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Teaching sustainability knowledge comprehensibly and effectively

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Scope and goals of CCES@School

- CCES@School is the environmental education initiative of CCES
- CCES@School
  - provides teaching materials with new and scientifically sound knowledge about the environmental system for secondary school students
  - ensures that teaching materials fulfill both, scientific and pedagogic quality standards through collaboration between experts from both fields
  - integrates the latest results of empirical research on learning and instruction
  - facilitates the compatibility with the curriculum and the user friendliness for teachers

Teaching unit on river restoration for teaching environmental and sustainability knowledge

- Sustainability issues and environmental topics are inherently complex by nature.
- Problem understanding and solution development require at least as much understanding of scientific principles as disciplinary topics.
- The MINT Leaning Center of ETH Zurich and CCES jointly developed a teaching unit on river restoration for Swiss high schools (class levels 9 to 13).
- In order to facilitate the integration into the regular curriculum, this teaching unit contains materials for biology, chemistry, mathematics, and physics.

Collaboration between environmental and educational scientists to ensure scientific and pedagogical quality

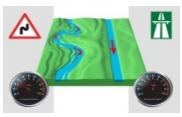
- CCES scientists do research on complex environmental systems.
- At the MINT Learning Center, researchers on learning and instruction are closely cooperating with teachers to develop teaching units from chemistry, mathematics, and physics. It is part of the ETH competence center for learning and instruction: EducETH.
- Cognitively activating forms of learning such as inventing with contrasting cases, prompts for self-explanations, instructions for metacognitive questions, and inquiry learning are integrated into these teaching units.
- All teaching materials are empirically tested and contain specific pre- and posttests for measuring learning gains.

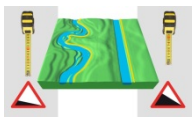
Use and dissemination of the teaching unit

- This teaching unit can be used
  - to teach important topics of the regular science curriculum seperately in biology, chemistry, mathematics or physics lessons
  - to teach different aspects of the issue from an interdisciplinary perspective
- The teaching units developed by the MINT Learning Center are disseminated in two different ways:
  - the MINT Learning Center regularly organizes seminars for teachers who are already teaching at schools.
  - the teaching units are also integrated into the teacher education program of the ETH Zurich.

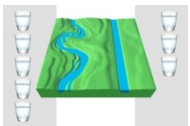
Introductory lesson

- Central question of the introductory lesson: Why are many rivers nowadays restored after investing so much time and money to excavate, to straighten and to embank them?
- The aim of this lesson is that students understand, firstly, the reasons for excavating, straightening and embanking rivers, and, secondly, why some of them are restored these days.
- This introductory lesson can be combined with the biology, chemistry, mathematics and physics parts of this teaching unit.





- Exemplary question: People want to use their river for producing electricity. However, the water in the curvy river runs too slowly to power the turbines of a river power plant. What can they do to increase the flow velocity of their river?
- Answer: They can straighten the river. First, due to the straightening the water looses less kinetic energy through changes of direction. Second, the downward slope increases. Thus, the flow velocity can be increased.
- Question: Which unwanted side effects might the straightening and embanking of rivers have?
- Answer: In straightened and embanked rivers, the water has less space. Thus, the danger of flooding increases.
- Question: What can we do as a protection against flooding?
- Answer: To give the water more space, one could build more curves and regions where the water can flow.



Sections of the River Thur near Nierderneunforn (Switzerland) before and after river restoration. Copyright: BHAteam Frauenfeld

Biology lessons

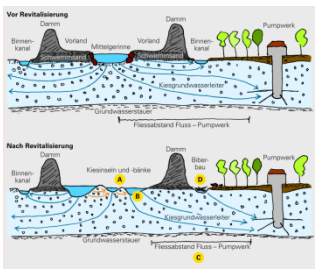
- What is changed by river restoration – and how can these changes be measured?
- What is a bioindicator?
- Which kinds of animals and plants are suited as bioindicators for measuring the water quality of rivers?

Little ringed plover, larva of the stonefly, dandelion

- Thus, the aim of the biology lessons consists in giving students a thorough understanding of bioindicators by guiding them to construct bioindicators for different possible effects of river restoration activities.

Chemistry lessons

- The aim of the chemistry lessons consists in enhancing students' understanding that there is a potential conflict between river restoration and the protection of drinking water.
- The reason is that river restoration may decrease the time the water needs to flow from the river to the source of drinking water. Thus, the water has less time to be cleaned by the aquifer.



- In order to understand how the time the water stays in the aquifer can be measured, students learn the relations between the cycle of lime and the conductibility of water.
- Thereby, the understand a new measurement method recently developed by the EAWAG.