Module 11

INTERCULTURAL SCIENCE
LEARNING OUTSIDE OF SCHOOL
This Module is based on the work within the project Intercultural learning in mathematics and science initial teacher education (IncluSMe). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education Freiburg, Germany. Partners: University of Nicosia, Cyprus; University of Hradec Králové, Czech Republic; University of Jaen, Spain; National and Kapodistrian University of Athens, Greece; Vilnius University, Lithuania; University of Malta, Malta; Utrecht University, Netherlands; Norwegian University of Science and Technology, Norway; Jönköping University, Sweden; Constantine the Philosopher University, Slovakia.

The project Intercultural learning in mathematics and science initial teacher education (IncluSMe) has received co-funding by the Erasmus+ programme of the European Union under grant no. 2016-1-DE01-KA203-002910. Neither the European Union/European Commission nor the project’s national funding agency DAAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.

IncluSMe project (grant no. 2016-1-DE01-KA203-002910) 2016-2019, lead contributions (in alphabetical order) by Cyvin, J., Febri, M.I.M., Lund, A.C.B., Sachdeva, S. and Staberg, R.L., Norwegian University of Science and Technology, Trondheim, Norway. CC-BY-NC-SA 4.0 license granted (find explicit terms of use at: https://creativecommons.org/licenses/by-nc-sa/4.0/deed.en)
General overview and aim

In this module, teachers at ITE (initial teacher education) are introduced to intercultural science learning outside of school.

The environmental challenges being encountered by the society are growing simultaneously with the challenges faced by the current school system due to increasing cultural diversity. Being at the intersection between out-of-school pedagogy, intercultural pedagogy and science education, this module aims to equip future science teachers with knowledge and skills to teach the topics relating education for sustainable development in an out-of-school intercultural context.

In an intercultural pedagogical practice, it is important to focus on the dynamics and interactions that occur between students having diverse cultural backgrounds. The focus of such practice lies on relationships and interaction where backgrounds or contrasts are substantiated and made visible, and mutual understanding is developed through interaction and dialogue (Lahdenperä, 2004; Lorentz & Bergstedt, 2006; Østberg, 2013). Emphasis is not only laid on making children aware of the differences but also the similarities between different cultures, countries and diversity of all other kinds.

In this module, we focus on science and school organized activities outside the classroom. Different cultural backgrounds and pre-knowledge of preservice teachers are seen as resources. Interactions between preservice teachers having diverse cultural backgrounds are at focus. Preservice science teachers will acquire subject and culturally relevant pedagogical content knowledge on education for sustainable development starting with biodiversity in different ecosystems, processes and factors influencing them, followed by fieldwork and classification of species (e.g. plants), then moving towards developing action competencies. The cultural aspects will be integrated throughout the whole phases of the module.

This module is part of:

- Personal dimension: values, attitudes and intercultural competences of prospective teachers;
- Mathematics and Science Subject dimension: (inter)cultural perspectives on the subjects themselves;
- Mathematics and Science Education dimension: pedagogical issues, in particular in respect to dealing with diversity in classrooms.
Relevant topics

The global society is going to encounter a series of environmental challenges in the years to come. The school as an institution has an important role to play in preparing children and youth for tomorrow's society. In 1992 the United Nations composed the declaration «Agenda 21, think globally – act locally” as a result of the UN conference: "Conference on Environment & Development" in Rio de Janeiro, Brazil (https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf).

The declaration is relevant until today and can be considered as a background for reflections related to education for sustainable development. Moreover, a pedagogical model like "The Environmental Staircase" (Halvorsen 1993; Jelavic 2014; Jordet 2000; Lysklett 2013) provides a realistic approach for this field of education. The main idea of this approach is to move forward gradually, from engaging children and youth into admiring nature and providing them with knowledge about nature, to applying this knowledge in a model and system thinking. Finally on the top of the staircase stands evaluation and management competence, which means the knowledge and skills that enable the students to use and utilize their knowledge in the context of society (Figure 1 and Presentation [1]).

The focus of the module described below is to provide preservice teachers with special competence in some of the "building blocks" of the knowledge that is necessary to climb the staircase from admiring the nature to becoming a conscious and responsible citizen of a society characterized by constantly increasing diversity. In order to achieve this aim, it is important to attain the knowledge about diversity of life found in different ecosystems, abiotic factors that co-operate with these diverse organisms, and the ecological processes and ecosystems. We hope that this module could develop students’ nature admiration and empathy, support their concrete biological knowledge about some key elements of ecology, and help them to be aware of the need of system thinking competence. This will hopefully increase their management ability faced to complex challenges connected to nature and environment.
Figure 1. The Environmental Staircase and Timeline of Module IO11 (Designed by Cyvin, J. with ideas from Jelavic 2014; Lysklett 2013).
Learning Outcomes

This module will enable prospective science teachers to:

- Become aware of the benefits of “outside of school” opportunities for learning scientific concepts and procedures in an intercultural context;
- Learn to value the importance of concrete out-of-school experiences to bridge communication/language problems;
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures;
- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding;
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.
Flowchart and Module plan

This module involves a number of sections, with 3 alternative routes.

The module is structured in 3 main parts according to the environmental staircase, 1) Admiring the nature: Introduction, 2) Discovering and understanding: Diversity and ecosystems, 3) Influencing and contributing: Action plan. Part one includes one plenary “warm-up” activity (1.1) and a homework task (1.2). Part two includes eight activities connected to outdoor science (2.1-2.8, where 2.7 and 2.8 are optional). Part three includes three activities connected to action competency (3.1, 3.2, 3.3). Part three is optional.

Among the thirteen activities, there is a mixture of face-to-face sessions, practical tasks (preparations, outdoor fieldwork, model building, production of an action plan, role play) and homework. See flowchart for alternative options and duration.

For the practical work, divide the class into groups of 4-6 students.

There should be a geographical diversity in each group. If the class is geographically homogeneous and / or sharing the same cultural background, the teacher assigns a geographical belonging to each group member in such a way that within each group there will be a diversity in relation to natural presuppositions and cultural backgrounds. Alternatively, the students themselves, instead of the teacher, can select geographical belongings that are different from each other to create a heterogeneous group. This intercultural pedagogical practice should focus on both similarities and dissimilarities, and discuss these in the light of subject-specific content in order to develop an increased understanding for their own and others' cultural backgrounds and experiences.
Alternative 1 (minimum, duration: 250 min + 60 min homework):

Admiring the nature: Introduction

- Activity 1.1: General Introduction - What is intercultural science learning outside of school? (30 min)
- Activity 1.2: Preparations to group work on diversity (flipped classroom) (homework, 60 min)

Discovering and understanding: Diversity and ecosystems

- Activity 2.1: Introduction to Diversity (15 min)
- Activity 2.2: Modelling Diversity (30 min)
- Activity 2.3: Collecting pre-knowledge about trees (30 min)
- Activity 2.4: Introduction to fieldwork (10 min)
- Activity 2.5: Fieldwork (90 min)
- Activity 2.6: Reflections/Summary after fieldwork (45 min)
Alternative 2 (duration: 340 min + 60 min homework):

**Admiring the nature: Introduction**
- Activity 1.1: General Introduction - What is intercultural science learning outside of school? (30 min)
- Activity 1.2: Preparations to group work on diversity (flipped classroom) (homework, 60 min)

**Discovering and understanding: Diversity and ecosystems**
- Activity 2.1: Introduction to Diversity (15 min)
- Activity 2.2: Modelling Diversity (30 min)
- Activity 2.3: Collecting pre-knowledge about trees (30 min)
- Activity 2.4: Introduction to fieldwork (10 min)
- Activity 2.5: Fieldwork (90 min)
- Activity 2.6: Reflections/Summary after fieldwork (45 min)
- Activity 2.7: Exploring an ecosystem (60 min)
- Activity 2.8: Building a model of an ecosystem (30 min)
Alternative 3 (duration: 460 min + 120 min homework):

**Admiring the nature: Introduction**

- Activity 1.1: General Introduction - What is intercultural science learning outside of school? (30 min)
- Activity 1.2: Preparations to group work on diversity (flipped classroom) (homework, 60 min)

**Discovering and understanding: Diversity and ecosystems**

- Activity 2.1: Introduction to Diversity (15 min)
- Activity 2.2: Modelling Diversity (30 min)
- Activity 2.3: Collecting pre-knowledge about trees (30 min)
- Activity 2.4: Introduction to fieldwork (10 min)
- Activity 2.5: Fieldwork (90 min)
- Activity 2.6: Reflections/Summary after fieldwork (45 min)
- Activity 2.7: Exploring an ecosystem (60 min)
- Activity 2.8: Building a model of an ecosystem (30 min)

**Influencing and contributing: Action plan**

- Activity 3.1: Introduction – Area around us (flipped classroom) (homework, 60 min)
- Activity 3.2: Work out a plan for land-use of an area nearby (90 min)
- Activity 3.3: Role play, presentation of land-use plan, target group: local municipality (30 min)
I. Admiring the nature: Introduction into the topic “Intercultural science learning outside of school”

1.1. General Introduction - What is intercultural science learning outside of school?

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This is a “warm up” activity. The intention is to explore previous knowledge and beliefs about central topics of this module “intercultural science learning outside of school”. Teacher Educator introduces the module using the PowerPoint presentation [2] and then presents the activities 1.2 and activities 2.1-2.8 to preservice teachers (part 2.7 and 2.8 are optional).

