Material Cycles in the Neighbourhood & (School)Garden

Biology | IO5

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STEMkey | Introduction

STEMkey
Teaching standard STEM topics with a key competence approach

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What are key competences?

The key competences are a combination of knowledge, skills and attitudes.

- **Knowledge:** Knowledge is composed of the concepts, facts and figures, ideas and theories which are already established, and support the understanding of a certain area of subject
- **Skills:** Skills are defined as the ability to carry out processes and use the existing knowledge to achieve results.
- **Attitudes:** Attitudes describe the disposition and mindset to act or react to ideas, persons or situations.

Figure 1: Key Competence development for lifelong learning. DOI: 10.2766/569540 (COM, 2019)

Theoretical Background

What are common pre-conceptions of students about material cycles and the carbon cycle?

… about material cycles:
- the cycle of matter is equal to the ecosystem
- the cycle of matter is equal to the food chain

… about the carbon cycle:
- biochemical properties of molecules differ depending on their source
- atmospheric CO_2 concentration = global CO_2 emissions
- the state of matter does not change within the carbon cycle
  —> atoms switch from one chemical compound to another one (cf. Fig. 2)

(Kattmann 2016; Niebert 2017; Düsing, Asshoff, Hammann 2021)

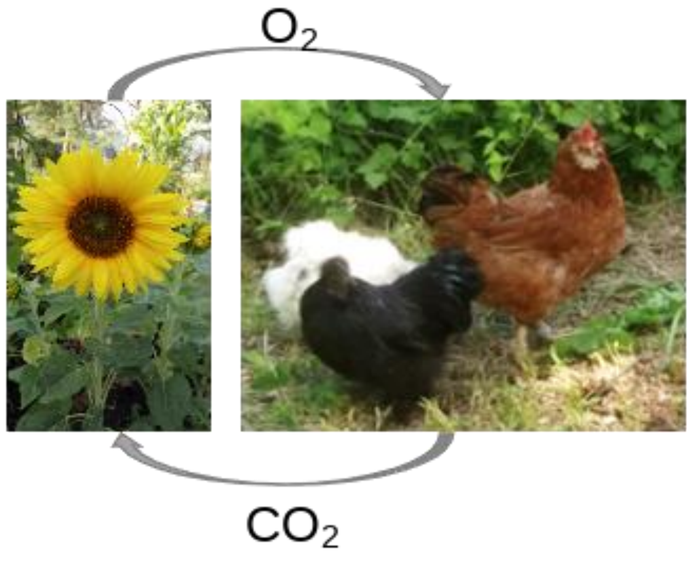

Figure 2: Gas-Gas-Cycle

Learning in the (School)Garden

„Piaget posited that children construct knowledge by interaction with their environment and gaining real-world experiences.
Vygotsky argued that children learn by doing, and by talking about their experiences [...].
Montessori proposed that children take and learn responsibility by direct interaction with their environment."

(Fine & Gee 2017, 7)

→ Core Idea of the Programme: Understanding the carbon cycle through concrete experience in a (school)garden environment.

Moving from Abstract Representations to Concrete Experience

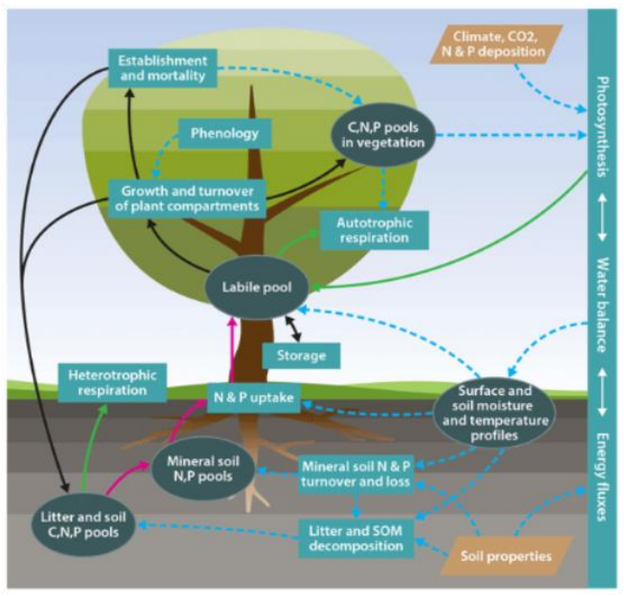

Figure 3: Abstract Representations of Material Cycles (Thum et al., 2019)

Figure 4: Concrete Objects showing Material Cycles in the School Garden

School book – schematic, reduced presentation: Challenge for students: understanding and interpreting schematic representations and creating a link to real objects.

School garden – real objects: Assistance for students: Establishing a link between schematic representations or models and real objects.

Learning Trail „The Carbon Cycle in our (School)Garden"

Phase 1 | Exploration

Students explore carbon sinks and carbon sources in the (school) garden.

Phase 2 | Creation

Students create a learning trail for their fellow students in the (school) garden.

Phase 3 | System Thinking

Students give feedback and create links between different components of the carbon cycle within the (school) garden.

References:
- *COM (2019): Key Competence development for lifelong learning. DOI: 10.2766/569540*
- Düsing, Asshoff, Hammann (2021): Von Stoffe verfolgen zu einem kohärenten Verständnis der biochemischen Umwandlungen kohlenstoffhaltiger Verbindungen im Kohlenstoffkreislauf. In: Suzanne Kapelari, Andrea Möller & Philipp Schmiemann (Ed.): Lehr- und Lernforschung in der Biologiedidaktik. Band 9. Innsbruck: StudienVerlag, pp. 111-125.
- Fine, Aubrey H.; Gee, Nancy R. (2017): How Animals Help children Leanr: Introducing a Roadmap for Action. In Nancy Gee, Aubrey Fina & Peggy McCardle (Ed.): How Animals Help Students Learn.New York: Routledge, pp. 3-11.
- Kattmann, Ulrich (2016): Schüler besser verstehen. Alltagsvorstellungen im Biologieunterricht. Hallbergmoos: Aulis Verlag
- Niebert, Kai (2017): Den Klimawandel bremsen lernen. In Ulrich Kattmann (Ed.): Biologie unterrichten mit Alltagsvorstellungen. Didaktische Rekonstruktion in Unterrichtseinheiten. 1. Auflage. Seelze: Klett/Kallmeyer, pp. 92–104
- Thum, Tea; Caldararu, Silvia; Engel, Jan; Kern, Melanie; Pallandt, Marleen; Schnur, Reiner et al. (2019): A new model of the coupled carbon, nitrogen, and phosphorus cycles in the terrestrial biosphere (QUINCY v1.0; revision 1996). In Geosci. Model Dev. 12 (11), pp. 4781–4802. DOI: 10.5194/gmd-12-4781-2019.

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