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Anatomy and life cycle of gymnosperm plants (conifers and relatives)

1. Description

1.1 Formal context

Part of course: Biodiversity and Systematics, basis course; part of the study program Biology and Environmental sciences with specialisation natural history.

Number of students: around 30

Level: First year, bachelor students

Time frame: The specific teaching event presented here takes four hours on one afternoon, the botany module lasts two weeks, the course goes one entire semester.

Type of teaching: Practical/lab work

1.2 Relation to other parts of the course

The teaching event described here is a practical, which is part of the botany module of the course (Institutionen för Biologi och miljövetenskap, 2017). The purpose of the entire course is to teach students the basic characteristics of the major taxonomic groups of plants and animals (mammals, birds, ferns, flowering plants and others), and use the characteristics and relate them with each other in an evolutionary context. Furthermore, students learn to identify and taxonomically classify organisms. The botany module consists of two weeks of lectures in the morning and practicals in the afternoon. Each day is dedicated to one taxonomic group (mosses, ferns, gymnosperms, flowering plants, etc.). The lectures in the morning give an introduction to the group and its characteristics. The practical (one of them described here), give the students the opportunity to study live material and link it to the information from the lecture. The elements of each module will be examined in two parts: (1.) a practical test (“dugga”) where students have to identify live plant material and (2.) an exam with questions, were students have to provide short written answers. The examination of each module takes place short time after the module was completed, for example one week after the Botany module was completed.

1.3 Background and Motivation

Gymnosperms ("naked seed plants") are a taxonomic group of plants characterized by production of seeds that are carried "naked" on the plants, i.e. without a seed coat. Gymnosperms are of intermediate evolutionary age and are the sister group to the flowering plants. Gymnosperms did dominate the world in terms of species richness and individual number for hundreds of million years, but have in the Cenozoic (the last 65 M years) mostly been replaced by angiosperms ("flowering plants"). Today, gymnosperms are mostly represented by conifer trees. An understanding of anatomical structures and the group's life cycle is critical to identify gymnosperm species, and to understand the evolutionary history and ecological context of a given plant species. Due to their shared characteristics gymnosperms, and conifers in particular are constrained in their life history strategies and, therefore, in the habitats they can colonize. An understanding of anatomical structures also enables a 'big-picture-understanding' on the course and mechanisms of evolution, in particular in the context of the entire module (i.e. by understanding the evolution of particular structures during the course of evolution).

1.4 Objectives

After this practical the students will be able to:

1. Identify major lineages and important species of gymnosperms from Sweden based on plant material.
2. Identify anatomical features characteristic for gymnosperms and relate them to their function in the life cycle.
3. Describe the life cycle of gymnosperms.

1.5 Teaching methods and activities

The practical will be divided into three subsections:

Introductory micro-lecture (c. 10 minutes): A short, power-point supported lecture in the beginning of the practical will: (1) orientate the students on the position of gymnosperms in the evolutionary tree of life; (2) give and impression of the importance of gymnosperms for humans; (3) show examples of gymnosperm species in nature and (4) state the objectives of the practical. The major purpose of the lecture is to get the student's mind set to the practical and create a positive learnings atmosphere (Elmgren & Henriksson, 2014a) .

Lab work in groups (c. 2 hours): The core element of this practical is group work investigating the course material. The students split into small groups of 2-3 persons. Fresh plant material for approx. ten species of plants chosen from the most common and important elements of

the Swedish flora is provided in the course room. Each group has their own working space with a stereolupe and a microscope, as well as dissection tools Each group works on the material in their own pace, using the tools provided. The students are encouraged to produce notes in form of detailed drawings of each species and the relevant characteristic structures (e.g. the type of cones, the needle structure). Additionally, microscopic slides of major developmental structures of the group are provided alongside with a schematized description. The material is presented in a way to facilitate interaction within and among student groups, and to encourage students to discuss and help each other with explanations and facilitate a shared "deep learning" (Braband & Andersen, 2006). Two teachers are present during this time to help students with questions and support the independent group work.

