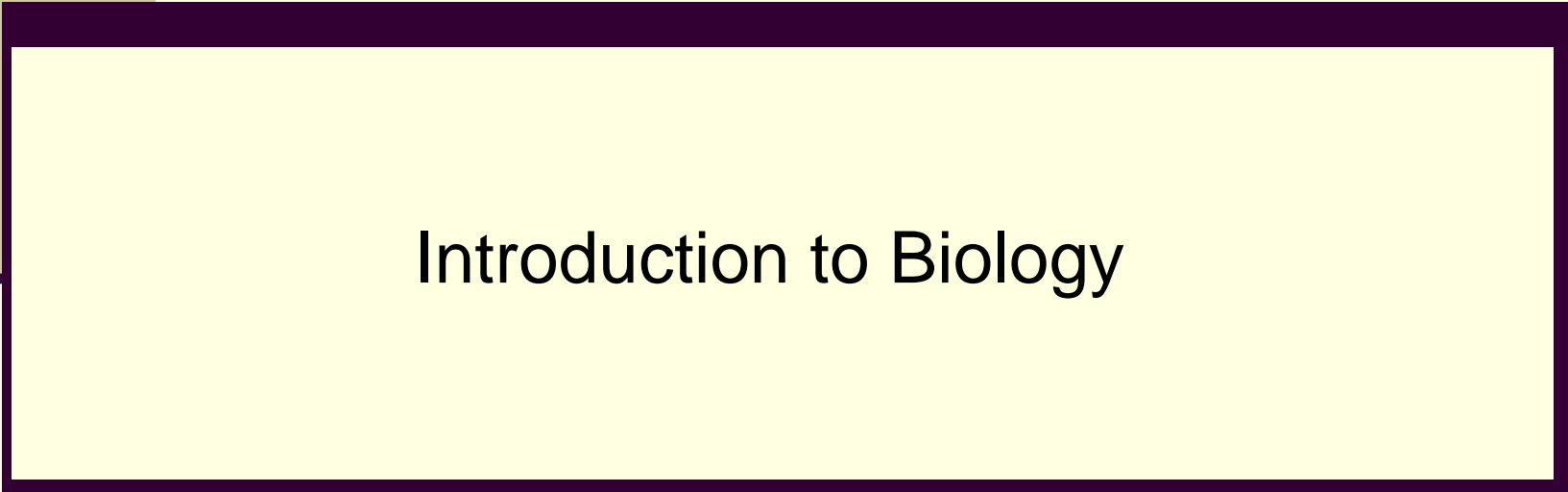




A creative take on testing learning outcomes



Introduction to Biology

This talk's menu

- The challenge
- The setting
- Two solutions
- Some examples
- Can this be generalized?

How do we measure learning?

- Traditional measurement instruments:
 - Written exam
 - Essay paper
 - Oral presentation
- Prevalence depends on discipline
 - Written exams abound in the sciences
 - Papers are more common in social sciences and humanities

Limitations of traditional approach

- Exams foster ephemeral learning
 - A.k.a. 'mental bulimia'
- Learning via papers can be more lasting, but
 - is time-consuming for the teacher
 - may become repetitive for the student
- Oral presentations stimulate learning mostly of the presenter – less so of the audience

The challenge

- Can we break free from the shackles of traditional forms of examining?



The setting

- Amsterdam University College
 - Liberal Arts and Sciences programme
 - Small-scale teaching (≤ 25 students per class)
- Course: Introduction to Biology
 - Open to all students
 - 16 weeks, two classes per week (10 hours/week)



Intended Learning Outcomes

- After successfully completing the course, students should be able to
 - remedy self-identified deficiencies in their background knowledge when reading a biological article;
 - ...
 - relate actual observations to biological theory.

Content-organizing papers

- Course is structured by six short papers
- Students read the papers twice
 - After the first reading, they identify what they don't understand
 - They choose chapters to be studied to improve their understanding
 - After studying the chapters and the classes about them, students read again the same paper

