The Learning Experience Framework.

Contents.

Introduction.

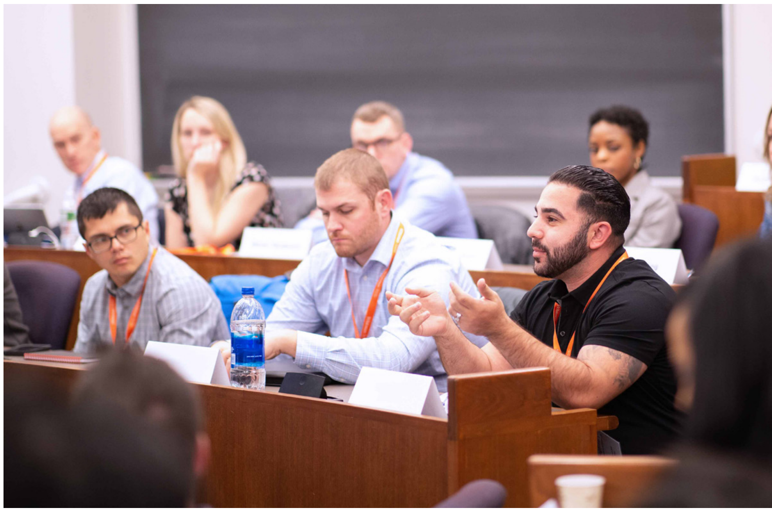
Learning has the power to dramatically improve lives. People seek out education to acquire knowledge and skills that will further their careers and create a better quality of life for themselves and their families. Today, lifelong learning is critical. Longer life spans, coupled with the rapid pace of technology-driven disruption in the workforce, create a greater and more consistent need—across many disciplines and fields of practice—for ongoing learning. For many, it has become essential to continually pursue learning opportunities in order to keep pace with this rapid evolution.

These students come to you, our partners, entrusting you with their learning. As educators, you strive to provide them with learning experiences that will deliver the life-changing outcomes they seek. At 2U, we are privileged to support you in that effort, helping you to deliver your courses and curricula most effectively in our digitally enabled environment. It is our mission to help you make the best use of our delivery model and technology in order to create learning experiences that not only facilitate mastery of knowledge and skills but also foster personal practices and mindsets that support lifelong learning.

To help you create an effective and engaging learning experience within our environment, we start with a “backward” approach to learning design. We begin this consultative process with a focus on the learning outcomes that will enable students to succeed in their chosen field. From there, we offer guidance on designing and developing assessments and digital learning experiences that align with those outcomes. The entire course design and development process is informed by our Learning Experience Framework (LXF)—a collection of research-based principles about how people learn specifically tailored to creating effective and meaningful learning experiences within the 2U environment.

Our approach encourages active, social learning that takes into consideration both the emotional and cognitive processes of learning. It promotes making teaching and learning strategies explicit to the student in order to help them learn how to learn. By design, the framework is not an exhaustive overview of research in learning science. These principles have been selected and curated for their relevance to teaching and learning in the 2U environment, and they can be used in different applications across asynchronous and synchronous digital and in-person learning. They span learner motivation, mindsets, and self-awareness; designing effective practice activities and assessments; the effective delivery of instructional content; incorporating feedback and reflection; and the value of social learning.

Our intent is to use the LXF as a shared reference and language to guide our work together, not as an enforced worldview. In our experience, the principles harmonize with a wide range of preferred pedagogical models—such as problem-based learning and Universal Design for Learning—some of which you may already be using in your teaching. We look forward to learning about your unique perspective, and incorporating it into our work together. Our goal is to draw on these principles to help you design and build digital learning experiences that honor your institution’s tradition of excellence as well as your expertise in understanding students’ needs. Together we will deliver the quality of education your students trust you to provide, which is nothing short of life changing.



Learning@2U.

How people learn.

"Learning is a change in knowledge attributable to experience" (Mayer, 2011, p. 14). That "change in knowledge" is the result of cognitive processing within the learner's brain, catalyzed by learning experiences like those we provide students in our courses and curricula. But learning is not just a **cognitive** process. It is an **emotional** one as well. Learners with the right attitude and positive feelings are more engaged in their learning experiences and, as a result, are more likely to be successful in their learning.

From a cognitive perspective, learning happens when the brain processes information to encode it as knowledge, helping the learner retrieve it later as needed. Very simply, the brain receives sensory information from its surroundings, which is then processed in **working memory**. With the right kind of processing, the brain stores that information as new knowledge in **long-term memory**. This cognitive processing is critical, whether learning occurs within the brick-and-mortar classroom or 2U's digital one.

There are three types of processing that occur as the brain moves information from working to long-term memory: **selecting**, **organizing**, and **integrating**. The brain selects what information is important and decides how to make sense of it. It creates mental models—or internal representations of how things work—to help organize the information (Baume & Baume, 2008). And the brain makes connections to what it already knows in order to integrate and store the new knowledge in long-term memory.

The working memory—where this processing occurs—has limited capacity and is subject to cognitive overload. There are three types of **cognitive load**, which we can manage in order to avoid **overload**:

- **Intrinsic load** refers to the base cognitive processing required for a particular learning event (any action a learner takes in order to learn). All learning events generate some intrinsic load. It can be managed but not eliminated. Some learning events, by their very nature, are more complex than others and generate greater intrinsic load.
- **Extraneous load** refers to cognitive processing that is unnecessary for a particular learning event. It is generated by ineffective teaching methods and can be reduced with effective design.
- **Germane load** refers to the deep and productive cognitive processing required to organize and store knowledge in long-term memory. It can and should be promoted by effective design.

A good learning experience needs to foster and guide the right kinds of cognitive processing. It needs to help facilitate the processes of selecting, organizing, and integrating. To manage intrinsic load, minimize the extraneous and make room for germane processing. But, more than that, the learning experience also needs to be motivating and supportive, because learners' emotions can have a significant impact on how they learn. Positive attitudes and feelings get students to show up and put in effort. They keep students engaged with the experiences we've designed together and the cognitive processing that is necessary for learning.

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> Learning is a change in knowledge attributable to experience.

Designing for effective learning.

The best learning experiences are designed to deliver learning that is applied, long-lasting, and transferable. They build the learner's confidence and provide knowledge and skills that can be used by the learner on the job in their future career. This "robust learning" lasts longer, can be used in a range of contexts, and lays the foundation for future learning (Koedinger, Aleven, Roll & Baker, 2009). We established the Learning Experience Framework to codify our approach to designing effective learning experiences that deliver the best possible learning in our environment.

At its heart, our approach is built around the science-supported ideas that students learn best when they are "learning by **doing**" and "**thinking** about what they are doing" (Bonwell & Eison, 1991), and that what students are **feeling** is also critically important. Learning is fostered by reinforcing loops of action and reflection. But without the right kinds of action and reflection, learning is slow or unsuccessful. As such, our courses should provide opportunities for "designed action and guided reflection" (Laurillard, 1993). We should help students engage in the types of doing and thinking that foster productive cognitive processing, manage cognitive load, and maintain the motivation and positive feelings that will keep students engaged with the process of learning. Our framework contains 16 principles, all grounded in the science of learning, that help us do exactly that. They are organized around the three factors we must consider when designing effective learning experiences—three essential elements in the process of successful learning:

Feel.

How a learner feels impacts their engagement with the learning process.

Do.

What a learner does and how they do it impacts the quality of learning.

Think.

How a student thinks about their learning impacts their ability to grow and improve.

Feel.

Students learn best when they are motivated and have the right attitude toward learning.