This session contributes to the achievement of the following learning outcome:
- Become aware of the benefits of “outside of school” for learning scientific concepts and procedures in an intercultural context.

I. Admiring the nature: Introduction into the topic “Intercultural science learning outside of school”

1.2. Preparations to group work on diversity (flipped classroom)

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Each student is given a designated geographical area, and is supposed to choose four common tree species from that area, find information about those tree species, the climate, growth conditions and growth site. In addition to biological knowledge, students are encouraged to collect cultural knowledge about the same trees, as well as information on what people use these kind of trees for. See worksheet, Activity 1.2. Pictures and information should be stored in a PowerPoint file. This information will be brought forward in activity 2.3 (Preparation to fieldwork, Collecting pre-knowledge about trees).

This session contributes to the achievement of the following learning outcome:
- Appreciate diverse backgrounds and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures in an intercultural manner.
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.
II. Discovering and understanding: Diversity and ecosystems

### 2.1. Introduction to Diversity (Preparations to fieldwork, part A)

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<td>Teacher Educator introduces diversity, taxonomy, and the role of “keys” as an approach for understanding biodiversity and the history behind nomenclature (e.g., The importance of giving animals and plants names due to food collection and survival in different cultures), using the PowerPoint presentation [3]. The teacher educator also introduces how you can design a dichotomous key (the concept of classification based on similarities and differences).</td>
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This session contributes to the achievement of the following learning outcomes:

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context

### 2.2. Modelling Diversity (Preparation for fieldwork, part B)

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<td>Task: Modelling diversity using “The nuts and bolts of classification” Students’ handouts [1]. Task and guides for student activity Modelling diversity (Activity 2.2)</td>
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This activity lead by teacher educator (PowerPoint presentation [4]) exemplifies how teachers can approach the concepts of classification and identification. The idea is to simplify tasks. The nuts and bolts exercise is an inexpensive and effective way of explaining the use, construction and value of a dichotomous key. It readily reinforces the concept of classification dealing with similarities and differences. The exercise can be used for students at any level. The exercise can also be a door opener for many topics as families of organisms, similarities in fruits and animals. The equipment is inexpensive, and can be collected at the local hardware store.

A dichotomous key is “a series of paired statements that describe physical characteristics of different organisms”. This key is not limited to the identification of living things. The term dichotomous means “divided into two parts”; thus, at each stage
of a dichotomous key, two choices are presented. Each choice leads to another alternative until the organism or object is identified.

Task for students (see student handout [1]):

1. In pairs: Construct a dichotomous key based on available nuts and bolts
2. Exchange your key with another pair of students
3. In pairs: Use the dichotomous key designed by another student group, to classify your nuts and bolts
4. Discuss your experiences with the other group

Optional: Further reading, see handouts:


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

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures.

II. Discovering and understanding: Diversity and ecosystems

2.3. Collecting pre-knowledge about trees (Preparation for field work, part C)

Group Work: Collecting pre-knowledge (based on Activity 1.2)

This is a “warm up” activity with the intention of building students’ awareness for biodiversity and a reasonable landscape planning with regard to sustainable development. In this session, preservice teachers are preparing investigation of the diversity of trees in the neighbourhood of their campus. They are encouraged to come
up with pre-knowledge of trees and leaves, and terminologies to categorize trees, leaves and seeds based on their background or languages. Teacher Educator introduces the activity using PowerPoint presentation [5].

During this session, preservice teachers are expected to share within their group and discuss within the whole class:

- Their knowledge of trees and leaves, terminologies to categorize trees, leaves and seeds based on their own background and language. They are supposed to use the information they have collected during the homework (Activity 1.2).
- Narratives (if any) about the trees in the area/country they come from or have grown up in: e.g. What people use these kinds of trees for (handcraft/art/music/survival/food/industry etc.)? Any legend about the trees? (see Activity 1.2)


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

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context
- Learn to value the importance of concrete out-of-school experiences to bridge communication/language problems.
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures.

II. Discovering and understanding: Diversity and ecosystems

2.4. Introduction to Fieldwork (Preparation for fieldwork, part D, Trees)

Duration: 10 minutes


Student handout [2] – Common leaf morphology, see Task and guide for Fieldwork (Activity 2.5. in the Worksheet)

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

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.
II. Discovering and understanding: Diversity and ecosystems

### 2.5. Fieldwork

| ![Icon] | ![Icon] | Duration: 90 minutes |

In this session, preservice teachers, working in groups, **collect data** about trees in their school’s neighbourhood (without necessarily being able to name the tree species), **observe** number of different species using shape, colour and characteristic traits of trees, **characterize** areas as natural habitats or planted habitats, inhabited or uninhabited, **compare** these with regard to diversity and **measure** green areas. Students can be grouped according to biotopes in the area, exploring one biotope each. In absence of trees, fruits and herbs can be used as alternatives. During the work, discuss as well about how to transfer the acquired knowledge into knowledge for teaching.

During this session the preservice teachers will acquire:

- **subject matter knowledge** on:
  - Species diversity, description and classification based on observation
  - Relations and interactions between biotic and abiotic factors
- **specialized content knowledge** (see Ball, Thames & Phelps, 2009) by:
  - Developing experience and knowledge using specific hands-on biological objects in open-air; in this case trees and leaves.
  - Using a digital system for registration of species, for example a net site like Google site, or a smartphone App like iNaturalist, British tree identification.

This session contributes to achievement of the following learning outcomes:

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.

### 2.6. Reflections/Summary after fieldwork

| ![Icon] | ![Icon] | Duration: 45 minutes |

In this session, preservice teachers have to summarize their findings: Discussion, reflections, reporting. Preservice teachers are encouraged to think creatively, use scientific language and show their understanding of scientific concepts. This session will
further help them to develop knowledge and skills in looking at a case from different sides and to use language actively to build arguments. Discussion on how to transfer acquired knowledge into knowledge for teaching will be an integral part of the session. First, they are given tasks for group work, and finally some of these tasks should be shared/discussed within the whole class. See below. Task is available in PowerPoint presentation [5].

Task, Group Work:
1. Classify the leaves you picked up according to similarities and differences (try to combine everyday language and scientific concepts when classifying)
2. Construct a dichotomous key based on your collected leaves (if time allows: Use the dichotomous key designed by another student group to classify your collected leaves)
3. Reflect on how out of school activities can promote intercultural understanding in science education, e.g.
   - How concretes from outdoor can help you to develop scientific language/knowledge of scientific concepts. Impact of cultural difference between students? How all senses can be utilized, if language barriers appear
   - What could be learnt from the fieldwork activity, regarding being a future teacher. Special emphasis on the different phases (preparation tasks, fieldwork tasks, summary tasks – and how they were or can be performed) and emphasis on diversity of students.

Plenary: Discuss within the whole class. Possible orientations/focuses:
1. Characterize the different areas with regard to diversity (each group present their area)
2. Reflections on how the how out of school activities can promote intercultural understanding in science education, e.g.:
   - On the role of concretes/artefacts in building scientific language, knowledge of concepts and procedures
   - How the preparations, the pedagogical approach during fieldwork and the reflections after fieldwork can facilitate intercultural learning
   - How the use of own words and senses can facilitate learning of science content in intercultural context

This session contributes to the achievement of the following learning outcomes:
- Become aware of the benefits of “outside of school” opportunities for learning scientific concepts and procedures in an intercultural context
- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context
- Learn to value the importance of concrete out-of-school experiences to bridge communication/language problems.
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures.

### II. Discovering and understanding: Diversity and ecosystems

#### 2.7. Exploring an ecosystem (optional)

| Duration: 60 minutes |

Based on the geographical diversity in each group, they have to select one ecosystem or one local biotop, typical for a geographical area one or some of you come from or have grown up in. It is expected that through collaborative work rich in discussion and exchange of ideas that communication problems will be bridged and creativity blossoms.

Tasks for students:

- Discuss where you find this kind of ecosystem or biotop.
- Discuss different types of plants that will endure this ecosystem or biotope.