Concluding recapitulation and exercise (c. 40 minutes): The practical is wrapped up in a plenary session, led by the teacher. Results and questions (including common questions noted by the teachers during the lab work in groups) are discussed and on the blackboard the morphological structures are placed in a scheme of the gymnosperm life cycle by the different student groups. Furthermore the teachers will demonstrate major characteristic for identifying gymnosperm species on the study material, and present 'tricks' to identify particular species. A particular focus of the summary is to create a link to content from previous practicals on different plant groups to facilitate 'accommodation' of the content into existing student knowledge (Elmgren & Henriksson, 2014b)

1.6 Frames, conditions and resources

There is a relative strong frame on the practical from the general course and module syllabus and the form of the examination. These are fixed and only the practical sessions can be planned by the teacher. Technologies -in the broadest sense- employed are: pencil & paper, stereolupe, microscope, fresh plant material, prepared microscope sliced, projector, blackboard. The practical includes 1.5 hours additional preparation time for the teacher, in which the fresh plant material is collected from a closed by forest and the botanical garden, as well as the working space is being prepared.

2. Discussion

This teaching session is designed to maximize the students' practical interaction with the study material and to embed relative complex, partly monotonous information in a socio-cultural teaching context (Elmgren & Henriksson, 2014a; Illeris, 2007). Therefore 'lecture' and 'seminar' type elements with a dominant role of the teacher are restricted to the beginning and end of the course. The "*lab work in groups"* with the plant material, situated in a socio-cultural framework is the main focus of this teaching session, other teaching

methods applied are *(short) "introductory lecture"* and a "c*oncluding recapitulation and exercise seminar"* (see section 1.5). The choice of these teaching methods has been motivated in section one, but they might also have certain disadvantages. One disadvantage of group work in the particular setting this teaching session is that, due to the high number of students and the limited amount of course material, delays can occur. The practical is designed to minimize these, but due to time constraints only a limited amount of material can be presented, so that delays cannot be completely avoided. Two challenges of the wrap up in form of the "c*oncluding recapitulation and exercise",* are to address issues relevant to the questions of the students and to create an constructive learning atmosphere (Walklin, 1990) so that students ask questions and participate actively in the discussions, in other words, to create an motivating learning environment (Elmgren & Henriksson, 2014b). In general, this teaching session orientates on the six Cs of Turner & Paris (1995), to achieve this: The students can chose how to investigate the plant material and which material to choose (choice), if student's proceed fast, additional tasks or "deeper" questions are provided by the teacher (challenge), students have the opportunity to learn from each other (collaboration) and constant (positive) feedback is provided by the teachers (consequences).

Due to the format of the teaching session, two particular challenges emerge to "good teaching":

1. The strong embedding of the course in the general course syllabus, which limits the application of teaching strategies and methods. As this is a basic course, designed to give students the foundation for subsequent courses, the examination is mostly designed to test factual knowledge of students. This is a challenge to achieve a constructive alignment of, at least the teachers intention and the examination (Biggs & Tang, 2011).
2. A huge span in degrees and causes of motivation and prior knowledge of the students (Elmgren & Henriksson, 2014c). This course module is compulsory for all students of a study program with a wide subject (biology). Therefore some students are genuinely interested in and intrinsically motivated to study the specific subject, many students are not. The practical itself is not compulsory, but a good fraction of the attending students might be predominantly extrinsically motivated (to perform well in the exam). Accounting for these differences in motivation might be challenging.

References

Biggs, J., & Tang, C. (2011) *Teaching for quality learning at university* (Fourth). Maidenhaed: Open University Press.

Braband, C., & Andersen, J. (2006) *Teaching Teaching & Understanding Understanding*. Denmark: Aarhus University Press.

Elmgren, M., & Henriksson, A.-S. (2014a) Knowledge and Learning In *Academic Teaching* (pp. 21–55). Lund: Studentlitteratur AB.

Elmgren, M., & Henriksson, A.-S. (2014b) The students In *Academic Teaching* (pp. 73–126). Lund: Studentlitteratur AB.

Elmgren, M., & Henriksson, A.-S. (2014) What promotes learning? In *Academic Teaching* (pp. 57–71). Lund: Studentlitteratur AB.

Illeris, K. (2007) *How we learn. Learning and non-learning in school and beyond.* Oxon: Routledge.

Institutionen för Biologi och miljövetenskap (2017) Biodiversitet och systematik, baskurs. Retrieved from http://utbildning.gu.se/kurser/kurs_information/?courseId=BIO920

Turner, J., & Paris, P. (1995) How literacy tasks influence children's motivation for literacy *The Reading Teacher*, *48*(8): 662–673.

Walklin, L. (1990) *Teaching and Learning in Further Adult Education*. Cheltenham: Nelson Thornes.