Positive feelings and mindsets drive engagement, effort, and perseverance, which are critical to success. The research on learner motivation is vast, but the consensus is that people learn better when motivated more by internal reasons than external consequences. That's why our first principle focuses on intrinsic motivation, which drives increased effort and fosters the persistence required to complete prescribed coursework.

You will find that many of the principles throughout this framework, when applied correctly, work to elicit and sustain intrinsic motivation in a reinforcing cycle. For example, students—particularly adult learners—who take control of their own learning process and are self-regulated (Principle 2) tend to be more intrinsically motivated. This self-regulation can lay the foundation for a practice of lifelong learning, which is why it is critical to help adult learners learn how to learn and manage their own cognitive and learning processes. It can also help students build a desire to learn for the sake of learning (as opposed to learning simply for the sake of passing a class) and a belief that they are competent and capable of learning, both positive attitudes that can lead to greater success.

Principles in this category include:

- Intrinsic motivation
- Self-regulated learning
- Learning goals and mindsets

Do.

Students learn best when they learn by doing.

Research broadly supports the concept that active learning that fosters the right kind of cognitive processing leads to better outcomes, which is why applied practice and "doing" plays a central role in our approach (Bonwell & Eison, 1991; Clark & Mayer, 2008). However, in order to **do** something, one must **know** how to do it. And so, the principles in this category also apply to designing instructional content that most effectively delivers the knowledge students need in order to master the skills of their discipline.

In our approach, instructional content supports the active learning we aim to foster. This supportive role does not diminish its importance—on the contrary, research tells us that foundational knowledge is critical to helping people learn better. Drawing on existing knowledge makes acquiring new knowledge easier and faster. It facilitates more complex and sophisticated cognitive processing. The more a learner knows, the more a learner can learn (Willingham, 2006).

Understanding the roles of both activity and content, we strive to place primary emphasis on the effective practice opportunities in a course and use instructional content strategically to support them. The principles in this category inform both what the students should do and learn—the substance of practice and content—and how they should do and learn it—the structure.

Principles in this category include:

- Instructional alignment
- Cognitive load
- Challenge and complexity
- Prior knowledge
- Modality
- Practice in context
- Desirable difficulties
- Deliberate practice
- Stories and examples
- Expert thinking

Think.

Students learn best when they think about what they are doing.

With active learning, it is not enough to simply **know** and **do**—one must also **think**. Feedback is key to growing and improving throughout the process of learning, and can be provided by the instructor, peers, or even the learner themselves in the form of reflection.

Feedback provides input to the learning process that helps students understand what they know—or know how to do—and evaluate their progress in learning. It helps learners organize and integrate new knowledge and refine and develop their mental models. Feedback is inherent to social learning, which provides meaningful opportunities to be exposed to other perspectives that help deepen and enrich individual learning. It prompts students to think about what they are doing and how they are learning.

When we find ways to make that thinking visible, we enable opportunities for examination, correction, and reflection in ways that further benefit the learner (Collins, Brown & Holum, 1991). This thinking about thinking and reflection on the learning process—referred to as **metacognition**—is part of the cognitive processing that helps learners learn better. It helps to refine our mental models as we integrate them into long-term memory. It is essential to adults becoming self-regulated learners and developing the skills required for lifelong learning, and so we begin to see how thinking can not only inform what the learner is doing but also impact how they are feeling.

Principles in this category include:

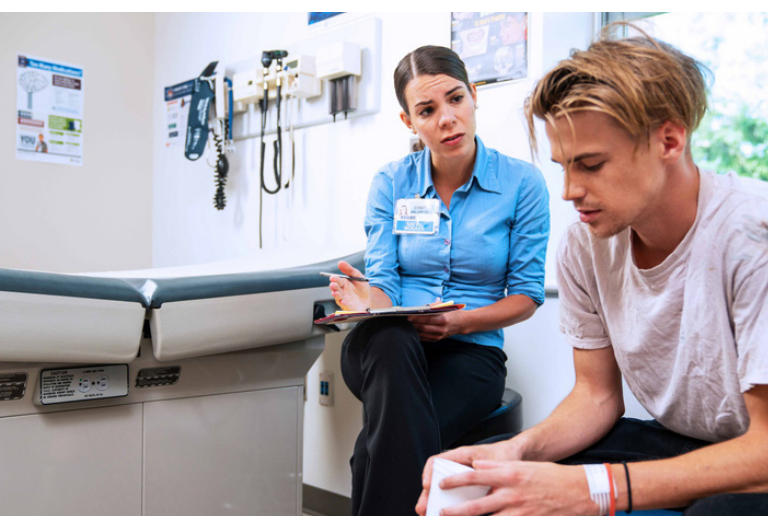
- Formative feedback
- Social learning
- Metacognition

Delivering effective digital learning.

The 2U model is designed to deliver powerful digitally enabled learning at scale. It combines synchronous digital classes with asynchronous digital coursework and strategically placed in-person experiences in order to provide students with learning that will change their lives. Our unique ecosystem offers diverse modalities that are well suited to exactly the kinds of feeling, doing, and thinking that help students learn best.

Synchronous live sessions.

Synchronous live sessions are a cornerstone of the 2U approach to delivering digital degree programs and certificates. They provide an incredibly effective venue for regular social interaction, real-time feedback, and deepening individual learning. In live sessions, students have the opportunity to build community with their peers and receive valuable support from their instructor—factors that can be critical to increasing motivation and positive feelings in learners. They can discuss important concepts and clarify misconceptions to refine and develop their mental models or work through problems in groups and practice in pairs to develop key skills—all while getting beneficial input on their progress and performance in the form of informal or formal feedback from peers and the instructor.



Asynchronous coursework.

Many of the learning experiences we offer across the Career Curriculum Continuum contain some asynchronous coursework, which can provide effective opportunities for delivering content, engaging students in practice, and even encouraging social interaction. Our asynchronous coursework is delivered via 2U's state-of-the-art learning technology, which is purpose-built to foster positive feelings about the learning experience by providing easy navigation and offering the learner choices in how they choose to consume their coursework, including options for mobile learning. It can host a wide range of practice and reflection activities that students can complete (and repeat) at their own convenience, including discussion forums and other tools to promote social interaction. Our video production teams help partners create studio-quality instructional content for asynchronous coursework that is both effective and engaging.

In-person experiences.

Some of the skills our partners want their students to learn require in-person, hands-on learning. Nurses, social workers, and physical therapists, for example, must interact with patients and clients. That's why some 2U-powered learning experiences include in-person components like on-campus immersions or on-site fieldwork placements. These learning experiences help students understand what it is really like to be a professional in the field and see how their learning is relevant—an important factor in sustaining motivation. Fieldwork placements provide students with on-the-job practice opportunities and valuable feedback that bring to life everything they've learned in the digital space. And immersions can provide an opportunity for valuable skills practice and assessment, in addition to meaningful community building, that help students stay motivated and engaged throughout their degree program.

Summary.

At 2U, our approach to designing and delivering digital education combines our unique delivery model with the science of how people learn to provide students with powerfully effective and transformative learning experiences. The principles in our Learning Experience Framework are the foundational building blocks that make this possible. Each has been identified from research as a principle that is relevant to teaching and learning in the 2U environment. Our intention is neither to provide a comprehensive overview of all research nor to limit creativity and alternate perspectives in our work with partners. It is simply to provide a shared language to use in our work together—and a lens through which to critically evaluate quality.

