

Communicating Computer Science

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Motivation & Learning Theory

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2 Motivation & Learning Theory

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- 2.3 Theories of Learning

Goal for this unit

- ▶ Give you the **vocabulary** to talk about theories of learning.
- ▶ List some best practices for teaching.

2.1 A Warning

Pre-session activity

Not every theory that “appears plausible” is true

↪ Don't follow advice blindly!

In particular: Do **not separate** your class by learning styles.



↪ This example demonstrates the importance of empirical research in education.

▶ But there is a lot of truth in the original observation:

▶ We can represent the same material in different ways.

▶ *visual, auditory, read/write, and kinesthetic* are good categories for representations.

▶ Different representations of material do help.

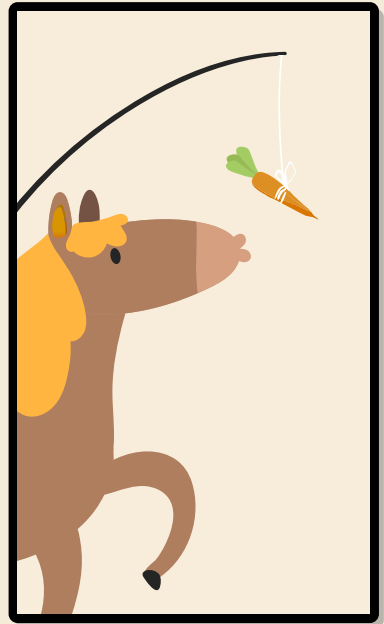
But you want to show them together. That helps everyone.

▶ ... and comparing VARK profiles still kinda fun 😊

2.2 Motivating Learners

Forms of motivation

- ▶ **extrinsic motivation** *“carrot and stick”*
 - ▶ marks/grades
 - ▶ rewards (Gold Stars, Dojo points, teacher’s awards, . . .)
 - ▶ punishment
 - ▶ fear/pressure
 - ▶ **intrinsic motivation**
 - ▶ interest in a task
 - ▶ task is enjoyable, fun
 - ▶ ambition to achieve a specific goal
 - ▶ curiosity
 - ▶ largely agreed:
intrinsic motivation is much stronger
extrinsic measures may do more harm than they help
- ~> *How can we foster intrinsic motivation?
Where does it come from?*



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Expectancy-Value Theory

Key factors for (intrinsic) motivation:

- 1. Subjective *value* of a goal**

“Do I care about this? Does it help me?”

- 2. Expectations for attainment of a goal**

“Am I likely to succeed? Do I have the skills?”

more details: https://www.queensu.ca/teachingandlearning/modules/students/15_motivation.html

Barriers for motivation can arise from both factors!

How can we make learning matter to students?

- ▶ Connect material to learners' environment
 - ▶ Solve a (small) real problem
 - ▶ Explain how something works that students use every day
 - ▶ Discuss the history of a topic
 - ▶ Show how something can serve society at large / a greater cause
- ▶ Use humor and stories
- ▶ Give students choices (over topics, learning paths, modes of learning)
- ▶ Embed creative tasks

It's hard! And it takes lots of creativity!

Social motivation

- ▶ Apart from learning material, **social context** plays important role
 - ▶ It can be motivating if there is a sense of belonging
 - ▶ Good group work can add to a tasks value
- ▶ But: classroom climate can also alienate if you feel as an *outsider*
 - ▶ underrepresented gender, culture, race, age, religion, sexual orientation
 - ▶ English as additional language
 - ▶ neurodiversity, learning impairments, disabilities



▶ Best practices

- ▶ Establish class social rules, classroom as safe zone
- ▶ Avoid stereotypes
- ▶ Use diverse personas in examples

Growth Mindset vs. Fixed Mindset

Growth Mindset

- ▶ “Mistakes are opportunities to grow.”
- ▶ “I am **not yet** there.”
- ▶ “This is hard; I’ll have to break it down / ask for a hint / keep trying.”
- ▶ “She seems ahead in maths, maybe we can offer her stretch tasks.”

