Supplemental Material

Item examples

Biology *Sorting task*:	**Physics *Sorting task*:**
Task 7: Giant Bacteria Giant Bacteria are bigger in size than most other bacteria. Only a few species are noted until now. One of these Giant bacteria is called *Epulopiscium fishelsoni.* It is a gram positive bacterium, which is living in symbiosis with tangs (*Acanthuridae*). The bacterium lives in the fish's intestine, where it can get 600x80 µm large. Because of its size *E. fishelsoni* has a higher nutrition exchange rate to cover its demand on nutrition. Therefore, its outer membrane is equipped with features like tubule and vesical, which are usually found in eukaryotes, exclusively. These structures of *E. fishelsoni* are an example of convergent evolution. **Task:** **Explain the structural adjustments the bacterium needs, in relation to its size.** (It is not necessary to solve the task itself. Please just find the correct approach which is needed to solve the problem.)	**Task 6: Apex Speed** A truck of mass m = 3500 kg is driving through a circular curve. The coefficient of static friction µ between the tires and the asphalt is 0.6. The curve's radius is 50 m. **Task:** **Calculate the maximum speed the truck can reach, without sliding out of the curve.** (It is not necessary to solve the task itself. Please just find the correct approach which is needed to solve the problem.)
Problem-solving approach: **Expansion of the surface area**	**Problem-solving approach:** **Transmission of force (f=ma)**

Figure I: Examples items from the biology and physics sorting tasks with correct solutions. All Items can be found in Authors (2019b).

Biology *Knowledge of facts*:	**Biology *Knowledge of meaning*:**
Elements, which belong to the bio membrane are… Please cross the right answer! (1) …cellulose & lipids. (2) …carbohydrates & DNA. (3) …DNA & cellulose. (4) …proteins & lipids.	Explain the biological term **Fitness** in one sentence. Fitness is… _____ _____ _____
Physics *Knowledge of facts*:	**Physics *Knowledge of meaning*:**
Force $\vec{F}$ is a physical quantity. The entetiy of force is labeled [$\vec{F}$]. Which formula relates to the force? Please cross the right answer! (1) $\vec{F} = \frac{kg \cdot m}{s}$ (2) $\vec{F} = \frac{kg \cdot m}{s^2}$ (3) $\vec{F} = \frac{m}{kg \cdot s}$ (4) $\vec{F} = \frac{m}{kg \cdot s^2}$	Explain the physical term **oscillation** in one sentence. Oscillation is … _____ _____ _____

Figure II: Examples items from the knowledge of facts and knowledge of meaning tests

Table 1: Detail of the knowledge of meaning scoring rubric for the biology item of Figure II. The students can reach a maximum of two points.

Category	**Niveau of the explanation**	**Rules for Coding**	**Examples from pilot study**
Adaption to the environment	0 No adaption mentioned	Answers of this type describe fitness not as a measure of adaption to a specific environment. These answers are coded with 0 points. Answers which describe adaption as an active process of the animal are likewise coded with 0 points.	*Fitness is when a male individual fathers a lot of offspring or has many female partners.* *… is body adaption towards an environment, which steals energy. Adaption of a body towards endevour.*
	1 Fitness as adaption to an environment	Answers of this type describe fitness as a measure of adaption to a specific environment. These answers are coded with 1 points.	*Fitness is a measure of adaption of an individual to its environment, which can be measures through the number of its offspring.* *…survival of a species. The better it is adapted to the environment, the better is it's fitness and it adds his genes to the gene pool.*
Category	**Nivea of the explanation**	**Rules for Coding**	**Examples from pilot study**
Number of offspring	0 no measure of fitness mentioned	Answers of this type do not mention a measure of fitness	*Fitness is recurring vitality.*
	1 number of offspring as a measure of fitness mentioned	Answers of this type mention a measure of fitness (offspring). These answers are coded with 1 points	*Fitness is when a male individual fathers a lot of offspring or has many female partners.* *… the notion for the fecundity in the animal world. (sexual fitness)*