While discrete, the principles are naturally interconnected, and using them together strengthens their impact on fostering effective learning. Although they are presented here in a specific order, it is important to understand that learning is messy and overlapping and, in many experiences, the student's processes of feeling, doing, and thinking happen simultaneously. Although the LXF provides you with a wealth of detail on 2U's unique approach, rest assured that the 2Utes who help you design, develop, and deliver your course, and those who help support your instructors and students, are here to help apply the principles effectively in practice. We thank you for your partnership and look forward to working with you to deliver transformative digital learning experiences.

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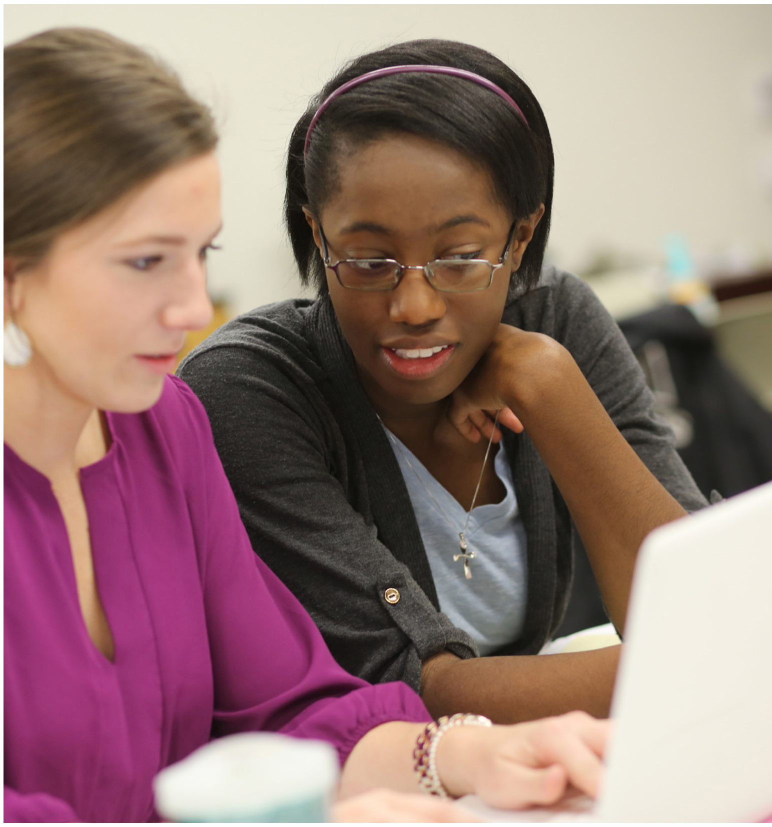
At 2U, our approach to designing and delivering digital education combines our unique delivery model with the science of how people learn.



The Framework.

Feel.

Students learn best when they are motivated and have the right attitude toward learning. The principles in this category touch on the inner world of the learner and refer to the fact that emotions play an important role in helping learners achieve success. They are highly interconnected both within the category and with the rest of the principles. Motivation and positive feelings drive the learner to engage with the doing and thinking fostered by the rest of the LXF principles and are often mutually reinforced by them as well.

1 Intrinsic motivation.

Students learn better when they are driven more by internal reasons than external rewards or consequences. This intrinsic motivation leads to increased engagement with the learning process, which, in turn, reinforces motivation.

Thomas Malone and Mark Lepper (1987) “define an activity as being intrinsically motivating if people engage in it for its own sake, rather than in order to receive some external reward or avoid some external punishment” (p. 229). Intrinsically motivated students might choose to learn because they are interested in a particular topic or passionate about a field of work. Extrinsically motivated students may be choosing to learn only to get a passing grade and avoid failing, for example. These students are much less likely to engage deeply and willingly with coursework than those who are driven by internal motivations.

As we all know, one problem is that students must occasionally learn things that they don’t immediately find inherently interesting. For example, a speech therapist in training might be passionate about helping people and interested in the subject matter of certain courses but not care for, say, the foundational course she has to take on neuroanatomy. How can we help her stay engaged?

Motivation is more complex than a pure dichotomy between extrinsic and intrinsic. There is a spectrum of motivation between the two points. Students can internalize external factors to varying degrees, and we can design learning experiences that help them do just that. The more students integrate reasons for learning with their own personal beliefs and values, the more likely they are to engage with the process of learning (Ryan & Deci, 2000). Particularly for adult learners, understanding the immediate relevance of coursework, or the value of coursework to one’s future career, can be a powerful motivating factor (Knowles, Holton & Swanson, 2012; Keller, 2010).

Returning to our example of the speech therapy student, helping her understand how knowledge of the brain’s anatomy will enable her to diagnose and treat patients can help her internalize the importance of learning the material and keep her engaged with her neuroanatomy coursework. We might accomplish this, for example, by including in asynchronous coursework a recorded interview with a practicing speech therapist explaining how he uses neuroanatomy in his work, or by asking her to role-play a client-clinician interaction with a peer in the live session in which she must explain to the client their diagnosis, referring to concepts of neuroanatomy.

Self-determination theory is "one of the most comprehensive and empirically supported theories of motivation available today" (Pintrich & Schunk, 2002, p. 257). It provides additional insight into how to elicit and sustain intrinsic motivation, and recent research has suggested that it is a helpful construct for examining motivation in online environments (Chen & Jang, 2010; Hartnett, 2010). Self-determination theory tells us that students are intrinsically motivated when they feel **competence, relatedness, and autonomy** (Ryan & Deci, 2000).

Competence refers to how capable people feel of mastery in some domain. Students are motivated by tasks that are challenging and help build their competence. Seymour Papert describes this motivating challenge as "hard fun" (Papert, 2002). But the tasks need to be something that they are capable of completing—even if completion takes some support. Feedback—which can be provided via automatically or manually graded questions in asynchronous coursework or in real-time face-to-face interactions digitally or in-person—is critical to feelings of competence. Students need evidence that they are succeeding and guidance on what they need to do in order to succeed.

Relatedness refers to how much people feel supported by and connected to others. This might include having a supportive instructor or being able to successfully complete work within a group of peers. In an online learning environment, where isolation is a common concern, community is of particular importance. While community and relatedness can be fostered with carefully designed asynchronous coursework, live sessions are a clear asset in this regard (Rovai & Jordan, 2004).

Autonomy refers to how much choice and control the student has. Tasks that allow students to choose what they want to do, how they want to do it, or what topic they might want to use as a basis for practicing a skill can all make students feel more autonomous. Feelings of autonomy can also be fostered with choices supported by the learning technology. For example, students are given control when they are allowed to choose to complete coursework on mobile devices, or to turn on captions when watching videos.

Applications in learning design.

- Make explicit why knowledge and skills are valuable in the field and necessary for success as a professional. Understanding the relevance of learning helps students integrate reasons for learning with their own personal beliefs and values.
- Design practice to reflect contexts and choices that are realistic to the students' future professions. Authentic practice helps make explicit the reasons for pursuing specific competencies.
- Use stories, examples, humor, and intrigue that generate curiosity and interest in the material.
- Design assignments that let students choose a topic, allowing them to dig in on something that they find personally interesting.
- Design practice that is challenging but achievable. Provide coaching on how to meet the challenge, and prepare students to expect and embrace mistakes as part of the learning process.
- Incorporate opportunities for feedback to provide students with evidence of success and input on how to improve. Feedback builds feelings of competence, confidence, and satisfaction.
- Consider group work as a means of building a sense of community among students.

2 Self-regulated learning.

Students learn better when they take responsibility for their own learning. This self-regulation can include behaviors like taking ownership of tasks, timing, and methods, or tracking and self-assessing progress (Zimmerman, 2002). Intrinsic motivation and self-regulation are correlated. Each begets the other, but it is unclear exactly which one causes which.

