the SCIENCE OF LEARNING

10 KEY PRACTICES
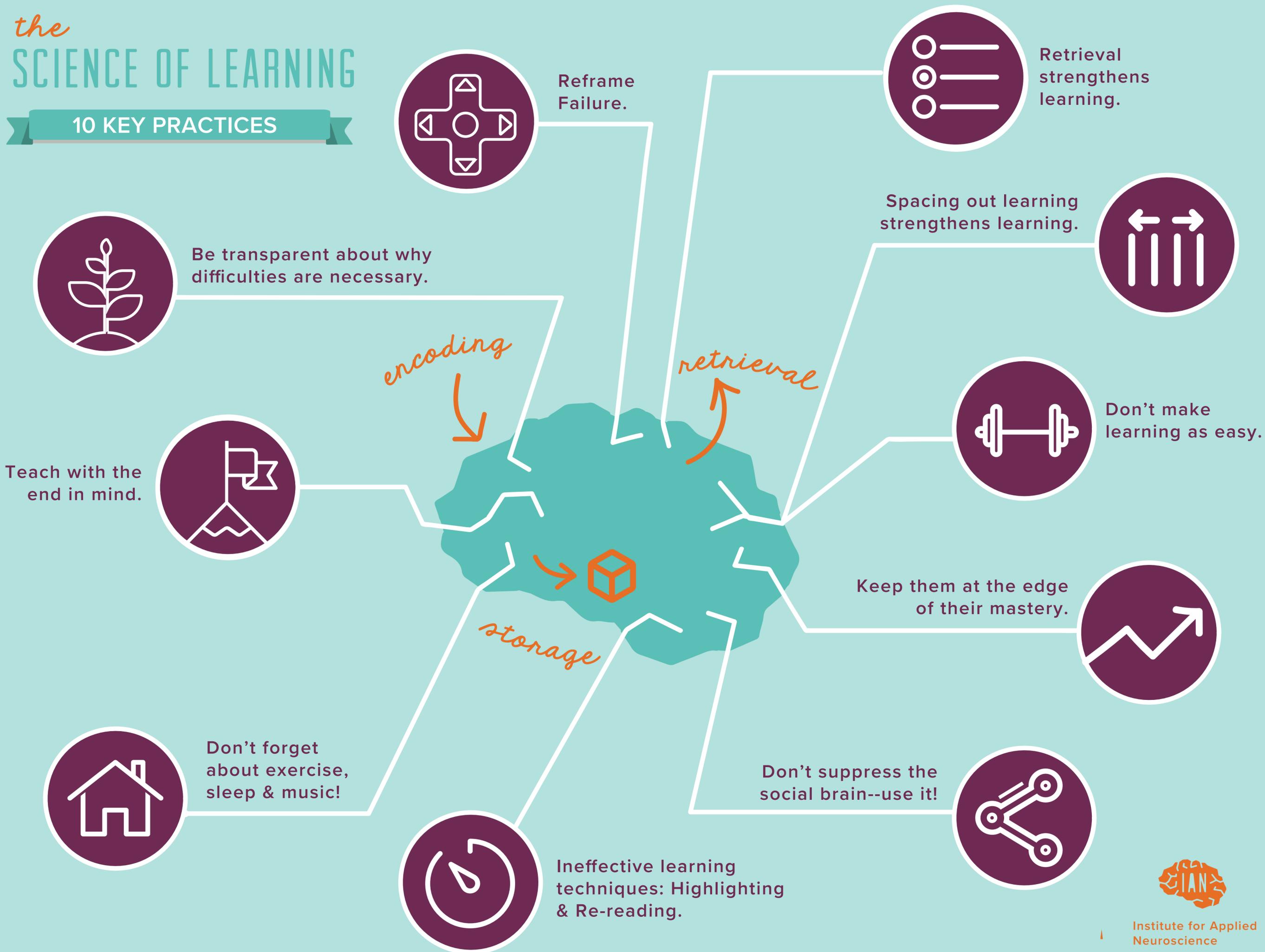
Reframe Failure.

Retrieval strengthens learning.

Be transparent about why difficulties are necessary.

Spacing out learning strengthens learning.

encoding

retrieval

Teach with the end in mind.

Don't make learning as easy.

storage

Keep them at the edge of their mastery.

Don't forget about exercise, sleep & music!

Don't suppress the social brain--use it!

Ineffective learning techniques: Highlighting & Re-reading.

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PRACTICAL APPLICATIONS OF SCIENCE OF LEARNING

Research findings are converging to identify many practices that inform an evidence-based understanding of how the brain learns and functions. **Use these as guiding principles to generate your own education innovations**. And don't forget to use your life as your lab! Test how well these work for you and your students.

1. **Don't make learning as easy! ('Desirable Difficulties')** *When learning is easy, it is soon forgotten. One of the best ways to foster long-lasting learning is to make it a little difficult for your students. It may seem frustrating at first, but it carves deep pathways in the brain for long-lasting learning.*

2. **Retrieval strengthens learning. ('Retrieval Practice')** *Anything that asks the student to practice remembering the information (like self-testing and low-stakes quizzing) actually changes the nature of the memory, strengthening the path to memory and enriching the memory itself. Both lead to stronger and more enduring learning.*

3. **Spacing out learning strengthens learning. ('Spaced Practice')** *The same amount of learning, spaced over time, can dramatically improve learning and retention. A relatively small shift in strategy that can lead to big learning gains.*

4. **Don't suppress the social brain--use it! ('Social Learning')** *Students are highly tuned to social dynamics, and the 'social brain' is a powerful learning asset. Teach content with social narratives in mind, and utilize the power of learning-to-teach (even if the students don't end up teaching the material, they will learn it better!).*

5. **Teach with the end in mind. ('Interleaved Learning')** *If you want your student to be able to flexibly access the learning in unpredictable environments, teach them to retrieve it in unpredictable environments! To do so, interleave different learning topics and practice retrieving in an interleaved way.*

6. **Reframe failure. ('Failure as Fodder')** *When students see failture as an opportunity to find out what they don't know in order to adjust their learning strategies (like they do in video games) rather than seeing failure as an indication of self-worth, they are more likely to perservere in the learning task.*

7. **Keep them at the edge of their mastery. ('Leveling-Up')** *A form of desirable difficulty, and consistent with principles of game design, the ability to find the edge of their mastery so they can surpass their current level of ability engages the brain deeply and builds strong memories.*

8. **Be transparent about why difficulties are necessary. ('Learning Mindset')** *Framing desirable difficulties as a way to grow your students' brains can promote 'growth mindset', and foster a healthy 'stress mindset'.*

9. **Don't forget about exercise, sleep, and music! ('Non-cognitive Support')** *Aerobic exercise can increase a growth factor ('BDNF') that improves the brain's plasticity for at least a short while, and increases hippocampal volume (a key part of the brain that allows us to learn new information). Sleep is critical for consolidating (solidifying) learning from the day (so put some sleep between learning and the test!). Musical training has been shown to increase attention abilities, reduce the impact of distraction, and increase verbal and nonverbal skills.*

10. **Ineffective learning techniques: Highlighting and Re-reading.** *While these are the most popular study techniques, they are very ineffective, fostering only short-term learning. Students get trapped in the myth of fluency, where they feel fluent with the information in the short term, but cannot access it later.*