Choose one of these plants and visualize it in the following way:

- Find information on its geographic location(s), climate conditions (e.g. coast, inland, mountain,...), growth conditions (biological knowledge)
- Try to find out if this plant is used in any symbols, paintings, pictures, mysteries, legends and/or stories in the area or country you come from or have grown up in (cultural knowledge)
- Find information on what people use these kind of plant for (handcraft/art/music/survival/food/industry etc.)

- Make a presentation for rest of the class where different approaches of using plants are described in connection to the cultural traditions, climatic and culinary specialities.

For this session Teacher Educator uses PowerPoint Presentation [6] to guide the students (as an example).

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

- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding
- Learn to value the importance of concrete out-of-school experiences to bridge communication/language problems.

### II. Discovering and understanding: Diversity and ecosystems

#### 2.8. Building a model of an ecosystem (optional)

**Duration: 30 minutes**

In this session, preservice teachers are supervised in building an ecosystem in a small format. They grow a certain selection of plants and give reasons why they select them. Their justifications will reflect their knowledge and cultural background and pre-knowledge. They are also encouraged to think how to integrate this activity into school's syllabus/curriculum. Further, by going through this session, preservice teachers acquire relevant knowledge and skills that can be transferable to their own teaching of this topic in future. Besides, this activity can help preservice teachers understand how local actions can serve as starting point for discussion what is happening around the world, e.g. in relation to climate change and or other environmental challenges (Local Agenda 21).

For this session Teacher Educator uses PowerPoint Presentation [7] to guide the students.

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

- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures.

### III. Influencing and contributing: Action plan (optional)

In this part students will move further from acquiring knowledge of biodiversity and interaction between biotic and abiotic factors, to developing action competency. After the introduction part (compulsory if part III is conducted), preservice teachers are encouraged to perform the following activities:

- Drawing a land-use plan of an area in the nearby of their school
- Present their ideas in a role-play
### III. Influencing and contributing: Action plan (optional)

#### 3.1. Introduction – Area around us (flipped classroom)

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Based on a Youtube video or an e-lecture, reading a text and given questions, preservice teachers are to find ideas on how they can take benefit of the area in the surrounding of their school to raise awareness on action competency. Link: https://www.youtube.com/watch?v=kHhspf5IfdE

The video or e-lecture explains what is meant by action competency and why is it important in education for sustainable development.

The text to read (Reading [1]) presents excerpts from the ideas of a Norwegian school project «The Natural Backpack» (http://www.natursekken.no/), see Worksheet IO11. It serves as source of inspiration and it will by no means limit the preservice teachers' creativity.

The given questions will guide preservice teachers to reflect on (1) how the action taken (i.e. use of area) can be based on the conceptual understanding of biodiversity and on system thinking in ecology and (2) how the action taken will affect the society.

This session is preparing the preservice teachers for the step 5 of "The Environmental Staircase": Influence and Contribute (Jelavic, 2014; Jordet, 2000).

This session contributes to the achievement of the following learning outcomes:
- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding

#### 3.2. Work out a plan for land use of area nearby

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In this session, preservice teachers will set up a land-use plan for their local school or an area nearby based using pedagogy, environment friendly use of the area, a scientific understanding of sustainability and its interaction with nature. They will be required to think about ecology, energy and nutrient cycles while at the same time think through on how to use the area. The preservice teachers are also expected to experience a real-life cooperation with a local municipality. On the whole this session will contribute to make preservice teachers understand the importance of diversity in urban or rural areas.
(depending on where the school is located) and improve their awareness of sustainable development.

For this session Teacher Educator uses PowerPoint Presentation [8] to guide the students.

This session contributes to the achievement of the following learning outcomes:
- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding;
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.

III. Influencing and contributing: Action plan (optional)

3.3. Role play, presentation of land-use plan, target group: local municipality

Based on produced land-use plans, teacher educators will guide and establish a debate about the selected schools’ land-use plans (Role play: Meeting for local municipality). Different groups present their ideas. This requires a well-developed language, but we think it will be a useful activity for preservice teachers. They may also present a real drawing/sketch in addition to the presentations or as an alternative in case language competency becomes an issue.

This session serves as a model for preservice teachers for teaching topics related to the diversity of nature in order to develop action competency for sustainable development in an intercultural context.

For this session Teacher Educator uses PowerPoint Presentation [9] to guide the students.

This session contributes to the achievement of the following learning outcomes:
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.
Materials and resources


Presentation 2 (pptx). Teacher Educator. General Introduction to “Science Learning outside of school” (Activity 1.1)

Presentation 3 (pptx). Teacher Educator. Introduction to Diversity (Activity 2.1)

Presentation 4 (pptx). Teacher Educator. Modelling Diversity_Bolts nuts (Activity 2.2)

Presentation 5 (pptx). Teacher Educator. Fieldwork:
  Collecting pre-knowledge (activity 2.3),
  Introduction to "Fieldwork" (activity 2.4)
  Reflections/Summary after fieldwork (activity 2.6)

Presentation 6 (pptx). Teacher Educator. Exploring an Ecosystem. (Activity 2.7). Optional

Presentation 7 (pptx). Teacher Educator. Building a Model of an Ecosystem. (Activity 2.8). Optional

Presentation 8 (pptx). Teacher Educator. Plan for Land Use. (Activity 3.2). Optional

Presentation 9 (pptx). Teacher Educator. Role Play. (Activity 3.3). Optional

Further reading, for activity 2.2:


Student handout [1]. Nuts and Bolts Cards, see Task and guides for student activity Modelling diversity (activity 2.2). Available as separate file.

Student handout [2]. Leaf Morphology, see Task and guide for Fieldwork (Activity 2.5). Available as separate file.

You tube video or e-lecture: Preparation for action plan (flipped classroom) [https://www.youtube.com/watch?v=kHlspf5IdE](https://www.youtube.com/watch?v=kHlspf5IdE) (Activity 3.1)
Readings 1. Preparation for action plan (flipped classroom) (reading material available in the Worksheet, Activity 3.1)

Internet research and collaborative work (preparations, role play) (see Worksheet, Activity 3.2)

Granularity

Select fewer activities, eg. skip Activities 2.7-2.8 AND/ OR skip Activities 3.1-3.3.

References


Further readings

These further readings are for those who wish to deepen the topic of intercultural science learning outside of school. They consist of a selection of research literature dealing with the value of outdoor learning, preparing for outdoor/out of school science learning, culturally responsive teaching approaches in science, preservice science teachers’ and teacher educators’ perception of culturally relevant pedagogy. In addition, further readings related to the dichotomous principle and classification (Activity 2.2.) are also included here.


Assessment

The assessment are related to the given learning goals:

- Become aware of the benefits of “outside of school” opportunities for learning scientific concepts and procedures in an intercultural context;
- Learn to value the importance of concrete out-of-school experiences to bridge communication/language problems;
- Appreciate the intercultural background and pre-knowledge of students as resources rather than barriers for learning scientific concepts and procedures;
- Develop pedagogical approaches by using different arenas (e.g. urban or rural areas, museums, local factories) – to promote creativity, language learning and conceptual understanding;
- Develop competency in teaching topics related to the diversity of nature (ecology, evolution, energy, and nutrient cycles) in an intercultural context.

Assessment methods
Individual portfolio of students’ work, based on the activities 1.2, 2.2, 2.3, 2.5, 2.6, 2.7, 3.2 and 3.3, depending on the granularity.

Assessment criteria
The assessment criteria are based on the scientific content and the pedagogical aspects.
Regarding the scientific content, the criteria can for instance be:

1. Ability to find information on tree(species), the climate, the growth conditions and site; and relate the information to each other.
2. Ability to construct a dichotomous key and apply the dichotomous principle to classify and describe the leaves collected during the fieldwork.
3. Correctness in the use of scientific terminologies.
4. (optional activity) How well the model of the chosen ecosystem was built and whether the model is suitable to represent the intended scientific contents.
5. (optional activity) How well the student understand the concept of “Education for sustainable development”
6. (optional activity) Ability to discuss on the plan of land use

Regarding the pedagogical aspect, the criteria are related to both the reflections on the use of out-of-school pedagogy in science education and the intercultural pedagogy. Teacher educators can look for instance to how well students are able to reflect on the following points:

1. How relating the trees to the cultures (e.g. use in handcraft/art/music/survival/food/industry, etc.) can promote intercultural understanding.
2. The role of concretes/artefacts in building scientific language, knowledge of concepts and procedures.
3. How the preparations, the pedagogical approach during fieldwork and the reflections after fieldwork can facilitate intercultural learning.
4. How the use of own words and senses can facilitate learning of science content in intercultural context.