Students select chapters

Weekly Programme

Wk	Date	Subject	Readings	Miscellaneous
1a	5 Sept	Getting to know each other Introduction to course set up		
1b	8 Sept	Preliminary conversation paper 1 Introduction model system assignment	<ul style="list-style-type: none"> • Paper 1: What is a gene? • Biology's next top model 	
2a	12 Sept	Sex determination		Choice model organism
2b	15 Sept	Regulation of gene expression		
3a	19 Sept	Debriefing paper 1; Preliminary conversation paper 2	<ul style="list-style-type: none"> • Paper 2: Darwin's bridge between microevolution of macroevolution 	
3b	22 Sept	Species & Taxonomy		
4a	26 Sept	Taxonomy & Phylogeny		
4b	29 Sept	Debriefing paper 2; Preliminary conversation papers 3a, 3b	<ul style="list-style-type: none"> • Paper 3a: Green genes - Comparative genomics of the green branch of life • Paper 3b: On the origin of flowering plants 	<i>Draft essay model organism</i> due on 2 Oct 10:00 AM
5a	3 Oct	Cell biology		
5b	6 Oct	Protists & Plants		

Excursions

- Visit to Hortus botanicus
- Visit to Artis Zoo



From the abstract to the concrete

- In the course *Introduction to Biology*, can I evaluate student learning bypassing exams, papers and oral presentations?

Two solutions

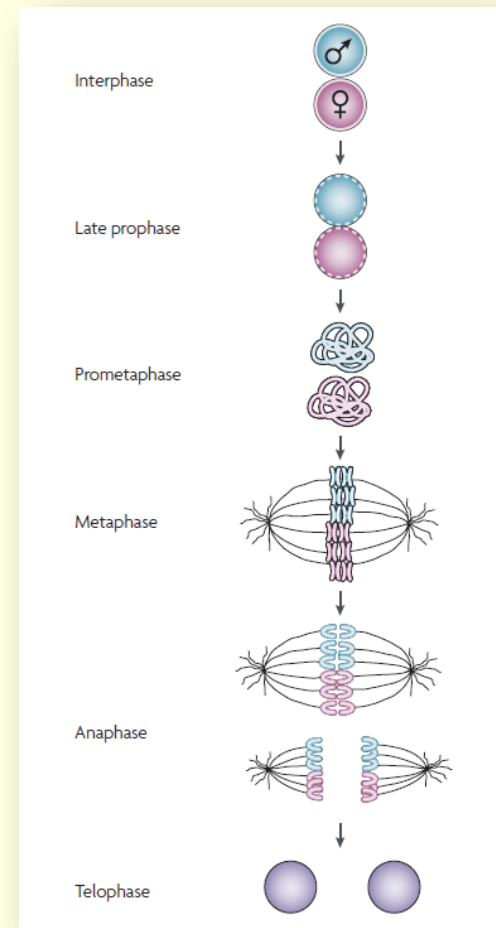
- Discussion-based tests
 - Students are able to remedy self-identified deficiencies in their background knowledge when reading a biological article;
- Free excursion report: Anything goes
 - Students can relate actual observations to biological theory.

Discussion-based tests

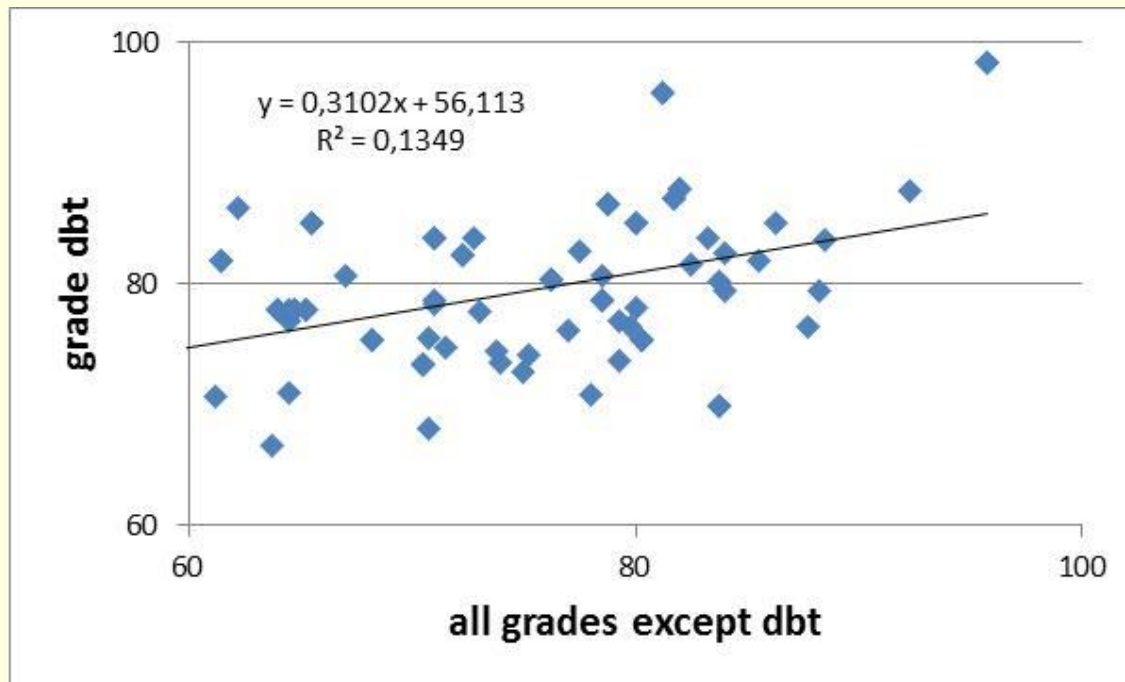
- Similar to ordinary test with open questions
 - But students **discuss their response in small groups** before they put their answer on paper!
- Advantages:
 - Students cooperate intensely for more than an hour to discuss the material!
 - More advanced questions are possible
 - Less test anxiety
 - Less grading

