

Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn.

Herbert Simon, a founder of the field of cognitive science, Nobel Laureate, and former professor at Carnegie Mellon University

7 Research-based Principles of Learning

What we know about learning and how to translate it to the classroom.

Students' prior knowledge can help or hinder learning.	
What you can do in the classroom	Examples
Gauge prior knowledge	<ul style="list-style-type: none"> • Administer low or no-stakes diagnostic to get a sense of student preparedness. • Have students brainstorm a topic in groups to uncover beliefs, assumptions, and associations (e.g., "What do you already know about ..." or "What comes to mind when you think of ...").
Activate accurate prior knowledge	<ul style="list-style-type: none"> • Explicitly link new material to prior content from the course ("Where have we seen this before?"). • Use analogies to connect course content with everyday knowledge.
Address insufficient prior knowledge	<ul style="list-style-type: none"> • Be sure to differentiate declarative (knowing what and why) from procedural (knowing how and when). Your students may know certain facts but may not know how to use them.
Correct inaccurate knowledge	<ul style="list-style-type: none"> • Have students make and test predictions. When evidence contradicts beliefs or expectations you can help them see source of error. • Provide checklist or set of rules to help students determine if prior knowledge is relevant to a given problem or question.

How students organize knowledge influences how they learn and apply what they know.	
What you can do in the classroom	Examples
Reveal and enhance knowledge organizations	<ul style="list-style-type: none"> • Show "big picture" organizational structure of course -- how key concepts of class inter-relate -- and refer to this structure explicitly over the semester. • Have students draw a concept map. This will illustrate not only their prior knowledge but how they are organizing it. • Have students complete a sorting task (e.g., sort different problems, concepts, or situations into categories). • Pay attention to the patterns of errors to see if a student is consistently mis-applying a formula or strategy. • Have students work with multiple organizational structures by asking them to categorize items in one schema and then another.

Students' motivation determines, directs, and sustains what they do to learn.

What you can do in the classroom	Examples
<p>Establish the value of class activities and goals for your students</p>	<ul style="list-style-type: none"> • Provide authentic, real world tasks so that students can see the usefulness of what they're learning. • Connect course content to student's interests. • Show your own passion and enthusiasm for the subject. (It can be contagious!) • Identify and reward what you value. If you value group interactions in a given project, identify what that looks like and include evaluation so it's integral in grade.
<p>Help students develop a positive expectancy (to believe they can achieve success)</p>	<ul style="list-style-type: none"> • Create assignments with the appropriate level of challenge. • Provide your students with early opportunities for success (e.g., shorter assignments that build to a larger project). • Provide rubrics that will explicitly represent your performance expectations. • Describe, model, and coach your students on effective study strategies. This gives them alternatives to those habitual study routines that result in poor performance. • Identify and applaud successful student behaviors.

To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned.

What you can do in the classroom	Examples
<p>Expose and reinforce component skills</p>	<ul style="list-style-type: none"> • Enlist the help of someone outside your discipline to decompose a complex task. This can help to reveal your blind spots. – those things you may have skipped over assuming that students will “just know.” • Diagnose weak or missing component skills and provide isolated practice for them. This will focus student energies on those parts of a task that most need additional attention.
<p>Build fluency and facilitate integration of skills</p>	<ul style="list-style-type: none"> • Assign exercises that are specifically designed to increase students' efficiency and automaticity. Be explicit about the level of fluency you expect students to achieve (e.g., “Practice these sorts of problems until you can complete one question in about 10 minutes.”).
<p>Facilitate transfer of skills</p>	<ul style="list-style-type: none"> • Discuss conditions of applicability (e.g., when an equation is relevant, in what situations a concept applies, when a technique can be used). • Help students connect what they've learned to other contexts. Be explicit when moving from one context to another; don't assume that students will just see how something translates.

Goal-directed practice coupled with targeted feedback enhances the quality of students' learning.	
What you can do in the classroom	Examples
Identify the skill to be developed and define the target level of performance	<ul style="list-style-type: none"> • Be explicit about what you want students to be able to do at the end of an assignment so that students can use your expectations to guide practice (i.e., use your learning objective to drive the purpose of the class!). • Give examples or models of target performance so students have an idea of what this skill looks like. You might even contrast those examples with what you do NOT want. • Use a rubric (scoring tool) that specifies performance criteria and share the rubric with your class. Students will be able to monitor their progress when they know what is poor versus satisfactory versus superior.
Provide opportunities for goal-directed practice	<ul style="list-style-type: none"> • Build in plenty of low-risk opportunities for practice so students can develop requisite skills over time. For example, if there's a significant oral presentation to be delivered at the end of the course, help students prepare with activities that develop component skills along the way. • Provide an appropriate level of challenge for students by scaffolding their practice. Give instructional supports early on and then gradually remove these supports as students develop greater mastery.
Provide targeted feedback	<ul style="list-style-type: none"> • Design frequent opportunities for feedback, and think carefully about what information you can provide that will be most helpful to the student. Focus your feedback on key aspects of the assignment so as not to overwhelm and to let students target their practice. • When you incorporate peer feedback, provide clear instructions to students on how to give feedback and what to note in order to make it meaningful. (And remember that giving feedback is also a skill that requires practice!) • Require that students specify how they incorporated feedback into subsequent work. This helps students make connections between different assignments and aspects of the course.

Students' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning.	
What you can do in the classroom	Examples
Create a productive learning climate and support student development	<ul style="list-style-type: none"> • Make uncertainty safe and resist the temptation for a single right answer by validating different viewpoints, avoiding over-simplification, and reinforcing that a key purpose of discussion is not consensus but to enrich thinking. • Facilitate active listening by having students paraphrase what someone else said, and checking-in about interpretations. • Establish and reinforce ground rules for interaction to create an inclusive and respectful environment. You might even include students in the development of rules or standards of behavior for your classroom. • Don't ask an individual to be a spokesperson for a group (e.g., race, generation, nationality).

To become self-directed learners, students must learn to monitor and adjust their approaches to learning.

What you can do in the classroom	Examples
<p>Help students assess the task at hand and evaluate their own strengths & weaknesses, plan an approach, apply strategies and monitor their performance</p>	<ul style="list-style-type: none"> • Be more explicit about task definition than you may think necessary. Be clear about course goals and why they are important, what students need to do to meet the objectives of an assignment, etc. Share samples of work (anonymously, from a previous semester) and highlight strong and weak features, or do's and don'ts. • “Think out loud” and describe how you would approach a problem or task. Model your own metacognitive processes to demonstrate that even experts reassess and adapt their thinking. • Provide simple heuristics for students to assess their own work, identify errors, and self-correct. For example, “Is this a reasonable answer?” or “What assumptions am I making here?” • Have students analyze work of their classmates and provide feedback. This not only yields helpful ideas from others, it helps students monitor and evaluate their own work more effectively.
<p>Attend to student beliefs about intelligence and learning</p>	<ul style="list-style-type: none"> • Disabuse students of unproductive beliefs (e.g., “I can’t do math .”) by highlighting the positive effects of practice, effort, and adaptation. • Show how different types of knowledge are needed for different types of tasks. For example, distinguish procedural knowledge (HOW to do something) from conceptual knowledge (WHY is that important? What does it mean?). Or walk students through the levels of Bloom’s taxonomy and note the difference between being able to recall a fact, discuss a concept, solve a problem, etc. • Help students set realistic expectations for their learning. When students have a truer sense of just how much time and effort is required, they’ll be more likely to persevere when they encounter challenge or frustration.

*Adapted from **How Learning Works: Seven Research-Based Principles for Smart Teaching** (2010, Ambrose et al.)*