Of course teacher educators can modify or add their own criteria according to what suit them best.
Module 11

INTERCULTURAL SCIENCE
LEARNING OUTSIDE OF SCHOOL

Worksheets
This worksheet is based on the work within the project Intercultural learning in mathematics and science initial teacher education (IncluSMe). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education Freiburg, Germany. Partners: University of Nicosia, Cyprus; University of Hradec Králové, Czech Republic; University of Jaen, Spain; National and Kapodistrian University of Athens, Greece; Vilnius University, Lithuania; University of Malta, Malta; Utrecht University, Netherlands; Norwegian University of Science and Technology, Norway; Jönköping University, Sweden; Constantine the Philosopher University, Slovakia.

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I. Admiring the nature: Introduction into the topic “Intercultural science learning outside of school”

1.1. General Introduction - What is intercultural science learning outside of school?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration: 30 minutes</td>
<td><strong>Handout: PPT Presentation for teacher educator, PowerPoint presentation [1] – see separate file.</strong></td>
</tr>
</tbody>
</table>

This is a “warm up” activity. The intention is to explore your previous knowledge and beliefs about central topics of this module:

- Culture and what has to do with learning
- Intercultural science learning
- Out of school science learning
- Intercultural science learning outside of school
- Why do we need Intercultural science learning outside of school?

Teacher Educator introduces the module using the PowerPoint presentation [2].

I. Admiring the nature: Introduction into the topic “Intercultural science learning outside of school”

1.2. Preparations to group work on diversity (flipped classroom)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration: 60 minutes (homework)</td>
<td><strong>Task:</strong> Collect information about the most common trees from the area / county in which you live, or you have grown up.</td>
</tr>
</tbody>
</table>

1. Choose four common tree (species) from the area you have selected.
2. Find the following information about each of them: the climate (e.g. coast, inland, mountain,...), growth conditions and growth site. Also find out whether they are thermophilic (elm, hazel,...etc) or hardy types of trees (spruce, birch, pine,...etc) (biological knowledge)
3. Try to find out if these trees are used in any symbols, paintings, pictures, mysteries, legends and/or stories in the area or country you come from or have grown up in (cultural knowledge).
4. Find information on what people use these kind of trees for (handcraft/art/music/survival/food/industry etc.)
5. Collect and store your pictures and information in a PowerPoint file.
6. This information will be brought forward and discussed in activity 2.3. (Preparation to fieldwork, Collecting pre-knowledge about trees).

<table>
<thead>
<tr>
<th>II. Discovering and understanding: Diversity and ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Introduction to Diversity (Preparations to fieldwork, part A)</td>
</tr>
<tr>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Handout: PPT Presentation for teacher educator, PowerPoint presentation [3] – see separate file.</strong></td>
</tr>
</tbody>
</table>

Teacher Educator introduces diversity, taxonomy, and the role of “keys” as an approach for understanding biodiversity and the history behind nomenclature (eg. The importance of giving animals and plants names due to food collection and survival in different cultures), using the PowerPoint presentation. The teacher educator also introduces how you can design a dichotomous key (the concept of classification based on similarities and differences).
II. Discovering and understanding: Diversity and ecosystems

2.2. Modelling Diversity (Preparation for field work, part B)

Task: Modelling diversity using “The nuts and bolts of classification”

Students` handouts [1]: nuts and bolts cards.

The nuts and bolts exercise is an inexpensive and effective way of explaining the use, construction and value of a dichotomous key. It readily reinforces the concept of classification dealing with similarities and differences. The exercise can be used for students at any level. The exercise can also be a door opener for many topics as families of organisms, similarities in fruits and animals. The equipment is inexpensive, and can be collected at the local hardware store.

1. In pairs: Construct a dichotomous key based on available nuts and bolts
2. Exchange your key with another pair of students
3. In pairs: Use the dichotomous key designed by another student group, to classify your nuts and bolts
4. Discuss your experiences with the other group

EXPLANATION, DICHOTOMOUS KEY: A dichotomous key is “a series of paired statements that describe physical characteristics of different organisms”. This key is not limited to the identification of living things. The term dichotomous means “divided into two parts”; thus, at each stage of a dichotomous key, two choices are presented. Each choice leads to another alternative until the organism or object is identified.

Optional: Further reading, see handouts:


II. Discovering and understanding: Diversity and ecosystems

2.3. Collecting pre-knowledge about trees (Preparation for field work, part C)

**Task Group Work: Collecting pre-knowledge**

- Share within the group:
  - Your knowledge of trees and leaves, terminologies to categorize trees, leaves and seeds based on your own background and language. You can eventually use the information you have collected during the homework (Activity 1.2).
  - Narratives (if any) about the trees in the area/county you come from or have grown up in: e.g. What people use these kinds of trees for (handcraft/art/music/survival/food/industry etc.)? Any legend about the trees? (see Activity 1.2)

- Share/Discuss with the whole class.


II. Discovering and understanding: Diversity and ecosystems

2.4. Introduction to Fieldwork (Preparation for fieldwork, part D,Trees)


- Student handout [2] – Common leaf morphology, see Task and guide for Fieldwork (Activity 2.5. in the Worksheet)
### II. Discovering and understanding: Diversity and ecosystems

#### 2.5. Fieldwork

<table>
<thead>
<tr>
<th>Task and guide for fieldwork</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration: 90 minutes</strong></td>
</tr>
</tbody>
</table>

**Work outside in groups to do the following:**

- **Study your area in general:**
  - Characterize your area (natural habitat or planted habitats, inhabited or uninhabited, ...)
  - Take notes on sun direction, building placement (to account for shadow), whether the plants were watered or not
  - Describe your area with regard to diversity
  - Measure green areas

- **Study trees in your area:**
  - Collect data about trees in your designated area
  - Observe shape, colour and characteristic traits of trees
  - Collect the leaves, categorize and describe them. Use your own words and senses, but you can use «leaf morphology» handout as support if necessary

- **Take pictures of your area and the species you find**
- **Optional:** Use a digital system for registration of species, e.g. Google site, or a smartphone App like iNaturalist, British tree identification

**Remarks:**

- Each group should study different areas around the school
- You don’t have to know the name of the tree species to be able to accomplish the tasks
- As you work outside, it is desirable to discuss how to transfer the knowledge you get into knowledge for teaching
- Remember to bring leaf samples back to the classroom

**Student handout [2] – See pictures of leaves morphology to help you out with vocabulary needed in describing leaves.**

**Students study the handout [2]: Common leaf morphology**

(evt. printed out and copied, preferably use national versions)
Morphology, in biology, the study of the size, shape, and structure of animals, plants, and microorganisms and of the relationships of their constituent parts. The term refers to the general aspects of biological form and arrangement of the parts of a plant or an animal. The term anatomy also refers to the study of biological structure but usually suggests study of the details of either gross or microscopic structure. In practice, however, the two terms are used almost synonymously.

Typically, morphology is contrasted with physiology, which deals with studies of the functions of organisms and their parts; function and structure are so closely interrelated, however, that their separation is somewhat artificial.

II. Discovering and understanding: Diversity and ecosystems

2.6. Reflections/Summary after fieldwork

Duration: 45 minutes


Task Group Work:
1. Classify the leaves you picked up according to similarities and differences (try to combine everyday language and scientific concepts when classifying)
2. Construct a dichotomous key based on your collected leaves (if time allows; Use the dichotomous key designed by another student group to classify your collected leaves)
3. Reflect on how out of school activities can promote intercultural understanding in science education, e.g.
   • How concretes from outdoor can help you to develop scientific language/knowledge of scientific concepts. Impact of cultural difference between students? How all senses can be utilized, if language barriers appear
   • What could be learnt from the fieldwork activity, regarding being a future teacher. Special emphasis on the different phases (preparation tasks, fieldwork tasks, summary tasks – and how they were or can be performed) and emphasis on diversity of students.

Plenary: Share with the whole class. Possible orientations/focuses:
1. Characterize the different areas with regard to diversity (each group present their area)
2. Reflections on how the how out of school activities can promote intercultural understanding in science education, e.g.:
   • On the role of concretes/artefacts in building scientific language, knowledge of concepts and procedures
   • How the preparations, the pedagogical approach during fieldwork and the reflections after fieldwork can facilitate intercultural learning
   • How the use of own words and senses can facilitate learning of science content in intercultural context
II. Discovering and understanding: Diversity and ecosystems

2.7. Exploring an ecosystem (optional)

Duration: 60 minutes


Task Group Work:

1. Based on the geographical diversity in your group, select one ecosystem or one local biotop, typical for a geographical area one or some of you come from or have grown up in.
2. Discuss where in the world you find this kind of ecosystem or biotop.
3. Discuss different types of plants that will endure this ecosystem or biotop. Choose one of these plants and visualize it in the following way:
   - Find information on its geographic location(s), climate conditions (e.g. coast, inland, mountain,...), growth conditions (biological knowledge)
   - Try to find out if this plant is used in any symbols, paintings, pictures, mysteries, legends and/or stories in the area or country you come from or have grown up in (cultural knowledge)
   - Find information on what people use this kind of plant for (handcraft/art/music/survival/food/industry etc.) (economical importance)
4. Make a presentation of your plant for the class, based on your answers to A, B and C above.

