinary approach in mathematics lessons (Activity 1.3.)

1.4. How to adapt two lessons?



Duration: 30 minutes

To be more actual and motivated, including SSI principles intention of this activity is provoke future teachers to be more open and try to deal with open ended problems, which can be derived from previous topics of existing lessons. Future teachers might be familiar with controversial and critical aspect of socio-scientific issues from previous project modules, especially Module 1. Two open ended SSI problems are suggested:

- Massive aircraft transport over living areas massively hurts the environment and badly influences the quality of vegetables.
- Building small hydropower systems on small rivers is the ecological catastrophe!

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 1.4 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Knowledge that dealing with environmental socio-scientific issues includes transversal skills like critical thinking, ethical, social, economic, and moral issues as well as country or nation specific cultural, political or historical features (Activity 1.4)

1.5. Redesigning the lesson



Duration: 10 minutes + homework

The activity is a challenge for future mathematics teachers, emphasis their awareness in SSI with focus to ecology and provoking their creativity in mathematics lesson design. Future teachers of mathematics are expected to also show their information about local, regional, national, or global problems and public discussion. They should understand that the SSI topics can be controversial, and solutions can be represented by different mathematical models of the situation or issue.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 1.5 to preservice teachers, the first homework. Student teachers hand out the presentation of the lesson for further discussion on the next session.

This session contributes to the achievement of the following learning outcomes:

- Knowledge on the features of environmental socio-scientific issues and see that are different to “traditional” mathematics tasks, project or activities on mathematics lessons (Activity 1.5)

1.6. Redesigned STEM lessons plans: Homework presentations and discussion



Duration: 45 minutes

Students plenaries present their redesigned lessons. They should emphasis innovativeness and actuality of the SSI in ecological topics. The focus of the redesigned lesson lies also on innovative and active methods using during the designed lesson, in comparison to more traditional methods in existing examples of STEM lessons.

Teacher educator introduces the principles of lesson study approach. Short introduction and instructions are available in further readings.

This session contributes to the achievement of the following learning outcomes:

- Skills on how to deal with environmental socio-scientific topics in an appropriate way and how to redesign the existing models of mathematics lesson into more active and flexible activities for mathematics education (Activity 1.6)

2. Examples of lessons designs (270 minutes + Homework)

2.1. Quiz. Topic: Tree



Duration: 10 + 20 minutes

This is a “warm up” activity. The intention is to allow future mathematics teachers to gain new insights on environmental SSI, topic: Tree. First reflections on the connections of the topic, which the quiz provokes, can be for some students surprising. Discussion unfolds how rich the topic Tree is for mathematics indoor and outdoor lessons, with SSI ecological focus.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 2.1 to preservice teachers. Students complete the quiz on their mobile phones, tablets, or other digital devices. Quiz is available for sharing on application: b.socrative, student login, quiz code: SOC-52853951. The activity can be enriched by the other innovative, creative and attractive method: mind mapping. The application <https://www.mindmup.com/#storage> is recommended. One example of expected result of mind mapping can be found in ppt presentation [1].

This session contributes to the achievement of the following learning outcomes:

- Skills on how to deal with environmental socio-scientific topics in an appropriate way and how to design own attractive and motivating mathematics lesson (Activity 2.1)

2.2. Outdoor lesson introduction



Duration: 30 minutes

The aim of this activity is to give future teachers insight into using digital platform and personal digital device in solving mathematical problems with context to real objects. The MathCityMap application and portal allows to prepare and run various mathematics tasks about real objects. Moreover, the rich online database of generic tasks is available for free using and can be exploited as an inspiration for new tasks design, the tasks about objects with SSI ecological context.

Teacher Educators introduce the module using the ppt presentation [1] and then present the activity 2.2 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Knowledge how to adapt principles of key competencies framework to tasks, project or activities suitable for outdoor mathematics education (Activity 2.2)

2.3. Outdoor lesson experience; Homework



Duration: 30 minutes + homework

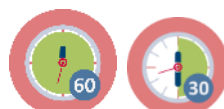
The intention of this activity is to let future teachers gain the experience with solving mathematical tasks, composed into online outdoor trail. Tasks are solved by instruments for measurement, calculators and by using online digital platform with digital devices. The application is interactive and sends immediate feedback about success in particular tasks solving. The feedback is based on “semaphore” principle. Student teachers prepare their feedback to the outdoor trail experience and discuss SSI principles with ecological focus in outdoor trail tasks.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 2.3 to preservice teachers. Student teachers are invited to run the outdoor trail individually ([MCM@home] trail) or in small groups (3-4 members in one group; in real outdoor environment).