Example questions of dbt

- What is the haploid chromosome number of the pictured species?
- There is a glaring error in the figure. What is the error?



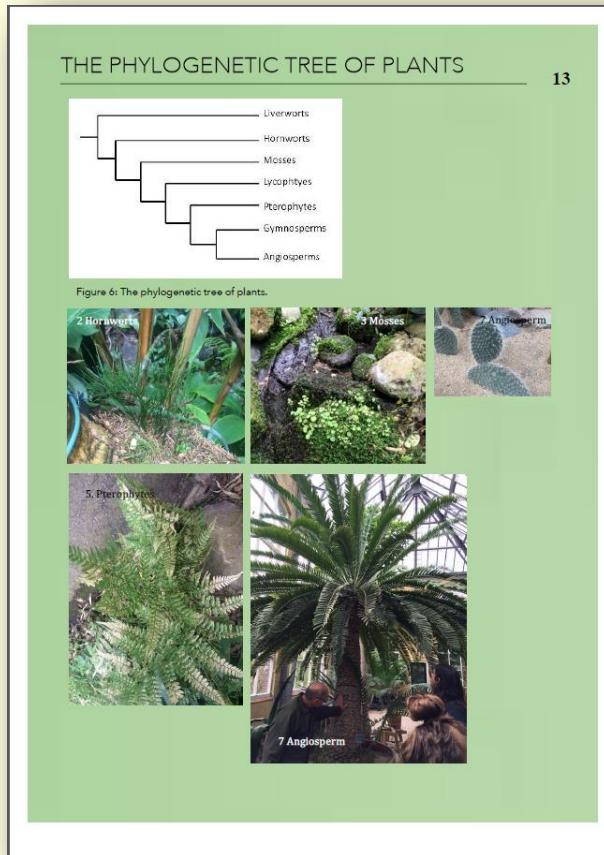
Reliability of discussion-based test



Anything goes!

- Students are invited to show in *any* format that they can relate theory to observations
 - They chose among others blogs, board games, lyrics, poems, drawings, magazine, and a video rap.

Some examples



A NOTE FROM THE AUTHOR

ear wizard,
D what lies in front of you is an original copy of the marvelous guide for the always curious, forever wondering, everlastingly fascinated natural explorer (who might just happen to wear goat wool socks in their sandals). If expanded closely, the reader can expect to find enlightening descriptions of the evolutionary features of Fantastic plants & animals, and perhaps even other peculiar creatures, that can be found in the magical worlds of Hortus Botanicus and Natura Artis Magistra. Accompanied by authentic illustrations, fantastic facts are given on how they evolved, their classification and the names Muggles (non-wizards) use for them. All of the bewitching beasts and puzzling plants are in alphabetical order for the convenience of the reader. However, this does not mean that the creatures have no connection with each other whatsoever. The reader can find interesting comparisons being made throughout the guide. For now, great pleasures and luck with exploring the nature's marvelous creations is wished upon the reader and may the magic of evolution be enlightening.

Yours sincerely,
 Fry Brauser, Professor of Care of Magical Creatures

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IMPORTANT TERMS EXPLAINED

HOMOLOGY
 Homologous features are similar features of organisms that originally had the same building plan and function but due to adaptation to changing environments and natural selection have acquired different functions. The similarity between the features is a result of common ancestry.

VESTIGIAL ORGANS
 Vestigial organs are remnants of homologous features that once served a function in the ancestors. In the present organisms, they have a marginal to no function.

ANALOGY
 Analogous features are features of organisms that share the same function. The similarity is not a result of common ancestry, like for homologous features, but of convergent evolution. This means the organisms adapted to similar environments in similar ways but evolved independently from different ancestors.

