Different contexts for learning: why do we need to make learning meaningful (and why we often fail in that)?

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What is learning… and how it happens?

- …building new synapses and neural circuits, scaffolding the ones you use most, and making your brain more effective
- …processing (new) information deeply
- …reorganizing one's previous knowledge system according to new infromation
- …building memory traces one can easily retrieve
- …organizing learning material in a way it is transferable to other contexts

- Effective learning…
- …assumes low emotional and high cognitive pressure = effort and strategy shifting and no stress
- …assumes activity of prefrontal cortex (at least)
- …is more effective when metacognition is applied
- …is more effective – especially in learning new concepts – when previously held interpretations and knowledge are brought out

All that sounds easy…

…why it is often difficult to create the environment that enables it?

…how should we build the environment that would enhance learning optimally?

1 The role of autonomy in motivation

- Why autonomous motivation is important
- Is there some fundamental knowledge about scaffolding motivation that both academic and non-academic fields can deliberately learn to apply?

Why real life contexts seem to be more meaningful than learning abstract knowledge?

- Central „trick“ of motivation: supporting basic psychological needs (relatedness, competence, autonomy)

(But that is not enough, though)

- To support motivation thats grows from inside, giving meaning and value *from the learners’ perspective* to the learning content is crucial
- *„A critical point to be derived here is that there are degrees of autonomy and that the extent of autonomy is often dependent upon the extent to which the individual has mindfully and reflectively identified with and integrated a particular regulation or value. The varied types of internalization that we empirically explore within SDT reflect differences in this depth of integration.“*

Deci, E. L., & Ryan, R. M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268.
Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54-67.
Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.

2 „Let’s tell them stories!“

- One way to associate „real“ world to the students aspirations at school is to bring successful and inspiring people to the classroom for sharing their knowledge, experiences and different perspectives
- These narratives, personally delivered success stories are common way to raise students’ interest, courage, knowledge etc toward various topics
- In fact, it is found that storytelling and -reading can powerfully impact people’s attitudes, beliefs, perspectives, emotions and behaviors (Kaufman & Libby, 2012; Oatley, 1999; Miall & Kuiken, 1998).

So, storytelling is a form of instructional design – but does it work? How do we know?

How should we talk about success to young people?

- In line with Carol Dweck's theory of ability beliefs: people hold diferent beliefs about whether abilities are fixed or malleable
- These beliefs vary from person to person and intrapersonally from ability to ability
- For example, many young people tend to believe that math and science abilities are innate, but, e.g., writing skills can be developed (Dweck & Master, 2009).
- In the beginning of adolescence, when students engage in higher level science and math learning, the tendency to believe that exceptional talents are required to succeed in these areas increases (Rattan, Savani, Naidu, & Dweck, 2012; Stipek & Gralinski, 1996).

➢ Beliefs are not harmless, as they affect (learning) behavior

- For example, when students believe that in order to excel in science, exceptional talents are needed; this has been shown to be one of the major factors steering students away from science and math courses in both high school and college (Blickenstaff, 2005; Singh, Granville, & Dika, 2002; Wang, 2013).
- Students with the belief that success in science requires exceptional talent often avoid science classes, give up easily when they experience setbacks in their experiments, and often feel threatened by students who thrive in science classes (Shumow & Schmidt, 2014).

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F. F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology*, *108*(3), 314.

In order to study the effect of different stypes of stories to academic achievement and connectedness to the science…

…in a study of Lin-Siegler et al, 2016, three versions of story-based instructional designs were used:

a) one group of students read about the intellectual struggles that the three scientists (Albert Einstein, Marie Curie, and Michael Faraday) experienced during their scientific discoveries

b) one group of students read about struggles of the same three scientists, but the stories focused on the difficulties they experienced in their personal lives, such as poverty

c) one group of students read stories about the three scientists' achievements

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What did they found

- Exposing students to scientists' struggle stories improved their science-class performance, whereas exposing students to achievement stories did not. *Moreover - reading achievement stories might actually be harmful* as students who read the achievement story had lower science grades postintervention compared to preintervention

➢ Reading struggle stories about scientists was most beneficial for students who were low performing – the exposure to struggling stories led to significantly better science-class performance than low-performing students who read achievement stories.