Planning is a critical part of self-regulated learning (Zumbrunn, Tadlock & Roberts, 2011). An instructor or learning management system might support self-regulation by sending due date reminders or storing grades, but decisions on how to act on this information must be made by the student (Ambrose, Bridges, DiPietro, Lovett & Norman, 2010). For example, an instructor might remind the class that the midterm paper is due in two weeks, but a self-regulated learner would then decide on an appropriate schedule to pick a topic, create an outline, write a draft, revise, and finalize.

Metacognition—an awareness of one's own learning and thinking processes—can enable this kind of self-regulated learning (Bjork, Dunlosky & Kornell, 2013). We can incorporate metacognitive activities throughout the design of the learning experience to promote this self-awareness. For example, we might assign journaling as a quick homework task at the end of a unit's activities for students to reflect on what went well and what they might do differently next time. This awareness should extend to emotional aspects of learning as well. For example, teaching students strategies for addressing boredom, reducing exam anxiety, and finding satisfaction in completing work can help learners to regulate their own emotional responses (Eynde, De Corte & Verschaffel, 2007). Building in opportunities to discuss those emotions in a safe space—whether in private responses to asynchronous questions or in live sessions where clear norms have been set—supports this emotional self-regulation.

Helping students understand why particular activities help them learn is a powerful way to promote self-regulated learning. Often, the design of a learning experience is not clear to students, and they are unaware of how a particular teaching tactic helps them learn. More than that, they may have an assumption about how best to learn that is, in fact, incorrect. For example, a student may think they know concepts well having reread a textbook chapter several times but not realize that this learning strategy can give a false sense of fluency and is less effective than self-testing. Given this popular misconception, knowledge-heavy courses might deliberately include an ungraded question set in each unit for students to complete asynchronously, with introductory language that explains how testing is a more effective study habit than reviewing notes alone. By explaining teaching and learning principles, students are made more aware of their own learning process, which they can then evaluate and regulate. This awareness can encourage students to make better choices while studying, which can improve learning.

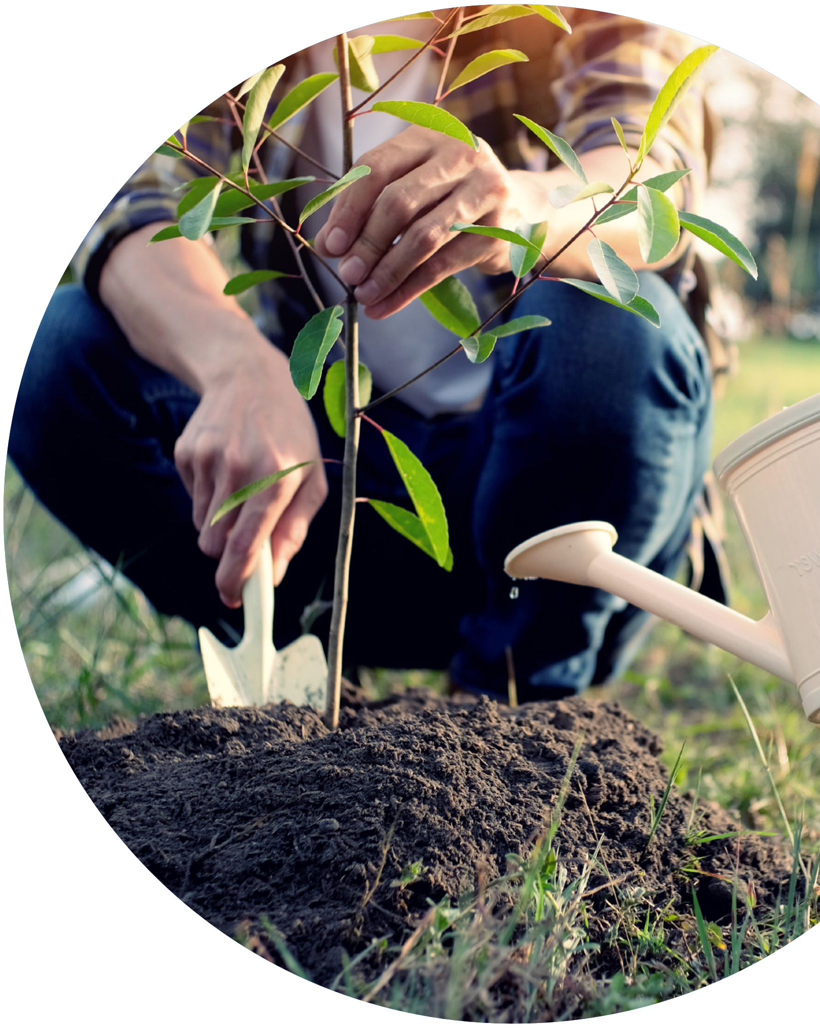
Applications in learning design.

- Design activities that ask students to track and reflect on their own learning process.
- Build in opportunities to discuss the emotional aspects of learning, and share strategies to help learners regulate their emotional responses.
- Use a variety of teaching and learning tactics to help students discern which they prefer.
- Be explicit about the benefit of challenging tasks, and explain why a certain teaching or learning tactic is being used. In particular, when learning activities are hard, point out how working through the challenge will benefit the student.
- Provide timely and specific feedback with rationale to help students develop the ability to self-assess.

3 Learning goals and mindsets.

Students learn more when they are focused on mastery rather than performance and when they believe that they are capable of learning and growth. These good attitudes toward learning help students be more intrinsically motivated and engaged.

Students learn more effectively when they have goals for learning that focus on mastery rather than simply performing well on an assessment. Mastery learning goals focus a student on becoming better at a skill, or acquiring more knowledge in a subject. In contrast, performance goals focus a student on performing well based on some standard (Ames, 1992). For example, if a student's idea of success is based on getting an A in a class, or ending up in the 90th percentile, then they have a performance goal. A student whose idea for success is based on actually learning the material has a mastery goal.



Although the findings on the effects of performance goals are mixed (Locke & Latham, 2002), early work on performance goals suggested that they can have deleterious effects. For example, performance goals have been linked to lower intrinsic motivation, lower concentration, less persistence on a task after failure, less focus on learning for the sake of reaching the goal, and less of a belief in the importance of putting effort into learning tasks (Dweck & Leggett, 1988). Teachers can help students focus on mastery by deemphasizing the significance of grades and by allowing students to measure their own skill progression against their own competency development instead of comparing students to each other. Teachers can also establish a focus on mastery by assigning work that is "low stakes" and doesn't count toward a grade but does provide feedback on how well students are understanding the material.

Similarly, work by Carol Dweck (2008) on mindsets shows that the ways in which students think about learning can affect their ability to learn. There are two types of mindsets: growth and fixed. Growth mindset is the belief that abilities and intelligence can be developed with time and effort. This is in contrast to a fixed mindset, which is the belief that intellect and ability are determined by innate ability. When people believe that they are capable of becoming more competent through effort, they may be more likely to effectively manage their learning process and become more self-regulated learners. One study of attrition in online students found that successful learners were more likely to have a growth mindset than those who dropped out (Kizilcec & Halawa, 2015).

Instructors can instill a growth mindset in their students by recognizing the targeted engagement and effort students put into their work in order to achieve improvement rather than focusing simply on how well students perform on assessments. Additionally, faculty may encourage struggling students by explaining to them that the challenges they are facing are not unique to them—even experts struggle with challenging subject matter, and they only get better by working through that challenging material.