Plenary: Share/Discuss with the whole class.
II. Discovering and understanding: Diversity and ecosystems

2.8. Building a model of an ecosystem (optional)

Duration: 30 minutes


Task Group Work:

1. Collect the following equipment:
   a. A transparent glass or plexiglass container of minimum 1 litre (jam glass, goldfish bowl, aquarium, terrarium or similar).
   b. A transparent lid (plastic film, plastic bag, glass/plexiglass plate)
   c. A cup of water
   d. A light source
   e. One or more green plant(s) in some soil (or OPTIONAL just in water)
   f. Some small invertebrates (insects, earthworms, spiders, sow bugs etc.) - OPTIONAL
   g. Data logger with one or more sensors (light, oxygen, CO2, moisture, pH) - OPTIONAL

2. Put the plant(s) and a cup of water in the glass container, with a light source outside the glass. Now you have the most essential components to start photosynthesis.

3. Cover the glass container with the lid or transparent plastic and place it in a tempered room. You now have a small ecosystem, which for a while will keep going. Evaporation from the water cup and the plants will produce drops of water under the plastic, inside the container, and after a while, it will drip back to the plant(s) (primitive rain).

4. OPTIONAL. It is possible to connect data logger sensors to the ecosystem. Recording variations in CO2, O2 for example related to light intensity, or evaporation (amount of water under the lid) related to temperature. Several other experiments related to the growth of the plants are possible, and if you introduce some invertebrates, you expand the potential for observing interactions of the species involved in the food chain of your small ecosystem.

Plenary: Share/Discuss with the whole class.
III. Influencing and contributing: Action plan (optional)

3.1. Introduction – Area around us (flipped classroom)

The aim of this session is to prepare the teacher students for step 5 of "The Environmental Staircase": Influence and Contribute (Jelavic, 2014; Jordet, 2000).

TASK
Starter: see the video https://www.youtube.com/watch?v=kHhspf5lfdE

Read the text given below, reflect and answer the following tasks:

1. Summarize with your own words what is meant by "education for sustainable development"
2. Summarize with your own words what is meant by "competences for sustainable development"
3. Why is "action competence" important?
4. Why the local community can be an attractive learning arena for sustainable education

TEXT FOR THE TASK ABOVE
Reading [1] Activity 3.1. Preparation for action plan (flipped classroom)
Excerpt and translated from a Norwegian article (e-lecture):

Education and Teaching for Sustainable Development

Many of the environmental, societal and economic problems we are facing today show that local and national societies are entering into a symbiotic interaction with the global world community. Sustainable development is therefore about thinking and acting both locally, nationally and globally. Realization of sustainable development requires active participation by citizens having the competence to act right. To achieve this, it is imperative that we integrate education for sustainable development into the education system.
Sustainable development - social, economic and environmental considerations

In 1987, the World Commission for Environment and Development (WCED) with Gro Harlem Brundtland as chair defined the term "sustainable development" as "a development that meets today's needs without destroying the prospects for future generations to meet their needs" (Brundtland, 1987). Sustainable development, therefore, deals with that the human beings living both now and in the future, should get to meet their needs. In order for a development to be sustainable, it is always necessary to consider three main dimensions, viz.; social, economic and environment. These reflect the need to balance economic and social growth with respect to the environment.

**Education for Sustainable Development**

The goal of ensuring sustainable development, approved in 2000, is the seventh of a total of eight goals in the “UN Millennium Development Goals”, to combat world poverty. To highlight the important role education can play in achieving sustainable development, decade 2005-2014 was defined as UN's decade of education for sustainable development. The overall goal of the decade was "to integrate principles, values and practices for sustainable development in all the aspects of education and learning" (UNESCO, 2005).

Norway and the Norwegian Ministry of Education have followed up UN's decade of education for sustainable development, by launching its own "Strategy for Education for Sustainable Development 2005-2010" with a revised edition for the period 2012-2015, “Knowledge for a Common Future". Norway's strategy regarding education for sustainable development aims at:
• Developing children’s and young people’s skills so that they can contribute to sustainable development in various areas of nature and society.
• Helping the kindergartens and schools in having competence and frameworks for education for sustainable development.
• Stimulating the development of network and cooperation relationships between kindergartens, schools, relevant agencies, non-governmental organizations (NGOs) and research institutions at national, regional and local levels.
• Promoting participation in international forums to exchange experiences and raise the quality of education for sustainable development both in Norway and other countries.

Education for sustainable development has to do with facilitating teaching that can develop pupils' competencies for a sustainable world in change. The overall goal is to stimulate responsibility and active participation among students.

(...)

Teaching for Sustainable Development

It is important to think of sustainable development as a dynamic process and not a definite goal. The world and society are constantly evolving, and we must continuously find new solutions and adapt ourselves to complex systems. Therefore, teaching for sustainable development is not just about giving students the knowledge, but also understanding and commitment to sustainable development (Schreiner & Sjøberg, 2005). Through teaching we can raise students' awareness by developing their knowledge, skills and attitudes, and thus helping them develop action competencies for sustainable development (Breiting & Mogensen, 1999; FN-sambandet, 2016; Jegstad & Sinnes, 2013; Jensen & Schnack, 1997; Sinnes, 2015). Such competencies are not something that can be conveyed and transferred from teacher to student, but something that can be developed through varied, multidisciplinary and inquiry based teaching. In order to create relevance and motivation, teaching should be varied using external skills as well as using other learning arenas (local environment and local communities).
Knowledge

Some topics are central to having knowledge about sustainable development. These deal with climate, energy, consumption and resources, conflicts of interest, participation and democracy, biodiversity, natural areas, land use, health, waste and recycling, and water resources. Pupils can develop knowledge about these themes through multidisciplinary and inquiry based teaching where they collect and process information in different ways. Methods to give students such knowledge may be varied, for example, teaching with shorter theoretical reviews and lectures, information searches via the internet, reading scientific literature and reports. As a teacher, it is important to facilitate students’ access to good and relevant sources, selecting and disseminating relevant subject matter together with supervising the pupils’ under their own data collection.

Skills

Skills for sustainable development include being able to think critically, reflect, argue, collaborate, understand contexts (system understanding), communicate, innovate and create. Such skills can be trained by allowing students to work in groups, participate in debates, discuss conflicts and dilemmas, and develop solutions to the problems locally and globally. Teacher’s work, in such situations, is to find out the topics that can be relevant and engaging. Current topics brought into discussion by the media or community, and problems of students’ own everyday lives can be good starting points.
Attitudes

In order to act for sustainable development, it is important to have faith and hope for the future, but above all, the will to act. Such attitudes are created when students gain an insight into what opportunities they themselves have to influence. They can influence and can act positively both on their own lifestyle, for example by consumer choice, but also by participating in democratic processes through involvement in political work, or in non-governmental organizations (NGO’s), and in the future through their career choices. As a teacher, it will be important to focus on the possibilities rather than just on the challenges. An approach to that may be to work specifically with students’ current consumption choices on food and clothing, or to let students advise and make proposals for solutions to local politicians or businesses.

References


III. Influencing and contributing: Action plan (optional)

3.2. Work out a plan for land use of area nearby

Duration: 90 min


**TASK:** Develop a plan for land use of an area nearby your school

1. Think of an area by the school. Which possibilities for land-use can you see, using pedagogy, environmentally friendly use of the area, a scientific understanding of sustainability and interaction in the nature? Think also about ecology, energy and nutrient cycles.

2. Work out a plan for land use for your selected area.

3. Prepare your presentation for the role play (Activity 3.3):
   - Prepare argumentations for the plan of land use
   - Discuss possible counter arguments that might oppose your plan

**Useful materials:** overhead plastic sheets for making overlay maps and permanent marker pens.

---

III. Influencing and contributing: Action plan (optional)

3.3. Role play, presentation of land-use plan, target group: local municipality

Duration: 30 minutes

Teacher Educator leads the activity using PowerPoint [9]-see separate file. The Teacher Educator (or other persons) plays the role of municipality staff.

**TASK**

Work in the same group as in activity 3.2.

Present the idea of your land-use plan to the municipality.

