Cross-curricular Teaching between Mathematics and Biology

Nutrition Circle,
Proportions: Similarity and Allometry

Prof. Dr. Astrid Beckmann, University of Education Schwäbisch Gmünd

Programme

- Presentation
- Trying the material
- Discussion
- Developing own material for the classroom

Presentation

1 Introduction into the teaching modules
Nutrition Circle
Proportions: Similarity and Allometry

- Discussion of the teaching modules
upon the background of the ScienceMath-approach

1 Introduction into the teaching modules with **biology**

Nutrition Circle

Proportions: Similarity and Allometry

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Teaching module
Nutrition Circle

Proposal and Trial run: Annika Grube

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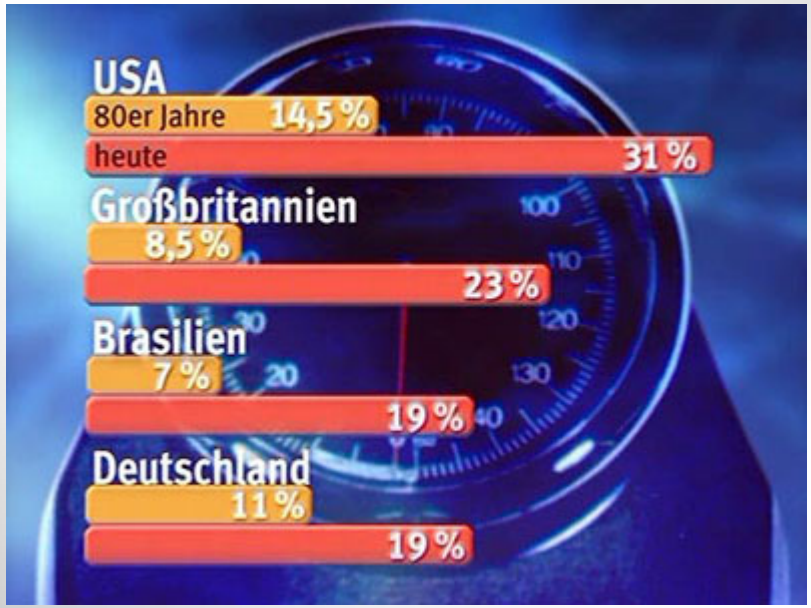
Initial position

Dramatic increase of overweight persons, especially adolescents



Quelle: http://www.wdr.de/tv/quarks/sendungsbeitraege/2004/0113/002_weltweit.jsp?pbild=1, 31.12.08

The Teaching concept

Interdisciplinarity between maths and biology

- Biology: Stimulation to developing healthy eating habits
- Mathematics: Introduction to pie charts (Apply percentage calculation)

Impulse: Nutrition circle of the German Nutrition Association

„Optimal distribution of food for a full-fledged nutrition“

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Run of the Teaching module

Preposed Homework task

Write down what you ate in one day (in grams).

	bread, noodles, potatoes (cereals)	vegetables, salads	fruit	milk, cheese, yoghurt (milk products)	meat, sausage, fish, eggs	sweets
breakfast						
school						
lunch						

Run of the Teaching module

1. Unit:

Impulse: Nutrition circle

Question: **Do my eating habits conform to the diet, suggested by the German Nutrition Association?**

→ Transfer the information of the table into a pie chart
(percentages, angular measures/ degrees, pie chart)

2. Unit:

Translation of one´s own eating habits into a nutrition circle and setting up a perfect nutrition plan, that closely follows the DGE guidelines.

→ By converting the percentages to angular measures, students can make their own pie charts.
→ Discussion of differences and common features in class.
→ Drawing up a perfect nutrition plan in group work.

Science Math Teaching module: Nutrition circle

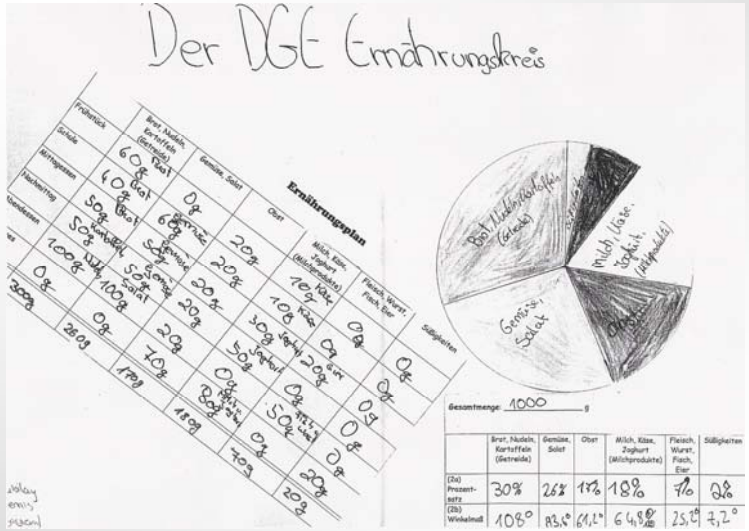
Run of the Teaching module

3. Unit:

Impulse: Home work task: Draw a pie chart for two (fiktive- preposed) pupils. Compare!

→ limits of pie charts

Presentation of the results and final discussion.