➢ Significantly larger number of students who read about scientists' struggles felt connected with the stories and scientists than did students who read about scientists' achievements.

➢ Emphasizing the scientists' innate intelligence discouraged students from feeling connected with the stories or the scientists. The stories that revealed failures and scientists' vulnerability through their struggles enhanced connectedness between the students and the scientists.

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F. F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology*, *108*(3), 314.

So how do we model the path to success for the young people?

- Do we think, that telling them about great discoveries that just "happen" to some people make students, who may currently struggle with much more simpler tasks, feel connected to these scientists' paths?
- Or maybe we should model the more correct idea, that success never came without effort and perseverance, and failures and setbacks are a natural part of the process.

The seemingly tiny details of how we give our well-meant message can be reconsidered and wisely designed

Brian Cox, physicist:

„Each and every one of us has the choice to became a scientist. Except for maybe rare exceptions, there were no „natural-born“ scientists. Science thrives mainly on hard work, motivation and interest.“

http://novaator.err.ee/602237/video-brian-cox-idiootsusel-on-loomulik-piir

3 Conceptual change and systemic thinking

- When learning new concepts, it often happens – but remains unnoticed – that students in classrooms construct pseudo- or synthetic concepts about phenomena they learn about the world
- These are concepts that “look like” scientific, when children use them (e.g., in tests), but actually not all of the students have deeply processed the information and relationships depicted in the concept and hence the understanding may be primitive and/or scientifically wrong (e.g., Kikas, 2003)

Kikas, E. (2003). 10. Constructing Knowledge Beyond the Senses: Worlds Too Big and Too Small to See. *Cultural guidance in the development of the human mind*, 211.

In the era when climatologists are jumping out of the window - why are systemic thinking skills important?

- The complexity of the world is not directly perceivable, but mediated through abstract, higher-order concepts, that enable us to think about complex systems ->

➢ *Understanding anything from climate change to respiratory system presumes, that one is able to use abstract concepts*

- Why do we need to think systemically -> the one and only reason is, that… **the world *is* systemically structured**

- Thus, in order to reflect the systemic phenomenon correctly, our tools for thinking should „match“ to it. Reflecting the world correctly is also probably the only way to effectively solve real world problems

- If students will learn concepts superficially and build only pseudo/synthetic concepts -> in case the knowledge is needed in new context, it turns out to be useless, because transferability of conceptual knowledge appears if the understanding of the idea is abstract enough
- If we allow students only to construct superficial concepts, we do not exercise the thinking processes and skills optimally, which individuals will very much need when making decisions in complex world

How to develop „real“ concepts?

- … we do not know fully, YET ☺
- But we know, that concept development is more effective…

- if there is time for thorough and substantive preassessment and pre-discussion, during which previously held interpretations and knowledge are brought out and understood (also: refutation texts is similar method)

- if perceptual information (“real-life”) and abstract, scientific information and explanations are constantly associated; if learning enables this cyclical process, relating perceptual to non-intuitive, which models that „there is so much more“ than our everyday experience. It is not enough when we support only everyday thinking, as well it is not enough when there is only scientific explanations – we need contantly both to build correct understanding of the world

- if there is constant interest to find out which are the the complex interrelated networks involved in representing conceptual knowledge (like executive functions), which informs us, e.g., that one of the crucial challenges in conceptual development is *to overcome interference and inhibit irrelevant information while activating the relevant information* (Mareshal, 2016)

Look also Houdé, O., Zago, L., Mellet, E., Moutier, S., Pineau, A., Mazoyer, B., & Tzourio-Mazoyer, N. (2000). Shifting from the perceptual brain to the logical brain: the neural impact of cognitive inhibition training. *Journal of Cognitive Neuroscience, 12,* 721–728
Mareschal, D. (2016). The neuroscience of conceptual learning in science and mathematics. *Current Opinion in Behavioral Sciences*, *10*, 114-118.

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How to make people eager to build and scaffold more effective synapses, is one of the most interesting questions ever asked; however, it is reasonable to *apply* as much all that, what we already *know,* and *ask* constantly new questions based on previous answers.

Knowledge is not wisdom, but it is a prerequisite for wisdom – and that's one thing the digital revolution hasn't changed.

William Poundstone

Thank you!

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