Fixed Mindset

- ▶ “Mistakes show everyone how stupid I am.”
- ▶ “I cannot do this.”
- ▶ “I’m not good at math.”
(What’s the point of trying?)
- ▶ “She is a maths brain.”
(So no need to challenge her.)

Good news: No scientific evidence for fixed mental capabilities!

↪ fixed mindset is only within us!

↪ Ban it from your teaching.

2.3 Theories of Learning

Learning Theories

What does it mean to *learn* something?

Behaviorism / Instructionism

- ▶ Learning = measurable change in learner's behavior
 - ▶ Pavlov's dog (reinforcement learning)
 - ▶ repetition, drill exercises
- ▶ Teacher delivers material to learner
 - ▶ teacher has the key active role
 - ▶ teacher decides structure, content, activities
 - ▶ learning mostly seen as one-way street: from teacher to learner
- ▶ emphasis on summative assessment

Constructivism

- ▶ Learning = change in learner's mind, learning as a transformation
 - ▶ Piaget's observation of children
 - ▶ through experience, concepts form
 - ▶ exploratory/discovery tasks, play
- ▶ teacher = guide on learning journey
 - ▶ learner has key role; teacher only facilitates
 - ▶ teacher set environment, organizes learning opportunities
- ▶ emphasis on learner's experience

Piaget's counter experiment <https://www.youtube.com/watch?v=gnArvcWah6I>

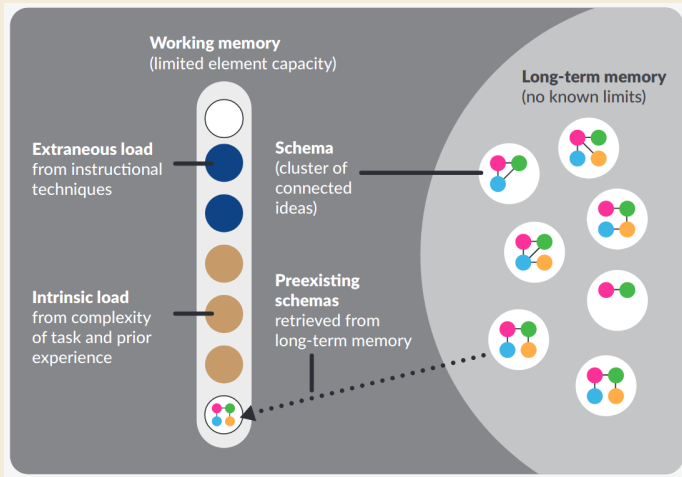
Constructivism-only fallacy

- ▶ It is tempting to condemn instructionism and to focus on open exploratory activities
 - ▶ works great for children already motivated to learn something
 - ▶ often overwhelms others!
“What do I have to do now?”

↪ Provide guidance & scaffolding

- ▶ use quizzes to trigger exploring a specific question
- ▶ de-brief: *“This is what could be observed here.”*

Cognitive load theory



- ▶ Working memory is **very limited**
 - ▶ ≈ 7 chunks
- ▶ But: each chunk can be **complex *schema*** if it is already internalized
- ~> need tasks of appropriate size/complexity
- ~> need to connect concepts to existing knowledge

<https://blog.teachcomputing.org/pedagogy-bytes-quick-reads-for-busy-educators/>

Bloom's Taxonomy

Streamlined version of Bloom's Taxonomy for CS
as used for ACM Curricula Recommendations

3 levels of **mastery**

▶ **Familiarity:**

The student understands what a concept is or what it means. This level of mastery concerns a basic awareness of a concept as opposed to expecting real facility with its application. It provides an answer to the question "What do you know about this?"

▶ **Usage:**

The student is able to use or apply a concept in a concrete way. Using a concept may include, for example, appropriately using a specific concept in a program, using a particular proof technique, or performing a particular analysis. It provides an answer to the question "What do you know how to do?"

▶ **Assessment:**

The student is able to consider a concept from multiple viewpoints and/or justify the selection of a particular approach to solve a problem. This level of mastery implies more than using a concept; it involves the ability to select an appropriate approach from understood alternatives. It provides an answer to the question "Why would you do that?"

↪ Use the taxonomy to balance assessments