This session contributes to the achievement of the following learning outcomes:

- Awareness about outdoor mathematics activities that dealing with environmental socio-scientific issues (Activity 2.3)

2.4. Outdoor mathematics lesson design



Duration: 90 minutes

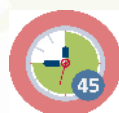
The intention of this activity is to let future teachers be creative and design their own mathematics tasks in the real area, with real objects. Tasks must reflect some SSI with focus to ecological topics. Topics: Tree or Water can be suggested as the possible context of tasks.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 2.4 to preservice teachers. Student teachers are invited to exploit online generic tasks database. Students design the outdoor lesson in small groups of two or three.

This session contributes to the achievement of the following learning outcomes:

- Awareness about the necessity that teaching mathematics should not only include learning mathematics but also includes active citizenship in local, national, and global level of ecological and environmental issues (Activity 2.4.)

2.5. Example lesson: Carbon footprint



Duration: 45 minutes

The aim of the activity is to introduce to future mathematics teachers at least two models of Carbon footprint. The models are available online. Student teachers discuss the principles of creating such mathematics models and compare their individual (or group) results after calculation the personal (or group) footprint.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 2.5 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Awareness about methods how to link citizenship education to mathematics education activities, which are closely connected with global environmental and ecological issues and with using different mathematical models (Activity 2.5)

2.6. Carbon footprint lesson design and reflection



Duration: 45 minutes

The aim of the activity is to practice creativity in lesson design with activating pedagogical methods using. Future mathematics discuss the principles of designing lesson with SSI ecological issues and with high sensitivity to personal (individual, family) data, which should their students give out when calculating their individual (or family) results after calculation the personal (or family) footprint.

Teacher educator introduces the module using the ppt presentation [1] and then present the activity 2.6 to preservice teachers.

This session contributes to the achievement of the following learning outcomes:

- Awareness about the necessity that teaching mathematics should not only include learning mathematics but also includes active citizenship in local, national, and global level of ecological and environmental issues (Activity 2.6.).

3. Usefulness and effectiveness of mathematics lessons in relation to SSI (50 minutes + homework)

3.1. Pedagogical concepts and active methods reflection



Duration: 45 minutes

This is one of the closing activities. The intention is to allow future teachers express freely their experience with the Module 10 activities. The principal question deals about pedagogical concepts for dealing with SSI in focus to ecological questions and situations and provoking creativity, critical thinking, and reasoning. And not forgetting mathematics background and importance of mathematical competences in dealing with these issues.

Teacher Educators introduce the module using the ppt presentation [1] and then present the activity 3.1 to preservice teachers. The activity is completed on Café sharing method principles in circulating groups of 4 students. The feedback is anonym and results to tuning Module 10 and its activities to eliminate its weaknesses. The posters filled out during Café sharing method will be displayed publicly as the Module 10 poster gallery.

This session contributes to the achievement of the following learning outcomes:

- Knowledge and skills on how to deal with environmental socio-scientific issues in future teaching of mathematics and how to reflect own work as well as work of colleagues (Activity 3.1. and 3.2.)

3.2. Importance and usefulness of key competencies



Duration: 20 minutes + homework

The aim of this activity is to get individual feedback about what student teachers have learnt in relation to importance and usefulness of mathematics and science knowledge and competencies for being active citizen and keeping the environmental principles and sustainability in everyday life. Student teachers compose essay (maximum three pages) dealing with personal feedback with Module 10 theoretical experience (as student teacher) and/or authentic experience with pupils during pedagogical practice at schools in reality.

Teacher Educators introduce the module using the ppt presentation [1] and then present the activity 3.2 to preservice teachers. Student teachers hand out their essays in digital format.

This session contributes to the achievement of the following learning outcomes:

- Knowledge and skills on how to deal with environmental socio-scientific issues in future teaching of mathematics and how to reflect own work as well as work of colleagues (Activity 3.1 and 3.2)



Materials and resources



Presentation 1 (pptx). Teacher Educator “Lesson planning II; Focus to methods”.