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FORM-FUNCTION RELATIONSHIPS
 Form-function relationships describe how (a part of) an organism's morphology is determined by its function.

ALTERNATION OF GENERATIONS
 Alternation of generations is a process in the life cycle of plants and some algae. Each generation gives rise to the other generation. The multicellular haploid gametophyte produces haploid gametes by mitosis. During fertilization the gametes fuse and form a diploid zygote. Then, the zygote develops into a multicellular diploid sporophyte by mitotic division. Haploid spores are then produced by the mature sporophyte by meiosis. These reproductive cells can then develop back into multicellular haploid gametophytes.

The life cycle of land plants has evolved over time and so has the relationship between the gametophyte and sporophyte. The fantastic plants in this guide show how that relationship and thus the alternation of generations varies among different groups of plants.

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Ambystoma mexicanum
 Axolotl
 Phylum: Chordata
 Class: Amphibia

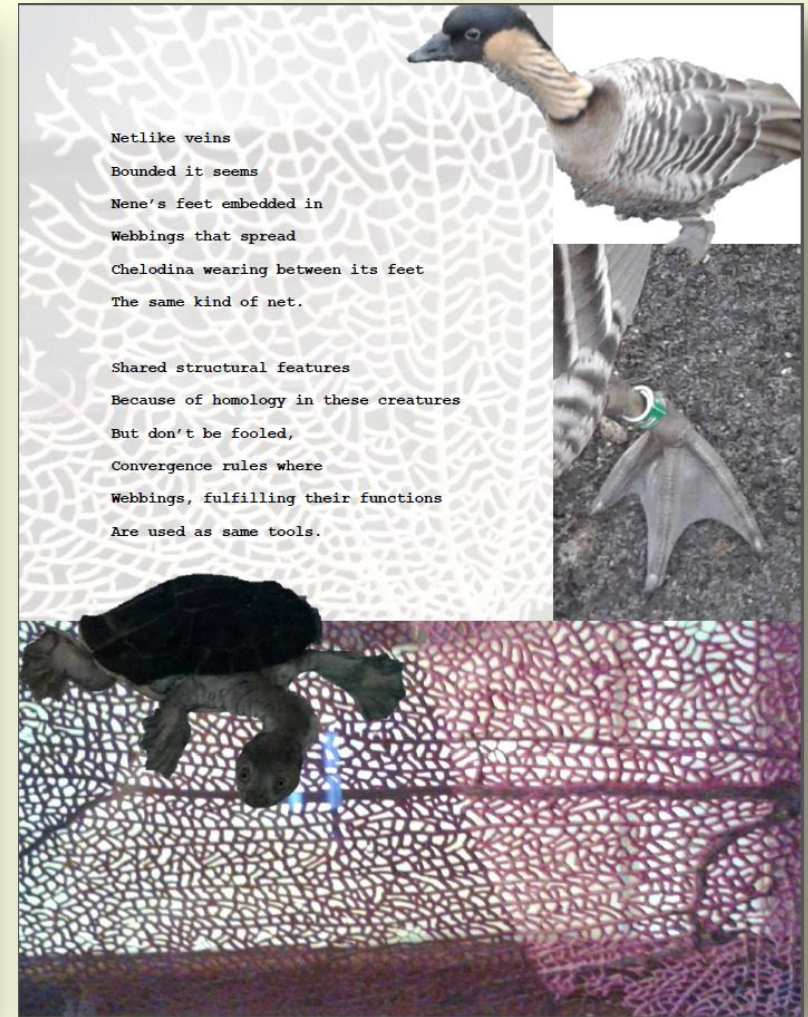
Due to a lack of iodine in the waters of their natural habitat axolotls never complete their growth process. They combine the gills and webbed tail of a juvenile with the sturdy walking legs of an adult salamander. This is an example of the concept neoteny.

Anas platyrhynchos
 Mallard or wild duck
 Phylum: Chordata
 Class: Aves

This best illustrates an example of a form-function relationship: a web between their toes can be used as a foot for swimming. Furthermore, the webbing between their toes can be used as a foot for walking.

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Another example



Final example

- <https://www.youtube.com/watch?v=IE4fvsow>
VIA



Conclusion

- **Discussion-based test** and **free format report** are alternatives to exam, paper and oral presentation
 - Both strongly stimulate student engagement
- **Free format report** greatly increases student commitment and leads to high quality products

Discussion

- How broadly applicable are the alternatives?
 - Can discussion-based tests and the free format report be used in other disciplines as well?