Although students with mastery goals tend to have a growth mindset, this is not always true. For example, a student might believe that if they try harder on an assignment, they will learn more (growth mindset), but they also might aim to get an A on the assignment because they want to perform well in the course rather than actually learn more (performance goal). For this reason, it is important that instructors focus on building both good goals and good mindsets in their students. When students with a growth mindset are given mastery goals, they tend to be more intrinsically motivated (Elliot & Harackiewicz, 1994).

Applications in learning design.

- Provide "low stakes" assessments as homework or asynchronous coursework in which students have opportunities to get feedback and fail without having to worry about it hurting their grade.
- Emphasize student effort instead of how correct students are. Ingrain in students that failing is a natural part of learning and that putting more effort into learning will help them push past that failure.
- Focus learning objectives on student mastery of the material rather than on student performance. Display them explicitly in your syllabus and asynchronous coursework.
- Provide opportunities to help students track their improvements over time rather than just their overall knowledge of the material at the end of the course.
- Give students the chance to retry assignments and assessments so that they can develop mastery over time.
- To promote growth mindsets, expose students to examples of success narratives in the field via asynchronous interviews, documentary-style videos, or written case studies, focusing on the pathway followed and effort expended to succeed.

Do.

Students learn best when they learn by doing. Applied practice is critically important to making sure that learning is usable and not inert. But in order to do, students must also know. The principles in this category inform the design of the active, applied practice that should be central to all learning experiences, and the instructional content that must support it. They include principles that inform what the student should learn and how the student should learn it.

4 Instructional alignment.

Students learn better when instructional strategies and assessments are aligned to clear learning objectives. The harmony of these three course components provides consistency and clarity of purpose for all pieces of the learning experience and helps the student understand what they should be learning and why.

Learning objectives.

Learning objectives describe the knowledge students should gain, or skills they should have mastered at the end of a course. Objectives serve as targets, guiding the learner toward what to aim for by the end of the course, and perspective for tracking their progress along the way. In doing so, objectives also provide us with a way to evaluate the effectiveness of our course designs and determine whether the learning experiences we've created are serving their intended purpose.

To enable this, learning objectives need to be measurable. They must clearly identify the specific skill or behavior as well as the criteria used to measure success or failure. And they should be student centered—constructed as statements of "what the learner will be able to perform as a result of some learning experience" (Mager, 1997). Finally, learning objectives ideally describe applicable skills, knowledge, or behavior as they might be used in a professional setting rather than simply stating a contextless task. For example, saying "students will be able to explain neuroanatomical structures and their functions to a client" is preferable to "students will be able to define neuroanatomical structures and their functions." Framing objectives as such exposes the relevance and value of learning to students, increasing internalized motivation (Merriam, 2018).

Assessments.

Assessments are tasks designed to determine students' achievement, or mastery, of a learning objective. They can be graded or ungraded, formative or summative. Most importantly, they provide opportunities for the learner to receive and incorporate feedback in order to advance and improve, and information for the instructor on student success that can help direct their teaching.

A student's intrinsic motivation increases when assessed on specific rather than "normative" criteria (Meece, Anderman & Anderman, 2006), where normative refers to assessing students in relation to other students in a generalized way. When students are not graded on a curve or in comparison to other students but purely on their own ability to meet a defined objective, they have a clearer understanding of what they need to be able to do (Nilson, 2015). This understanding provides students with a framework for internalizing feedback, increases their ability to self-regulate their learning, and makes preparing for summative assessments such as exams or final projects more objective and clear. Appropriate and clear assessment criteria that are clearly aligned with specific learning objectives can help students develop a growth mindset and master learning goals. Linda Nilson (2016) explains how criteria specifications ("specs") should be used:

> *The specs may be as simple as "completeness": for instance, all the questions are answered, all the problems attempted in good faith or all the directions followed (that is, the work satisfies the assignment), plus the work meets a required length. Or the specs may be more complex: for instance, the work fulfills the criteria you set out for a good literature review, research proposal, or substantial reflection.*

Complex assessments—such as a culminating essay or group project—that require students to demonstrate and combine multiple skills or knowledge areas need clear and detailed specifications and instructions. Without them, students can easily be surprised or confused when they receive a poor grade or feedback. A well-designed grading or evaluation rubric can promote greater consistency in class responses and set clear expectations on evaluation criteria and fairness.

For the same reasons that we aim to frame learning objectives as what students can do in their future careers, assessments should ideally be authentic—or as realistic as possible to the tasks and activities that students will be expected to perform once they are professionals practicing in the field (Wiggins, 1990).

Instructional strategies.

Instructional strategies are the teaching and learning activities in a course—whether readings, lectures, practice opportunities, or anything else—that are aimed at catalyzing the learning we hope to see in students. These are the "rungs of the ladder" that propel students toward completing their assessments and, by association, achieving the required learning objectives.

Alignment.

Alignment is achieved when a course's learning objectives are clear and explicit, the assessments accurately and effectively measure those objectives, and the instructional strategies help students gain the knowledge and skills they need in order to be successful on those assessments, thus achieving the stated objectives. There are many ways that assessments and strategies can be misaligned to objectives, for example when students are asked to complete readings or watch lectures covering material that will not impact their success on any assessment, or when assessments are incongruous with the practice activities of the course. Assessment is a valid reflection of the learning objective only if it is based on the instructional activities and is specific to the required knowledge and skills covered in the course.

It is important to note that this principle does not recommend "teaching to the test"—or simply giving students what they need to know and do to be successful on a particular test or assignment. That approach does not enable students to use knowledge effectively outside of the course. Instead, alignment is about ensuring that assessments measure what is actually expected of students and instruction teaches what students actually need to know, all of which is accurately and concisely stated in the learning objectives of the course. If what is being taught and what is being assessed are ever misaligned, then the course is either failing to measure what students have learned or students are not being effectively taught the things they are expected to know.

In 2U's learning design methodology, which is influenced by the backward design model of Understanding by Design, we generally start by identifying learning objectives, then we seek to establish assessments, and finally generate instructional strategies (Wiggins & McTighe, 2005). That said, we also accept that the alignment of these three things does not necessarily need to develop in such a strictly linear fashion. Learning objectives can be refined following an exploration of teaching tactics or assessments, for example. There are many possible entry points to the conversation, and alignment can be developed and refined in a dynamic and iterative process.

Applications in learning design.

- Establish clear, student-focused learning objectives that are driven by what the student will be able to do as a result of the learning experience.
- Focus learning objectives and assessments on the tasks and skills that will be expected of learners in their future careers.
- Design assessments that are accurate measures of what the student can do, as described in the learning objective.
- Provide rubrics and detailed instructions with clear expectations to help students understand the knowledge and skills they must acquire and demonstrate to meet a specific learning objective and succeed in a given assessment.
- Avoid grading students on a curve or in competition with other students.
- Assessment rubrics and descriptions should focus students on the knowledge or skills they are supposed to be practicing and presenting. Minimize extraneous cognitive load by minimizing the criteria that are not related to the knowledge and skills being learned.
- Design experiences that help students learn what they need to be able to do, as described in the learning objective, and give them opportunities to practice doing it.

5 Cognitive load.

Students learn better when the burden placed on working memory in the process of learning is managed appropriately. Overloading working memory can hamper learning by impeding the cognitive processes that help us select, organize, and integrate knowledge into long-term memory. It can make students feel demotivated and less willing to engage.

The brain "learns" by receiving sensory information from its surroundings, processing it in working memory, and storing it in long-term memory. But our working memories have a limited capacity. In his foundational work on the topic, cognitive psychologist George A. Miller (1956) proposed that most people can keep only five to nine pieces of information in working memory before overload, resulting in his "seven, plus or minus two" rule. As such, it is important to manage the sheer amount of information we're conveying to students in any given learning experience.