Readings and students' handouts

Access to computers for internet research and collaborative work

<https://b.socrative.com/login/student/>, quiz Tree, quiz code: SOC-52853951

<https://www.mindmup.com/#storage>

<https://www.mat2smcproject.eu/materials.asp?lang=en>



<http://momatre.eu/the-project/generic-tasks/>

<http://mathcitymap.eu/en/>

<http://www.compass-project.eu/>

<https://footprint.wwf.org.uk/#/>

<https://footprintcalculator.henkel.com/en>



Granularity

- Skip one of existing lessons in Activity 1.1., Aircraft, Flow of fluids (River).
- Introduce only part of lessons in Activity 1.1.
- Introduce the outdoor experience in Activity 1.1, existing lesson: Flow of fluids, measurement the stream of the running water (river). This depends on geographical situation of the university campus.
- Open ended problems in Activity 1.4 can be adapted to local, regional, national problems in particular country. Examples with ecological danger of massive aircraft transport and small hydropower systems are hot local and national topics in Slovakia.
- Activity 1.5., Homework can be assigned to small groups of students (two or three), not strictly individually.
- Activity 1.6., Homework presentation and discussion can be facilitated by students themselves.

- Activity 1.6., Homework presentation and discussion can be assessed, formative assessment is recommended. Future teachers can master their skills in composing the formative assessment. (Module O12: SSI and assessment)
- The activity 2.1, can be skipped or redesigned by teacher educator, the lecturer to the other preferable topic.
- Activity 2.1., the quiz, can be prepared by other online application. The topic can be changed.
- Activity 2.1., skip mind mapping.
- Activity 2.2., run the outdoor trial prepared in advance by educator or exploit the some existing [MCM@home] trial available on the MathCityMap portal.
- Activity 2.4: Designed outdoor lessons can be assessed by students (peer assessment principles). The activity can be run as a contest of the best outdoor lesson, based on MCM tasks. Criteria of the assessment must be discussed before the design starts. Future teachers can master their skills in composing the formative assessment. (Module O12: SSI and assessment)



References

COM (2019): Key Competence development for lifelong learning. DOI: 10.2766/569540

<https://euractiv.sk/section/voda/interview/po-roku-si-ludia-na-male-vodne-elektrarne-zvyknu-tvrdi-ich-hovorca/> (small water power plants, in Slovak language)

[https://www.researchgate.net/publication/271341357 Applying the Principle of Lesson Study in Teaching Science](https://www.researchgate.net/publication/271341357_Applying_the_Principle_of_Lesson_Study_in_Teaching_Science)

<http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/>



Further readings

A Guide to Ecological Green Space Management in Urban and Peri-urban Areas [online].

<http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=>

[file&fil=URBANBEES_Management_Plan.pdf](http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=URBANBEES_Management_Plan.pdf)

Biodiversity by design – a guide for sustainable communities, TCPA London 2004 Areas [online].

http://www.tcpa.org.uk/data/files/bd_biodiversity.pdf

<http://www.adalia.be/vpage.php?id=120>

Comment intégrer la biodiversité au sein d'un écoquartier? [online].

<http://www.dijon-ecolo.fr/dossiers/ecoquartiers/Rapport-etudiants-biodiversite-ecoquartier.pdf>

Guide de gestion différenciée a l'usage des collectivités, NatureParif [online].

<http://www.natureparif.fr/connaitre/publications/216-guide-de-gestion-differenciee>

Handbuch Naturnahe Pflege von Begleitgrün [online].

http://www.burgenland.at/fileadmin/user_upload/Downloads/Umwelt_und_Agrar/Umwelt/Umweltanwaltschaft/

Handbuch_Pflege_Begleitgruen_2014.pdf

<https://www.geographyrealm.com/how-many-trees-are-there-in-the-world/>

https://www.geographyrealm.com/mapping-where-planting-trees-can-help-with-climate-change-mitigation/?utm_medium=social&utm_source=grow.me&utm_campaign=grow_recommended

<https://mestske-vcely.sk/aktuality/dub-je-vynimocna-drevina/> (Quercus robur) in Slovak language

<http://www.capital-biodiversity.eu>

<https://www.cbd.int/>

<http://cbc.iclei.org/home>

<http://cbobook.org/?r=1&width=1366>

<http://www.gestiondifferenciee.be/particulier/la-gestion-differenciee-en-wallonie-/11/3>

<http://www.thenatureofcities.com/2012/08/14/discovering-urban-biodiversity/>

<http://www.unep-wcmc.org/>



Assessment

Student teacher

- One own designed (redesigned) lesson presentation
- Essay summary presentation

Formative assessment by lecturer or by schoolmate(s) or by colloquium board.