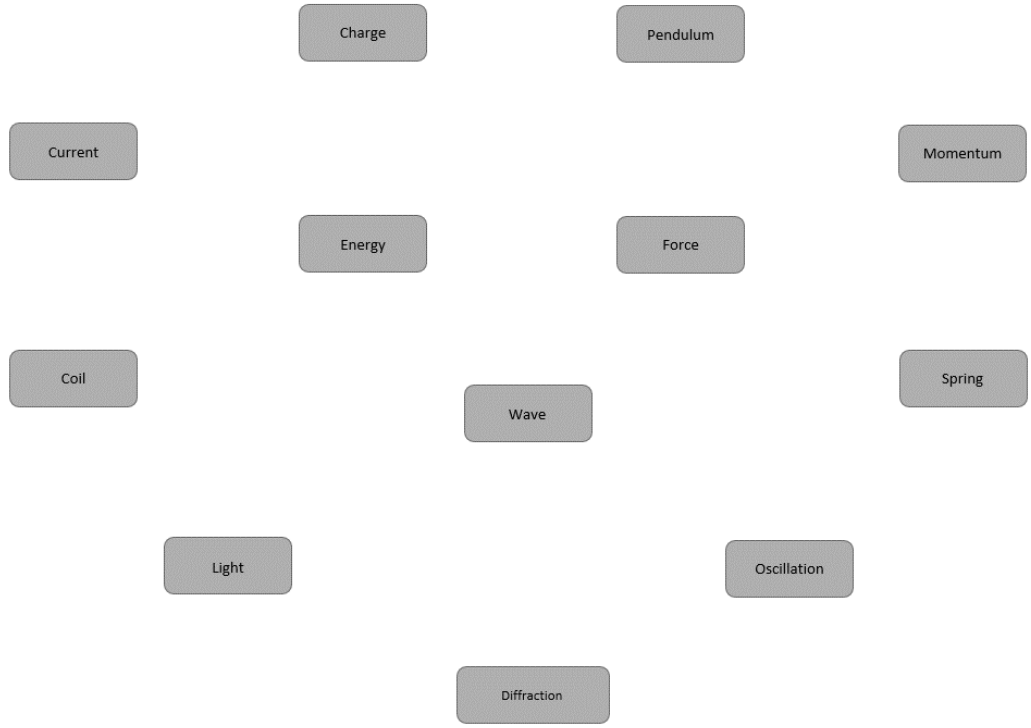


Figure III: Concept Map used in the integration of knowledge test in physics

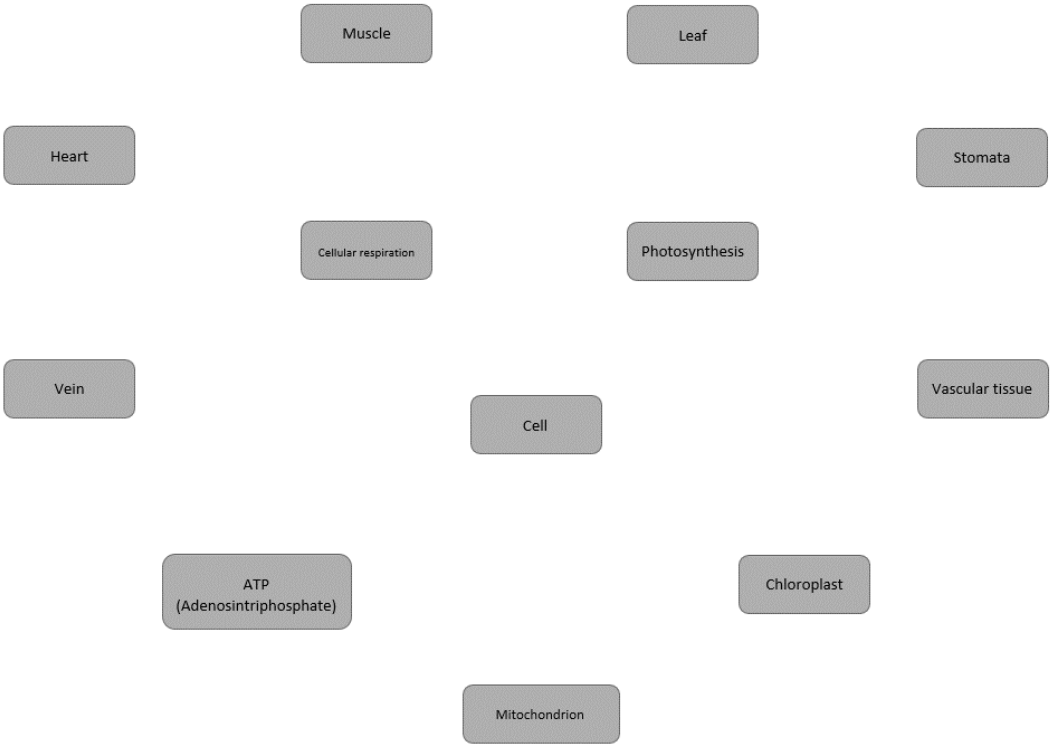
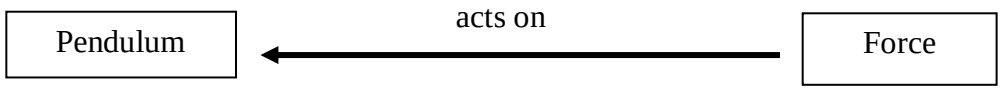


Figure IV: Concept Map used in the integration of knowledge test in biology

Table II: Detail from the Concept Map scoring procedure

Physics *Concept Map Scoring Example*:

Example of how to connect two physical principles in the Concept Map correctly.



For scoring, a rubric with correct answers was used. Examples of the rubric were produced in a pilot study. A point was awarded for a correct relation in the concept map.

Relation to score	Description	Examples
Force - Pendulum	Force (e.g. weight force) acts on objects (e.g. pendulum).	- Acts on - Deflects - Is needed for deflection
	Force as the cause of the pendulums motion	$F_{tan}(t) = -mg \cdot \sin(\varphi(t))$