In his Cognitive Load Theory, Sweller (1988) states that learners process and retain information better when it is presented in a way that doesn't unnecessarily tax working memory. Learning experiences can be designed to reduce unnecessary demands on working memory and prevent cognitive overload. Here it is worth recalling that cognitive load can be intrinsic, extraneous, or germane. All three may exist in any learning event.

- **Intrinsic load** refers to the base cognitive processing required for a particular learning event. All learning events generate some intrinsic load. It can be managed but not eliminated. Some learning events, by their very nature, are more complex than others and generate greater intrinsic load.
- **Extraneous load** refers to cognitive processing that is unnecessary for a particular learning event. It is generated by ineffective teaching methods and reduced with effective design.
- **Germane load** refers to the deep and productive cognitive processing required to organize and store knowledge in long-term memory. It can and should be promoted by effective design.

While a review of the research indicates that the distinction and relationship among these three types of cognitive loads is not always clear, our basic goal should be to design learning experiences that carefully consider both what we're asking students to learn and how we're asking them to learn it in order to avoid overload (de Jong, 2010). Selecting topics that are too hard carries too much load for the learner, as does presenting too much information at once or presenting it in a disorganized manner. You will find that many of the principles in this framework actively work to manage cognitive load when correctly applied.

When it comes to what we're asking students to learn, we should select concepts that are at the appropriate level of challenge and complexity. For example, you wouldn't want to teach a student algebra before they learned basic addition and subtraction. They wouldn't yet have the appropriate mental models to be able to understand and integrate the lessons on algebra. For this reason, it is valuable for us to understand and draw connections to the student's prior knowledge with tactics like diagnostic assessments and priming questions.

Presenting information in manageable segments—by, for example, splitting up long recorded lectures into shorter videos—helps manage cognitive load (Brame, 2016; Clark & Mayer, 2011). While the appropriate length of any given video may vary by discipline and topic, one study on video content in online learning found that keeping videos under six minutes significantly increased levels of engagement (Guo, Kim & Rubin, 2014). Consolidating and streamlining feedback instead of presenting a multitude of comments at once can also help prevent overload, as can using scaffolding techniques like partially completing problems for students before asking them to find the solution (van Merriënboer & Ayres, 2005). Using a familiar learning sequence each week—introduced with a clear outline—can also reduce the extraneous cognitive load that results from a student's struggling to figure out the format of learning rather than focusing on the content itself. And creating course materials—like lecture slides—that are free of extraneous details and using signaling tactics to point out key elements helps focus the student on what is important and manage cognitive load appropriately (Brame, 2016).

Managing cognitive load is a particularly important principle in the world of online and multimedia education, where it can be so easy to overload. Avoiding overload is not about making a course easy, boring, or bland but rather about appropriately managing the demands on working memory in order to help students meet the challenges before them.

Applications in learning design.

- Align pedagogy and assessments to learning objectives in order to reduce the extraneous load and dissonance caused by doing work that doesn't match the stated outcomes.
- Set criteria for assessments that help students focus on important knowledge and skills and minimize effort on extraneous tasks.
- Follow recommended design guidelines when creating visual materials such as lecture slides.
- Provide a clear and explicit organizational structure or outline for materials and experiences.
- Limit the amount of information presented in any given learning event, segmenting information into small, meaningful pieces.
- Consider a consistent learning sequence each week so students know what to expect from the format and can focus on the content.
- Use appropriate delivery modalities to manage cognitive load by reducing distractions caused by inappropriate modalities.
- Make sure work is at an appropriate level of difficulty for the learner. Addressing a topic that is too complex carries too high a burden of intrinsic load, leaving no space for germane processing to store the information long term.

6 Challenge and complexity.

Students learn better when coursework progresses from simple to complex at an appropriate level of challenge. Material that is too easy or too hard can negatively impact motivation and overload the cognitive processes critical to learning (Mayer, 2011).

We naturally see this happen across the learning arc of a well-mapped degree—students begin with courses covering foundational topics and progress to courses covering more advanced and integrated topics as they approach graduation. This progression allows students to build the necessary mental models along the way that enable learning of more complex material (van Merriënboer, Kirschner & Kester, 2003). It helps keep intrinsic load at a manageable level, which will prevent cognitive overload and help maintain motivation.

Psychologist Lev Vygotsky first introduced the concept of the "zone of proximal development" (ZPD) in the 1920s. It has been refined and built upon ever since. The idea behind ZPD is that there are some things that a learner can do without help; there are others that a learner cannot do even with help; and between those two, in the ZPD, there is a range of things a learner could do with help from an instructor or a more skilled peer (Vygotsky, 1978). Designing instructional activities that stretch the learner to accomplish things in their ZPD is a good way to help them learn and grow. These activities can be supported by scaffolding.

Scaffolding refers to a range of techniques that can be used to help a learner progress through complex material and challenges (Collins, Brown & Holum, 1991). As an example, when teaching a complex idea, one might provide an overview first, then break it down into its constituent parts or underlying suppositions (Rosenshine & Meister, 1992). Consider, for example, a course on Lean Six Sigma—a relatively complex problem-solving and process improvement methodology taught in some business programs. As a course designer you might choose to focus the first unit of your course on an overview of the methodology, including a case study or example to illustrate the whole process and end result. Then focus each of the following units on one particular step in the methodology before reintegrating the ideas in the final units with more in-depth case study analyses.

There are many other strategies for scaffolding learning. One might present targeted vocabulary before launching into a complex lesson. For example, a macroeconomics course might present unfamiliar terms like exogenous and endogenous on an asynchronous text page for students to learn before hearing them used in a lecture about economic models. One might break up a lesson into a sequence of increasingly complex activities with opportunities for feedback, provide worksheets and organizers to guide thinking, offer a model for students to emulate, provide hints or guiding questions throughout an activity, or complete parts of a complex problem in advance so that the learner can focus on targeted skills (Hmelo-Silver, Duncan & Chinn, 2007). Over time, scaffolding can be reduced and removed as the learner's skills and knowledge develop and they become more independently capable of completing the task at hand.

Applications in learning design.

- Assign asynchronous diagnostic assessments at the beginning of a course or unit to gain insight into students' existing level of knowledge, and appropriately tailor challenge and complexity. Use the results to inform live session activities or identify any need for supplemental content.
- When teaching a complex idea, start with an overview to orient the learner, then break down the concept into its constituent parts or underlying suppositions.
- Consider presenting unfamiliar vocabulary before a lesson that uses it.
- Consider where your course fits within the larger learning arc of the degree curriculum and what students can be expected to know coming in. Design activities that are not too easy and not too hard—those that students will be able to complete with help.
- Break up complex activities into smaller pieces with opportunities for feedback.
- Sequence activities from simple to more elaborate and complex.

7 Prior knowledge.

Students learn better when they can connect new knowledge to prior knowledge. Learners find it easier to understand and retain new knowledge when they integrate it with what they already know (Bonwell & Eison, 1991; Willingham, 2006).

Drawing connections to existing knowledge helps students integrate new knowledge into existing mental models and store it for easy retrieval in long-term memory. Psychologist David Ausubel's (1963) foundational work on the topic found that rote memorization isn't an effective learning technique because it fails to connect new to existing knowledge. Ausubel observed that existing knowledge can be activated and engaged, effectively priming the learner's memory to receive new knowledge.

Students who are new to a discipline may find it more challenging to learn new material than those who are already somewhat familiar with the field because they lack foundational mental models with which to build connections. In foundational courses early on in a degree program, designers should build in enough time for students to absorb new knowledge in what might be an unfamiliar field. It is also possible to draw connections to nondisciplinary prior knowledge in order to help the student learn.