You can also present a drawing/sketch. Be prepared to give arguments for your plan and to answer questions from the municipality staff.
INTERCULTURAL SCIENCE LEARNING OUTSIDE OF SCHOOL

Environmental Staircase and Timeline Module IO11
Environmental Staircase and Timeline of Module IO11

Design staircase: Jardar Cyvin, with ideas from Jelavic (2014), Lysklett (2013)
References


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Activity 1.1: General Introduction – What is intercultural science learning outside of school?
Overview

• Inclusion principles
• Diversity and superdiversity
• Intercultural education
• Science as culture and border crossing
• Out-of-school science learning
• Intercultural science learning outside of school
Inclusion

Inclusion is an underlying value and pedagogical principle - the democratic idea that all people have the same value.

Each individual should have the opportunity to realize his own learning potential regardless of background.

All people must have the possibility to be supported and strengthened in their mastering, motivation and learning abilities.

Impose different forms of differentiations.

(Abdallah-Pretceille, 2006; Portera, 2012; Sleeter, 2013)
The aim for an inclusive practice

• To stop all discrimination and to promote social belonging for all individuals and groups in school.

Discuss: HOW IS THIS IN YOUR COUNTRY?

• Do you recognize these values in your own country?
• How do you work to promote social belonging and inclusion in school?
Diversity

• ... should be coped up with "inclusion" as an ideology:
  • requires the learning arenas to develop equality between pupils and to their ability to develop relations.
  • ... also includes diversity of thoughts, actions, ethnicity, religion, interests, gender, experiences etc.

How do you understand diversity in your country?
Superdiversity/ Trans-culture
Growing up in different cultures

• We continue to be parts of the different cultures which we have grown up (is growing up) with
• We integrate different cultural practices because we move between different realities with different «(social) codes», expectations, languages.
• Important to know the different «(social) codes» and use them in different arenas → multicultural competences → impact on the development of a person’s identity
• People have to deal with a diversity of opinions / practices /discourses /points of views

(Vertovec, 2007)

All these happen in interaction with friends, family, other students and learning institutions.
Diversity as resource

Visualize differences as richness:

• Inequalities appear to be somewhat positive.
• Diversity works as starting point (underlying principle) for all activities in school.
• Teachers should focus on making teaching relevant for all students.

photo Anne B Lund
Interculturality
We have something in common
Something is different
We talk / tell/ aks about it
Interesting to learn!
Intercultural learning

- Communicate the similarities as well as differences
- Provide space and time to both yourself (teachers) and students to explore and learn about each other
- Focus on relations between people and groups and interactions for mutual understanding.
Intercultural science learning

• ... is about including and adapting to the ‘intercultural’ thinking within our science classes.
• ... calls for exploring the scientific reasonings of different pupils (individuals) in the class.
• ... initiates a dialogue among the science classroom community so that all the pupils participate equally — academically, socially and culturally.
• ... creates a room for discussion about various ways science is present in different cultural practices, e.g., food, perceptions about nature & animals, festivals, clothing etc.
Intercultural science learning

... creates a room for discussion about various ways science is present in different cultural practices, e.g., food, perceptions about nature & animals, festivals, clothing etc.

https://unsplash.com
Science as a culture has:

- Specific ways of thinking
- Specific ways of communicating
- Specific ways of understanding and describing the world
- Own values and ideals.
Cultural border crossing

- “Learning is like a cultural transmission or culture acquisition” (Aikenhead 1996)
- Teacher should help the students to cross the border (Aikenhead, 2000; Sjøberg, 2009)
Some thoughts…

Openness and respect:

E.g. There are other views on evolution than the scientific view

- Discuss differences between the views
- Train students to see both the advantages and limitations of the scientific view or scientific ways of thinking
- Avoid stereotyping
  
  Cyvin & Febri, 2017

- Possible to have more than one views on something, e.g. the scientific view and the religious view on the origin of human being.
  
  Sjøberg, 2009
Language barrier

- Language in science has a specific genre characterized by abstraction and technicality.
- In addition, some words (e.g. forces, energy, work, heat) mean different in scientific language than in everyday language. This in itself can cause challenges for border crossing.
- In addition, lack of language competencies in general can limit students’ understanding of scientific concepts.
Examples of some strategies to cope for language barrier

• Teacher needs to be extremely aware of the need for explaining the meaning of scientific terminologies and sentences. (Border crossing means among other to learn a “new” language)
• Use of “metatalk” - talk/discussion about the scientific words
• Use of dialog-based teaching
• Develop tools to help students in learning both language and concepts
• Extensive use of concrete artefacts
Out of school science learning:

• … is learning science through activities that happen outside the classroom arena (formal or informal)
• Examples of such activities include, visits to a zoo, museum, planetarium, using internet/TV to see scientific programs, learning about scientific facts in cooperation with nature (camping, field work, research, observing natural phenomena etc.).

(Léonie, 2014, p. 120-21)

DO YOU USE OUT OF SCHOOL SCIENCE IN YOUR COUNTRY??
Intercultural science learning outside of school:

- Interculturality
- Out-of-school pedagogy
- Science learning
Intercultural science learning outside of school can –

• ... make pupils observe and experience scientific phenomena in natural settings.
• ... encourage their communication skills by describing their observations within their groups and classroom.
• ... provide them with personalized experiences with scientific principles existent in nature itself; they can feel and touch a tree rather than looking at a tree’s picture in their textbooks.
• ... motivate an intercultural dialogue, exchange of ideas, thought processes, scientific experiences among the pupils having different backgrounds and cultures.
• ... help them become critical, aware and flexible to discussing their own and accepting different perspectives of looking at similar scientific practices.
Bibliography:

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Activity 2.1: Introduction to Diversity and Taxonomy
Ecology and the species

- An example from Arctic – Spitsbergen
  2000 km north of Prague, still 1200 km to the North Pole

  - Terrestrial ecology
  - Abiotic + biotic factors
  - «Simple» food chains on land (terrestrial)
  - Few species (compared to i.e. tropical regions, or the ocean
    - Extremely few mammals
    - Extremely few rodents
    - Extremely few predators
    - Few birds
    - No amphibians or snakes
    - Few invertebrates in general
    - Few insects
  - High numbers of specific species – i.e. cliff birds

- Consequence: Relatively easy to observe connections and interpret coherence
INTERCULTURAL SCIENCE LEARNING OUTSIDE OF SCHOOL
INTERCULTURAL SCIENCE LEARNING OUTSIDE OF SCHOOL

Photos: Jardar Cyvin

IncluSMe
Intercultural Learning in Science and Mathematics
Initial teacher education

NTNU
Norwegian University of Science and Technology

Co-funded by the European Programme of the European Union

Pädagogische Hochschule Freiburg
Université des Sciences de l'Education - University of Education

International Centre for STEM Education
**Taxonomy**

- Naming and classifying organisms
  - Part of the biological systematics (the phylogeny, evolution is added)

- **WHY?**

**TASK:** 1 minute think, 1 minute discuss with the person next to you)
Why taxonomy

• Create order (not chaos)
• Common concepts and naming (nomenclature)
  • Practical (culture and nature)
  • Pedagogical
  • Scientific (books, conversation)
How to sort and classify?
What is a dichotomous key?

• Goal: Put names on unknown species or objects
• Use: Characteristics and a key
• The term dichotomous means “divided into two parts”; thus, at each stage of a dichotomous key, only two choices are presented. Each choice leads to another alternative until the organism or object is identified.

• Example: Fruits
  • With stone or without stone
  • Skin thicker or thinner than 1 mm
  • Colour yellow/orange or not
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Activity 2.2: Modelling Diversity
Overview:

- Aim
- Handout – cards with bolts and nuts
- The task – making a dichotomous key
- The system of dichotomous keys and hierarchical thinking
Aim

• Be able to use a dichotomous biological key to determine correct species
• Be able to build up your own key; first by modelling some well known non-biological parts; candy, nuts/bolts, nails etc.
• Be able to use knowledge about dichotomous keys pedagogically in teaching about species diversity
Objects available
- Nuts and bolts

The task with nuts and bolts is rewritten from Watson & Miller, T. 2009.

Photos: Jardar Cyvin
Handout cards

Identification sheet for nuts and bolts

Your name:

Instruction: Use the dichotomous key to identify each piece of nuts and bolts that was handed out, and write the correct name on each picture.

Pair and group work

- Duration: 30 minutes
Task

1. In pairs: Construct a dichotomous key based on available nuts and bolts/cards of nuts and bolts
2. Exchange your key with another pair of students
3. In pairs: Use the dichotomous key designed by another student group, to classify your nuts and bolts
4. Discuss your experiences with the other group
Modelling a key with nuts and bolts

Identification sheet for nuts and bolts

Your name:

Instruction: Use the dichotomous key to identify each piece of nuts and bolts that was handed out, and write the correct name on each picture.

