

Understanding

What is understanding?

Understanding is

- **the ability** to connect a representation to many other representations. If you understand something in only one or two ways, you scarcely understand it at all.¹⁾
- **a psychological process** related to an abstract or physical object, such as a person, situation, or message whereby one is able to think about it and use concepts to deal adequately with that object.²⁾
- **a relation** between the knower and an object of understanding.³⁾

We suggest that:

- Understanding can be discussed **only for concepts that already are a part of one's acquired knowledge (schemata)**. In other words, knowledge is prerequisite for understanding.
 - For example, one can not understand how a plane can fly if one does not know what is a plane i.e. does not have a concept of plane in his schemata.
 - On the other hand, even if one has a concept of plane in his schemata i.e. knows what a plane is, that does not necessarily mean that he understands how a plane can fly.
- Understanding is **a state** defined by the **relation between a concept of understanding and other concepts in schemata** as well as **the structure of the concept of understanding**.
 - For example, one can prove to *know* the principle of osmosis by stating the definition: "*Osmosis is the net movement of solvent molecules through a partially permeable membrane into a region of higher solute concentration, in order to equalize the solute concentrations on the two sides*"⁴⁾. Yet to *understand* it, one has to not just know the definition but also (at least) the meaning of all the words (concepts) it includes, for example the concepts of a *solvent* and *concentration*. Once the concept of *osmosis* is acquired in one's schemata, understanding of that concept reflects how it is integrated into the concept map: how developed and interrelated are (among others) subconcepts of *concentration* and *solvent* and how interrelated is the very concept of *osmosis* into one's schemata, for example related to concepts of *plants* or *roots* since osmosis is responsible for the ability of plant roots to draw water from the soil.
- Understanding is **a continuous state**, proportional to the number and strength of connections between the concept of understanding and other elements of knowledge as well as within the concept of understanding. This can also be described as the **meta-knowledge** about the object of understanding.
 - There are more than just two states (yes/no) of how a concept can be integrated into one's concept map or schemata, therefore there are more than just two states of understanding. The concept of osmosis can include only the basic subconcepts like *partially permeable membrane*, *solvent* and *concentration*, or it can include additional detailed subconcepts like *osmotic pressure*, *biological membranes*, *lipids*, *solubility*, and *charge*. The concept of osmosis can also be related to any number of other concepts like

cell turgor, thermodynamic free energy, diffusion, active transport, etc.

- Understanding derives from ones schemata and cognitive reasoning and **reflects in the ability to:**
 - **define a set of simple rules** that apply to the concept of understanding,
 - **predict its behaviour,**
 - **explain its relation to other concepts or knowledge.**

Types of understanding

White and Gunnstone suggest the following forms of understanding⁵⁾:

- **Conceptual understanding** - set of memory elements one associates with the label; improved by better memory, better connections or more clarity in elements' formulation
- **Understanding whole disciplines** (?)
- **Understanding single elements of knowledge** - grammar, procedures, rules
- **Understanding extensive communication** - a poem, speech, painting, ballet, block of text
- **Understanding situations** - seeing parallels between a situation and previous experiences; having a script for it
- **Understanding people** - seeing parallels between a person's actions and their previous actions, and being able to predict actions

Wiggins and McTighe suggest, as an alternative (or supplement) to Bloom's Taxonomy of Learning outcomes, the "6 Facets of Understanding", claiming students can demonstrate their understanding if they can:

- Explain
- Interpret
- Apply
- Have perspective
- Empathize
- Have self-knowledge

Failures of Understanding

Diagnosed failures of understanding can be caused by⁶⁾:

- Too few connections
- Wrong connections (misunderstanding)
- Not having an index for retrieval (i.e. not knowing a word)
- Wrong symbols used in index (a communication failure)

We suggest that, since understanding is a function of acquired elements of knowledge and relations between them, all failures of understanding are caused by:

- **Lacking connections or lacking elements of knowledge**
- **Wrong connections or wrong elements of knowledge**

Assessing understanding

Assessment of understanding is usually referred to as *assessment of conceptual understanding*. This is achieved using the carefully developed multiple-choice tests (*concept inventories*) that examine conceptual understanding on a narrow set of topics.⁷⁾ Questions used in the assessment are supplied with potential answers addressing common student misunderstandings. Some authors combine multiple-choice and open-ended questions.⁸⁾

- *"The questions were intended to assess conceptual understanding of the learning goals rather than simple factual recall."*⁹⁾

¹⁾

Marvin Minsky, *The Society of Mind and The Emotion Machine*, 2007.

²⁾ ³⁾

Wikipedia: Understanding

⁴⁾

Wiki: Osmosis

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R. T. White and R. F. Gunstone, *Probing Understanding*. Routledge, 1992.

⁶⁾

Smith, D. A. What Is Understanding?

⁷⁾ ⁹⁾

M. K. Smith, W. B. Wood, and J. K. Knight, "The Genetics Concept Assessment: A New Concept Inventory for Gauging Student Understanding of Genetics," *CBE Life Sci Educ*, vol. 7, no. 4, pp. 422–430, 2008.

⁸⁾

G. Zhu and C. Singh, "Improving students' understanding of quantum measurement. II. Development of research-based learning tools," *Phys. Rev. Spec. Top.-Phys. Educ. R.*, vol. 8, no. 1, Apr. 2012.

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