Students come to each course with a host of experiences that they can pull from, and they use them to try to understand new information. One way to effectively activate prior knowledge is by asking students to relate their lived experience to the content that they will be learning about. For example, a leadership course might ask students to reflect on and describe productive and unproductive interactions that they have had with leaders in the past before teaching a lesson about the pros and cons of various leadership styles. Asking students to begin by activating relevant memories from their own life prepares them to connect new information about the content to their existing knowledge.

This technique is effective because prior knowledge forms the basis of students' mental models of the discipline and skills. That is to say that students already have some sort of mental model about almost every concept, even if that model is incomplete or inaccurate. In order for students to effectively learn something new, they first need to understand their current mental model. This can be done by having students solve an appropriate contextual problem with only the knowledge that they already have (Loibl, Roll & Rummel, 2017) in order to activate their current mental model. Then, for that model to effectively change, students must apply the new knowledge in appropriate contexts. This may include receiving some direct instruction like a lecture or reading on the material and then being asked to apply it to a real problem or scenario. This can help students connect new material to situations that they already understand and can relate to. In this way, students' experiences (i.e., prior knowledge) can help students both prepare to learn new ideas and better understand how to apply new ideas to various situations. This process can also aid students in effectively transferring what they have learned to their professional work life after completing the program.

Even students familiar with a field may find learning challenging if their existing mental models contain misconceptions—or prior knowledge that conflicts with new knowledge. In this case, learning requires a conceptual change in their understanding (Mayer, 2011; Pashler et al., 2007). It is important to surface and identify misconceptions, and proactively address and refute them in order to help students unlearn what is wrong, replacing it with what is right (Taylor, 2017).

Applications in learning design.

- Ask students to generate what they know about a concept before teaching it, to activate prior knowledge.
- Give students a relevant scenario to solve before they learn a new concept so that they can activate their prior knowledge while addressing the problem and before learning the new concept.
- Teach new concepts in relation to situations or scenarios that students can personally relate to, or already understand, so that students can anchor new knowledge to knowledge they already have.
- Use asynchronous questions and discussion forums to surface misconceptions. Address and refute them in asynchronous responses or live sessions.

8 Modality.

Students learn better when practice and instructional content are delivered in a mode that is appropriate for their pedagogical needs. The right mode—used the right way—can help replicate authentic contexts and make concepts easy to understand, while the wrong mode can generate extraneous cognitive load.

It is important to note that this principle is not about so-called learning styles—the myth of the visual, auditory, kinesthetic learner, and so on. Research has shown that such innate, cognitively driven styles do not exist (Doyle & Zakrajsek, 2018; Howard-Jones, 2014). Students may indeed have preferences based on their own individual experiences or situations but ultimately perform better when learning with the mode that best supports the pedagogical needs.

It is important to choose the right modes for delivering content and activities, whether text, image, video, real-time interaction, or some combination of these. For example, using images or flow charts to illustrate visual concepts or processes can aid learning (Clark & Mayer, 2011). Showing a hands-on procedure in a video demonstration helps the learner understand better than presenting a text-based explanation alone. Choosing to process a complex case study in a live interaction, where students have the opportunity to ask questions and get immediate feedback in real time, can provide major benefits to learning.

Another factor to consider is the mode in which students will encounter information or experience activities as future professionals in the field. In this way, the appropriate mode can set the stage for realistic practice that will help learners apply their knowledge later in their careers (Herrington & Herrington, 2007). Consider a nursing student who will one day be required to read and interpret text-based patient charts; it would be helpful to practice in class with a text-based format that authentically reflects these charts. Nurses are also expected to listen to patients verbally describing symptoms and respond in the moment. In this case, watching videos of patients—or even interacting with real or simulated patients—may be the most effective modality.

In many cases, presenting the same information in multiple modes can reinforce learning. By learning the same content in different ways and through different media, learners use different kinds of cognitive processing, building more neural pathways for learning and retaining the information (Hattie, 2009). A written explanation of a procedure plus static images of the steps plus a video demonstration plus practice opportunities can provide a multimodal learning experience that is richer than any single mode alone. However, as Moreno and Valdez (2005) note, it's important to be aware of cognitive load—too many variations and too many modalities or modalities that are poorly designed (for example, a dense PowerPoint lecture with hard-to-decipher graphics, poor use of color, and too much text) defeat the principle. The risk is cognitive overload, which leads to mental exhaustion, confusion, and frustration.

As such, once a mode has been selected, it is important to use recommended best practices in design for that particular mode in order to make it as effective as possible. For example, Richard Mayer's 12 principles of multimedia learning include advice on how to use images, words, and sounds in combination (Mayer, 2009). Among his suggestions are excluding extraneous words, using visual cues to signal important information, and presenting words and pictures near one another. Many correspond to helping manage cognitive load. Similar best practices are available for other modes and should be considered during development.

Offering multiple modes can also help facilitate greater accessibility in learning experiences and meet the different needs of individual learners (CAST, 2018). This can help students determine which learning tactics are most effective for them, encouraging self-regulated learning. However, it is important to note that this principle does not suggest "mixing it up" or using a variety of modes simply for the sake of keeping things interesting. The content or activity must match the mode in order to be effective. Many educators worry about being "boring" by doing the same thing over and over again each week. Variety and incongruity alone will not make content or activities interesting. In fact, using a consistent design sequence for each unit can improve learning by decreasing the extraneous load created when students must decipher an ever-changing format.

Applications in learning design.

- Select a delivery mode that is appropriate to the pedagogical needs.
- Consider the environment and interactions of professionals in the field, and select modes that are authentic to them.
- Use best practices in designing particular modes in order to make them most effective and manage cognitive load.
- Use multiple (appropriate) modes to enrich learning on complex topics.
- Consider a consistent design sequence for each unit in order to reduce extraneous load.

9 Practice in context.

Students learn better when knowledge and skills are presented and practiced in context. It is particularly valuable when the context reflects settings and scenarios that are authentic to the work that students will engage in as practitioners and professionals in the field. Learning in context helps students develop knowledge that is not inert but can actually be used.

Many learning theorists agree that learning is situated—that what people learn is inherently bound to the context in which it was learned (Lave, 2009). For this reason, it is important for students to learn in a context that is as similar as possible to the context in which they will later use and apply that knowledge. In many programs, that might provide a compelling argument for fieldwork placements or internships, or for working on real, complex challenges from their own life or work experiences. In some cases, this kind of learning experience may not be possible. Instead, a course might use recorded video to create realistic case studies, incorporate role-playing activities in synchronous live sessions, assign software simulations as homework, or use other tools to accurately represent a context that frames how knowledge and skills will be actively applied.

It is important to infuse simulated challenges with the same complexities that the learner will encounter in the real world; learning experiences are too often overly straightforward and lack the messiness that makes a problem authentic (Herrington & Herrington, 2007). This can hurt students when they later encounter challenges in the field that are not as clear cut and there is no guidance from an instructor to help them work through the complexity. Part of this is due to context-dependent learning (Godden & Baddeley, 1975; Smith, 1979), in which people have an easier time remembering things if the context in which they learned it is the same as the context in which they need to apply it. For example, a student will be more likely to remember anatomical terms as a nurse on rounds in the hospital if they were physically in a hospital when they learned those anatomical terms.

