

Threshold Concepts in Science

SciMaG – Work Package 2

Threshold concepts are conceptual gateways that can open a previously inaccessible way of thinking about a subject and enable further learning. They are commonly described as potentially transformative, irreversible, integrative, bounded, and troublesome. Not every difficult or important concept is necessarily a threshold concept; the key issue is whether understanding it changes the learner's way of seeing and using disciplinary knowledge.

Identified Threshold Concepts

Photosynthesis as a Threshold Concept

Photosynthesis is central to understanding plants, energy flow, food webs, and ecosystems.

Threshold characteristic	Explanation
Troublesome	The underlying processes are microscopic and not directly observable; learners may treat plants as obtaining food rather than producing it.
Transformative	Understanding photosynthesis shifts learners from a passive-consumer model of plants to a model of plants as producers and sites of energy transformation.
Integrative	It links plant biology, energy transformation, ecosystems, food webs, and matter cycling.
Bounded	The concept is situated within biological explanations of how plants transform light energy and matter.
Irreversible	The conceptual model becomes a stable basis for interpreting plant growth, food webs, and ecosystem processes.

Mass and Weight as a Threshold Concept

The distinction between mass and weight is central to scientific reasoning about matter, gravity, forces, and measurement.

Threshold characteristic	Explanation
Troublesome	Everyday language treats mass and weight as interchangeable, while scientific definitions distinguish an intrinsic property from gravitational force.

Transformative	Learners begin to interpret heaviness, gravity, and force using scientific quantities rather than everyday language alone.
Integrative	It connects measurement, gravity, force, density, and mechanics.
Bounded	The terms have precise meanings and units within physics.
Irreversible	Once understood, the distinction can be applied consistently across different gravitational contexts.

References

Meyer, J. H. F., & Land, R. (2005). Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education*, 49(3), 373–388. <https://doi.org/10.1007/s10734-004-6779-5>