1. Wing nut
2. Square nut
3. Hex nut
4. Flathead wood screw
5. Ovalhead machine screw
6. Roundhead wood screw
7. Roundhead machine screw
8. Hexhead machine screw


(rewritten from Watson and Miller, 2009.)

Photos: Jardar Cyvin
Optimal answer key

**Identification sheet for nuts and bolts**

Your name:

Instruction: Use the dichotomous key to identify each piece of nuts and bolts that was handed out, and write the correct name on each picture.

1. Item with a hole
   - Go to 2
2. Item without hole
   - Go to 4
3. Item has wings
   - Wing nut
4. Item without wings
   - Go to 3
5. Item four-sided
   - Square nut
6. Item six-sided
   - Hex nut
7. Item has threading & a pointed tip
   - Go to 5
8. Item has threading & without pointed tip
   - Go to 6
9. Item has flat head
   - Flathead wood screw
10. Item has round head
    - Roundhead wood screw
11. Item has a six-sided head
    - Hexhead machine screw
12. Item has not a six-sided head
    - Go to 7
13. Item has round head
    - Roundhead machine screw
14. Item has oval head
    - Hexhead machine screw


**Photos: Jardar Cyvin**

( Rewritten from Watson and Miller, 2009.)
Tree ID app

- Eg. British tree identification

A perfect scientific key vs. pedagogical key

• A pedagogical key could be very simple, or more advanced, but in any case – not complete, or contains all concepts and names perfectly

• A complete scientific key for a taxonomic group and an area, aims to be complete, in order to determine all individuals found to correct specie (or other taxonomic level as family).
References

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INTERCULTURAL SCIENCE LEARNING OUTSIDE OF SCHOOL

Activity 2.3: Collecting pre-knowledge
Activity 2.4: Introduction to fieldwork
Activity 2.5: Fieldwork
Activity 2.6: Summary/Reflections after fieldwork
Overview:

- Aim
- Collecting pre-knowledge
- Introducing the field work
- Handout – Leaves morphology
- Fieldwork
- After fieldwork
Aim

• “Warming up”
• Building awareness about biodiversity
• Building awareness about cultural aspect
Collecting Pre-knowledge about trees

Share in group:

• Your knowledge about trees and leaves, terminologies to categorize trees, leaves and seeds based on your background and language. Use the information you have collected during the homework (Activity 1.2).
  • Present the PowerPoint presentation you have made for the homework Activity 1.2.:
    • Tell about the tree species, display pictures, explain growth site and prevalence
    • Discuss what distinguishes the specific tree species from the other species and why

Then share in the class
Collecting Pre-knowledge about trees: Narratives

• Share in group:
  • Narratives (if any) about the trees in the area/county you come from or have grown up in: e.g.

  What people use these kinds of trees for (handcraft/art/music/survival/food/industry etc.)?

  Any legend about the trees?

  Use the information you have collected during the homework (Activity 1.2).

  Then share in the class
Field work: Trees

http://blogs.henrico.k12.va.us/21/files/2016/03/Selden.jpg (Creative commons)
Think-Pair-Share:
What do you know about the leaves morphology?

Based on your background and language:
Do you have concepts / terminologies (everyday language / scientific concepts) to categorize leaves? Which?
Handout - Common leaf morphology -
a sample of leaf morphology characteristics

<table>
<thead>
<tr>
<th>Venation</th>
<th>Shapes</th>
<th>Arrangement</th>
<th>Margins</th>
<th>Arrangement on the stem (phylotaxis)</th>
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<tr>
<td>Parallel</td>
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<td>Simple</td>
<td>Entire</td>
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<td></td>
<td>Ovale</td>
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<td>Pinnate</td>
<td>Lanceolate</td>
<td>Palmately compound</td>
<td>Crenate</td>
<td>Opposite</td>
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<td>Obovate</td>
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<tr>
<td>Palmate</td>
<td>Sagittate</td>
<td>Pinnately compound</td>
<td>Dentate</td>
<td>Whorled</td>
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<tr>
<td></td>
<td>Orbicular</td>
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<tr>
<td>Reticulate</td>
<td>Digitate</td>
<td>Bipinnately compound</td>
<td>Serrate</td>
<td>Rosette</td>
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<td></td>
<td>Reniform</td>
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<td>Palmeate</td>
<td>Trifoliate</td>
<td>Lobed</td>
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<td>Pinnatisect</td>
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</table>

Lay-out: Jardar Cyvin
Pictograms: [https://commons.wikimedia.org/wiki/Leaf_morphology](https://commons.wikimedia.org/wiki/Leaf_morphology)
Handout - Morphology

“Morphology, in biology, the study of the size, shape, and structure of animals, plants, and microorganisms and of the relationships of their constituent parts. The term refers to the general aspects of biological form and arrangement of the parts of a plant or an animal. The term anatomy also refers to the study of biological structure but usually suggests study of the details of either gross or microscopic structure. In practice, however, the two terms are used almost synonymously.

Typically, morphology is contrasted with physiology, which deals with studies of the functions of organisms and their parts; function and structure are so closely interrelated, however, that their separation is somewhat artificial.”

Field work: Trees (group work)

- Your area in general:
  - Characterize your area (natural habitat or planted habitats, inhabited or uninhabited,...)
  - Take notes on sun direction, building placement (to account for shadow), whether the plants were watered or not
  - Describe your area with regard to diversity
  - Measure green areas

- Trees in your area:
  - Collect data about trees in your designated area
  - Observe shape, colour and characteristic traits of trees
  - Collect the leaves, categorize and describe them. Use your own words and senses, but you can use «leave morphology» handout as support if necessary

- Take pictures of your area and the species you find

- Optional: Use a digital system for registration of species, e.g. Google site, or a smartphone App like iNaturalist, British tree identification
Field work (cont.)

Remarks:

• Each group should study a specific area
• You don’t have to know the name of the tree species to be able to accomplish the tasks
• As you work outside, it is desirable to discuss how to transfer the knowledge you get into knowledge for teaching
• Remember to bring leave samples back to the classroom
Field work (cont.)

• Duration: 90 minutes
After field work, Activity 2.6

Task, Group Work:

• Construct a dichotomous key based on your collected leaves (if time allows; Use the dichotomous key designed by another student group, to classify your collected leaves)

• Reflect on how out of school activities can promote intercultural understanding in science education, e.g.
  • How concretes from outdoor can help you to develop scientific language/knowledge of scientific concepts. Impact of cultural difference between students? How all senses can be utilized, if language barriers appear

• What could be learnt from the fieldwork activity, regarding being a future teacher. Special emphasis on the different phases (preparation tasks, fieldwork tasks, summary tasks – and how they were or can be performed) and emphasis on diversity of students.
After field work, Activity 2.6

Plenary: Share with the whole class.
Possible orientations/focuses:

• Characterize the different areas with regard to diversity (each group present their area)

• Reflections on how the how out of school activities can promote intercultural understanding in science education, e.g.:
  • On the role of concretes/artefacts in building scientific language/knowledge
  • How the preparations, pedagogical approach during fieldwork and reflections after fieldwork can facilitate intercultural learning
  • How the use of own words and senses can facilitate learning of science content in intercultural context
References


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Activity 2.7: Exploring an ecosystem
Task (group work)

1. Based on the geographical diversity in your group, select one ecosystem or local biotop, typical for one or more of your geographical areas.
2. Discuss where in the world you find this kind of ecosystem.
3. Discuss different types of plants that will endure. Choose one of these plants and visualize it in the following way:
   A. Find information on its geographic location(s), climate conditions (e.g. coast, inland, mountain,…), growth conditions (biological knowledge)
   B. Try to find out if this plant is used in any symbols, paintings, pictures, mysteries, legends and/or stories in the area or country you come from or have grown up in (cultural knowledge)
   C. Find information on what people use these kind of plant for (handcraft/art/music/survival/food/industry etc.) (economic importance)
4. Make a presentation of your plant for the class, based on your answers to A, B and C above.
Ecosystem: Cultural landscapes

Juniperus communis (Juniper)

Distribution map of Juniperus communis
Biological knowledge

*Juniperus communis*
Family: Cupressaceae, Genus: Juniperus
Species: Juniperus communis L.
English: Common juniper

Climate/growth conditions:
-coast, inland and mountains
-a variety of conditions!
Cultural knowledge

«Tree of the county», Sogn- og Fjordane, Norway
The tree «must have been biological, cultural and/or economic important for a long time»