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Teaching module
Proportions
Similarity and Allometry

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Background

- In animal kingdom there is allometry instead of similarity.
  That means: Animals, that appear similar differ in proportions.

- Weight resp. volume and surface of animals are characteristics,
  that allow conclusions on their live and behaviour.
  Important: Relation between volume (weight) and surface
  ($\rightarrow$ biological consequences)
  Examples:
  - There are insects that differ in length but not in weight.
  - Insects are small, while animals with an oxigen support through their blood can be very tall.
  - Small and tall animals differ in their relative physical strength.

The Teaching concept

Cross-curricular approach between mathematics and biology

Biology: Discovering biological phenomena through mathematics and their biological reasoning

Mathematcs: Experiencing mathematical methods, concepts, relations and their extra-mathematical meaning through biological examples, and applying them

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Two worksheet collections
for self-dependent work,
for deepening and linked application:

Worksheet collection 1:
Centric elongation and similarity in geometry,
connection between mass and volume (at the same density),
comparison of similarities between similar looking animals,
allometries and their reasons from a biological perspective**.**

Worksheet collection 2:
- Interrelations between volume and surface,
- comparisons of size in animals and their biological-mathematical reasons: oxygen-, energy supply and their connection with proportions and behaviour.

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Example

Is there similarity between animals?

a) Measure selected lenghts (shoulder heights, head and back lenghts). Are the animals similar (in the mathematical sense)?

b) Investigate the similarity in another way (streching factor, weight etc).

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Example

Allometries

We observe allometries in adult animals and their young.
The animals seem similar, they differ, however, in vital parts.

a) Give reasons from a mathematical point of view,
in how far the animals are not similar.
Confirm the allometries between the young and the old elephant.
Clue: Measure various body parts.

b) Determine the stretch factor k for the shoulder heights
and the stretch factor m for the head lengths.
Compare. Compare also the ratio
of head length and body length.

c) Find reasons, from a biological point
of view, for the advantages
of "non-similarity**"**.

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Example

Locomotion behaviour and body Shapes in Insects

For an insect's life a particular volume is obviously adequate.
Their body shapes, however, differ, according to their life styles.
A dragonfly, for example, is very slim, while a beetle is rather round and armoured.

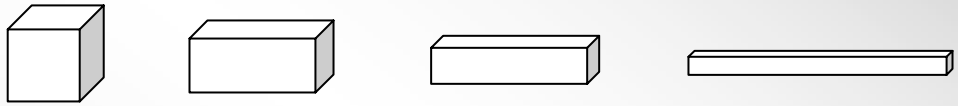
Tasks:

a) Estimate the volume and the surface in the dragonfly and the beetle by measuring them in the photos. Compare.

b) Compare the locomotion behaviour in the dragonfly and the beetle. Mark each by characteristic keywords:..

c) Find biological reasons for the differences under a) with the help of the characteristics under b).

Mathematical aspect



Proportions	volume in m^3	surface in m^2	Relation surface - volume
1:1:1	$1^2 \cdot 1$	6	6/m
1:1:2	$0{,}79^2 \cdot 1{,}59$	6,3	6,3/m
1:1:4	$0{,}63^2 \cdot 2{,}52$	7,1	7,1/m
1:1:8	$0{,}5^2 \cdot 4$	8,5	8,5/m
1:1:16	$0{,}4^2 \cdot 6{,}35$	10,4	10,4/m
1:1:32	$0{,}31^2 \cdot 10{,}08$	12,9	12,9/m

2 Discussion of the teaching modules upon the background of the ScienceMath-approach

Cross-curricular approach with the natural sciences

Charactersitics of the modules:
Stimulating a discussion,
where mathematics and biology are closely linked.

Example: To decide, if the eating habits are conform to the DGE guidelines, a pie chart has to be constructed resp. a mathematical interpretation of the nutrition circle is necessary.

Example: The construction of an individual nutrition circle should regard the DGE-guidelines (biology).

Experiencing mathematics – meaningful and adequate

Example: Allometries are detectable only with the help of mathematics.
This detection leads to a biological discussion:
→„scheme of childlike characteristics“
→ physique, behaviour

Example: Biological specifics are only comprehensible through mathematics.
→ physique/ size and nutrition behaviour etc.

Authentical experiences and intuitive understanding

Example: The construction of an individual nutrition plan needs a constant change between absolute indication, percentages and pie chart
in an extramathematical discussion.

Example: The question, if animals are similar, can be answered through measurements, calculations (streching factor) and through applying the properties of similarity.

It is a mathematical fact that figures with the same volume can differ in their surface. This fact is learned not only mathematically, but also through biological reasoning (loccomotion).

Conclusion:

- There are topics in mathematics and biology
  that can be taught in a meaningful way, also in lower secondary school.

- The mutual links between the two subjects ought to be stressed here:
  Biology is not only motivating but also requires
  a sound knowledge of mathematics
  in order to be able to discuss biological facts in a meaningful way.
  It is only through the use of mathematics,
  that biological interrelations and phenomena are recognized
  and the search for biological reasons is stimulated.

  On the other hand, through the biological perspective,
  the mathematical contexts are significantly enlarged
  and given a variety of new aspects.

Now:

Trying the material

During the trying:
Please think about discussion points
and how you would prepare it for use in the classroom

More worksheets to this module: see www.sciencemath.ph-gmuend.de

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