Ethnic and herbal use
- diabetes, female contraceptive, asthma, speed chilbirth
- saining rites, the smoke of burning juniper is used to cleanse, bless, and protect the household and its inhabitants
- Juniper ash is considered to be one of the main sources of calcium for the Navajo people, USA

Wood and leaves
Local people in Lahaul Valley, India, present juniper leaves to their deities as a folk tradition. It is also useful as a folk remedy for pains and aches as well as epilepsy and asthma. They are reported to collect large amounts of juniper leaves and wood for building and religious purposes
Economic importance - Uses

**Antioxidants**
- antimicrobial activity

**Essential oils**
- alpha pinene, cadinene, camphene and terpineol

**Culinary use**
- the primary flavoring in gin
- Juniper berry sauce is often a popular flavoring choice for meat dishes

**Ornamental use**

**Wood/Timber/handicrafts**

**Spices**

**Bonsai**

**Timber/handicrafts**
Task (group work)

1. Based on the geographical diversity in your group, select one ecosystem or local biotop, typical for one or more of your geographical areas.
2. Discuss where in the world you find this kind of ecosystem.
3. Discuss different types of plants that will endure. Choose one of these plants and visualize it in the following way:
   A. Find information on its geographic location(s), climate conditions (e.g., coast, inland, mountain,…), growth conditions (biological knowledge)
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   C. Find information on what people use these kind of plant for (handcraft/art/music/survival/food/industry etc.) (economic importance)
4. Make a presentation of your plant for the class, based on your answers to A, B and C above.
References (Images)

Klövsjö_June_2014_02.jpg:
https://upload.wikimedia.org/wikipedia/commons/thumb/b/b7/Kl%C3%B6vsj%C3%B6_June_2014_02.jpg/250px-Kl%C3%B6vsj%C3%B6_June_2014_02.jpg (Photographer: Arild Vågen)

Juniperus_communis_Haweswater.jpg:
https://upload.wikimedia.org/wikipedia/commons/thumb/3/34/Juniperus_communis_Haweswater.jpg/1280px-Juniperus_communis_Haweswater.jpg (Photographer: Chris Cant)

Juniperus_communis_range_map.png:
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Juniperus_communis_L:
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Lüneburger_Heide_006.jpg:
https://upload.wikimedia.org/wikipedia/commons/thumb/3/39/L%C3%Bcnneburger_Heide_006.jpg/180px-L%C3%Bcnneburger_Heide_006.jpg (Photographer: Nikanos)
References (Images)

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Eastern_Juniper_Sandy_Hook_Old_Dune_Trail_in_winter.jpg:

Sogn-og-Fjordane-våpen.svg:
https://upload.wikimedia.org/wikipedia/commons/thumb/e/ec/Sogn_og_Fjordane_v%C3%A5pen.svg/860px-Sogn_og_Fjordane_v%C3%A5pen.svg.png (Author: Skvalen)

Norway_Counties_Sogn_og_Fjordane_Position.svg:

Green leaf plant near houses: https://unsplash.com/photos/OgDBwcsdUg8 (Photo by Aubrey Odom on Unsplash)

Soubor, Juniperus_communis_wood_tangent_section_2_beentree.jpg:
https://upload.wikimedia.org/wikipedia/commons/f/fc/Juniperus_communis_wood_tangent_section_2_beentree.jpg (Photographer: Beentree)


Plik, Laguiole-en-aubrac-messer.jpg:
https://upload.wikimedia.org/wikipedia/commons/8/85/Laguiole-en-aubrac-messer.jpg (Photographer: Dr. Max Lennertz)
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Activity 2.8: Building a model of an ecosystem (optional)
Overview:

- Aim
- Task
- Equipment needed
- Templates (examples) for data collection
Aim

- Demonstrate what is needed to run a small ecosystem
- Introduce simple data logging technology to measure abiotic factors
- Follow the ecosystem over time, and make recordings, analogue or digital
Equipment needed

- A transparent glass or plexiglass container of minimum 1 litre (jam glass, goldfish bowl, aquarium, terrarium or similar)
- A transparent lid (plastic film, plastic bag, glass/plexiglass plate)
- A cup of water
- A light source
- One or more green plant(s) in some soil (or OPTIONAL just in water)
- Some small invertebrates (insects, earthworms, spiders, sow bugs etc.) - OPTIONAL
- Data logger with one or more sensors (light, oxygen, CO₂, moisture, pH) - OPTIONAL
Pair and group work

• Duration: 30 minutes
Task

• Put the plant(s) and a cup of water in the glass container, with a light source outside the glass. Now you have the most essential components to start photosynthesis.

• Cover the glass container with the lid or transparent plastic and place it in a tempered room. You now have a small ecosystem, which for a while will keep going. Evaporation from the water cup and the plants will produce drops of water under the plastic, inside the container, and after a while, it will drip back to the plant(s) (primitive rain)
Task (optional)

Connect data logger sensors to the ecosystem. I.e. CO$_2$, O$_2$, light intensity, moisture, temperature

- Record variations in CO$_2$, O$_2$ for example related to light intensity, or evaporation (amount of water under the lid) related to temperature.

- Several other experiments related to the growth of the plants are possible, and if you introduce some invertebrates, you expand the potential for observing interactions of the species involved in the food chain of your small ecosystem.
### Handout - template data collection (analogue)

<table>
<thead>
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<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
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<tr>
<td>Temperature</td>
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<tr>
<td>Water under the lid</td>
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<tr>
<td>(dripping, some water,</td>
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<td>no water)</td>
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<tr>
<td>Plants – condition</td>
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<td>Light</td>
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<td>length of day/night)</td>
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</tbody>
</table>

* The interval of recording can be changed or expanded due to the size of the project
Handout - template data collection (digital)

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<tr>
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<th>Sample 1 *</th>
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<th>Sample 3</th>
<th>Sample 4</th>
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<td>Temperature</td>
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<tr>
<td>Water under the lid</td>
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<tr>
<td>(dripping, some water, no water)</td>
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<td>Moisture (rel. %)</td>
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<td>Light (lux)</td>
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Activity 3.2.: Land use -
Develop a plan for land use of an area nearby your school
Duration: 90 min
Examples of analogue thematic maps made by primary and lower secondary school students (Cyvin, 2013b)

Thematic map: Nest boxes. 4 different layers. Scale and vegetation map: Upper right corner Names and type of nest boxes: Down left corner Topographic information: Down right corner Legend: Upper left corner.

Final thematic map with 4 layers. Be aware of the “X” in upper left corner. This is a mark to fit the layers together.
Examples of digital thematic maps made by primary and lower secondary school students (Cyvin, 2013a)

Topographic map with nest boxes (blue tit, starling and wagtail)

• (and a anthill = “maurtue”)

Topographic map image reproduced by the kind permission of Garmin.
Make a land use plan (group work)

1. Use the pictures from the park in combination with Google Maps and Google Street View to get a knowledge base of the topographic park area.

2. Write down interests of the different user groups of the park area:
   - Contractors/real estate companies
   - Employees nearby
   - Municipality authorities
   - Nature conserve authorities (including biologists)
   - Public / Neighbours
   - Children/ Students
   - Road authorities
   - Biology and wildlife protecting organizations (volunteers)
Based on your role:

3. Make a priority list of what you think is the most important use
4. Make a map with 2 layers showing:
   - the topography
   - themes that is important for your planned land use
5. Make one new layer showing the most important threat to your planned use
6. Make a map legend and a short explanation to your map
7. Prepare argumentations for your plan of land use
8. Discuss possible counter arguments that might oppose your plan
References

• Cyvin, J. 2013a. Students construction of their own thematic maps in primary school. [In Norwegian] Kimen 2013 (1) p. 110-122

This presentation is based on the work within the project Intercultural learning in mathematics and science initial teacher education (IncluSMe). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education Freiburg, Germany. Partners: University of Nicosia, Cyprus; University of Hradec Králové, Czech Republic; University of Jaen, Spain; National and Kapodistrian University of Athens, Greece; Vilnius University, Lithuania; University of Malta, Malta; Utrecht University, Netherlands; Norwegian University of Science and Technology, Norway; Jönköping University, Sweden; Constantine the Philosopher University, Slovakia.

The project Intercultural learning in mathematics and science initial teacher education (IncluSMe) has received co-funding by the Erasmus+ programme of the European Union under grant no. 2016-1-DE01-KA203-002910. Neither the European Union/European Commission nor the project's national funding agency DAAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.

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Activity 3.3.: Role play, presentation of land-use plan, target group: local municipality
Role play

• Work in the same group as in activity 3.2

• Present the idea of your land-use plan to the municipality

• Give arguments for your plan and answer questions from the municipality staff (be prepared to answer possible counter arguments that might oppose your plan).

https://cnho.files.wordpress.com/2011/02/debate.gif
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