Application also increases cognitive processing and makes explicit the relevancy of particular knowledge (Bransford, Brown & Cocking, 2000; Collins, Brown & Holum, 1991). As a result, practicing skills in context helps students remember what they learned when they need to apply it outside of class, in a real-life scenario. This process—where students use what they learn in a different situation or to solve a different problem—is called **transfer**. Learning and practicing in context can enable transfer when students either are able to foresee how they will use the information later in life or get so used to practicing the skill in context that it becomes automatic (Salomon & Perkins, 1989).

Applying knowledge in authentic contexts may also help students integrate future new knowledge more quickly. As such, even in foundational courses that are heavy on content, it is worth including thoughtfully designed application activities in addition to quizzes and simple recall practice. Students will retain more of that foundational knowledge and be able to access it more easily if they practice using it in meaningful ways (Kontra, Lyons, Fischer & Bellock, 2015).

Applications in learning design.

- Design practice activities that approximate the contexts that students will encounter in their future professions—including the intrinsic messiness of real-world challenges. One of the distinct advantages of asynchronous digital coursework and recorded video is that these modalities can portray and approximate authentic contexts in ways that are impossible in the on-ground classroom.
- Use delivery modes that are true to how students will be asked to process information in the real world. For example, if a social worker is expected to interact with clients one-on-one and face-to-face, incorporate paired role-playing exercises facilitated by breakout rooms in the live session.
- Use application activities even in courses where students need to memorize a lot of information. Consider designing an activity that asks students to practice explaining concepts to a client or colleague, for example.
- Tell students how what they are learning will apply to specific situations in their future work. This is especially helpful when explaining theoretical material, where it might be less clear to students how to apply the theory.

10 Desirable difficulties.

Students learn better when learning requires effort. Some learning tasks may feel hard for the learner but actually introduce difficulties that help promote long-term retention and transfer—and are thus "desirable."

Students often practice in ways that feel easy and effective—like rereading a text. In reality, these easy strategies often promote only short-term recall. Strategies that may feel harder—like self-testing—actually promote long-term retention and transfer.

Robert Bjork coined the term desirable difficulty to describe impediments that make students work harder to learn, but ultimately improve the quality of learning (Bjork, 1994). In his research, Bjork found that learning was enhanced by strategies like "varying the conditions of learning, rather than keeping them constant and predictable; interleaving instruction on separate topics, rather than grouping instruction by topic (called blocking); spacing, rather than massing, study sessions on a given topic; and using tests, rather than presentations, as study events" (Bjork & Bjork, 2011, p. 58).

Similarly, research has shown that asking students to solve problems before being taught the solution helps them learn the content of the problem more deeply (e.g., Kapur, 2008; Loibl, Roll & Rummel, 2017; Schwartz & Bransford, 1998; Schwartz, Chase, Oppezzo & Chin, 2011). While attempting the solution might be difficult, and students may fail to solve the problem, the cognitive work students do when trying to solve a problem that they don't know how to solve primes them for deeper learning later when instruction is finally given.

The idea of desirable difficulties can make some instructors nervous (Bye, 2011). Increasing difficulty can increase errors, which could be demoralizing for students and uncomfortable for well-meaning instructors. But making students work harder to retain knowledge increases their ability to recall and use it, improving long-term outcomes. Understanding this phenomenon—and making it explicit to students so that they know they are not simply being tortured—should provide the motivation required to persist with seemingly uncomfortable strategies.

Varied repetition.

Varied repetition gives learners experience applying knowledge or skills in different conditions or contexts. For example, a data science student learning principles for how to effectively visualize information might practice the same visualization techniques with several different types of data sets. She might have an initial, simple practice activity with one data set in her asynchronous coursework, practice with another data set in a small group in a live session, and finally practice with a third, varied example as homework following the live session. Providing the learner with varied scenarios for practice establishes "multiple retrieval cues" in the brain, making the information easier to access in the long term, even if it makes initial learning more difficult (Hakel & Halpern, 2005). Repetition increases muscle memory and reinforces learning. Varied repetition helps keep practice interesting and fosters deeper understanding by demonstrating the many ways an idea or skill can be applied. Asking students to retrieve and practice what they are learning in new ways helps strengthen neural pathways through further cognitive processing, strengthening their ability to problem solve, understand nuances, and transfer learning to new situations (Brown, Roediger & McDaniel, 2014).

Interleaving.

Interleaving refers to mixing up practice on varied topics or skills versus practicing in sequential blocks. Taylor and Rohrer (2010) describe interleaving as when "[t]he practice of different skills is intermixed rather than grouped by type (e.g., abcbcacab instead of aaabbbccc)" (p. 837). For example, consider a physical therapy student learning to treat different areas of the body in a single course. As he studies for the final exam, he may benefit from mixing up his practice, touching on each of the different areas of the body in every study session instead of focusing each session on a single area. This desirable difficulty allows students to practice in varied sequences, which helps them be able to discriminate, adjust, refocus, recall, problem solve, and differentiate. Interleaving improves the learner's adaptability and ability to handle new situations—an important skill for professionals across domains—and helps their learning last longer (Pan, 2015).

Spacing.

Spacing means studying or practicing skills intermittently, with time between each study or practice session. This is in contrast to massed practice, where a student practices or studies during a single, long session. It is the difference between spending six hours cramming for a test (massed practice) and distributing those six hours over the course of several weeks leading up to the test (spaced practice). While research shows that spaced practice is more effective than massed practice, this effect is larger for simpler tasks (Donovan & Radosevich, 1999). When studying more complex tasks, students benefit more if the time between each practice session is longer. As designers, we can build spaced practice into the structure of a course by including, for example, question sets and practice problems each week that refer to material covered in previous weeks. The 2U graduate course delivery model can leverage asynchronous assignments before a live session, the live session itself, and homework or asynchronous coursework after the live session as three different opportunities to practice; in this way, spaced practice can be built into every week.

Testing.

Often when we think of studying, we think of students reviewing material by rereading the text or by rewatching lectures. However, research suggests that students learn better by testing themselves instead of reviewing instructional material (for a review of the literature see Roediger & Butler, 2011). This is called the “testing effect,” or sometimes “retrieval practice,” because the focus is on the student trying to retrieve information from their long-term memory, rather than simply recognizing it by seeing it again (Agarwal, 2018). Research shows that even when students never review what they initially learned, repeated testing helps them learn the material better than repeated studying (Roediger & Karpicke, 2006).

Applications in learning design.

- Provide different contexts and scenarios for practicing the same skills.
- Consider mixing up the practice of different skills and topics instead of practicing each sequentially in blocks.
- Repeat practice and study over time instead of doing it all at once.
- Include low-stakes practice tests, and coach students on developing self-testing strategies.
- Have students attempt to solve a problem before teaching them the solution.
- Be explicit about how difficulties improve learning, helping the learner understand the benefits of engaging in tasks that require significant effort.

11 Deliberate practice.

Students learn from mindful, carefully planned practice with feedback—the opposite of mindless repetition. More effective than just hard work, deliberate practice helps learners develop and refine the right mental models and effectively and efficiently continue to improve (Ericsson & Pool, 2016).

Angela Duckworth and her colleagues provide a comprehensive definition for the type of practice recommended by this principle:

Deliberate practice entails engaging in a focused, typically planned training activity designed to improve some aspect of performance. During deliberate practice, individuals receive immediate informative feedback on their performance and can then repeat the same or similar tasks with full attention toward changing inferior or incorrect responses, thus improving the identified area of weakness (Duckworth, Kirby, Tsukayama, Berstein & Ericsson, 2011, p. 174).

Hands-on examples from sports and music are often used as illustration—whether it be a tennis player repeatedly practicing one particular aspect of her swing with corrective feedback from a coach, or a pianist deliberately repeating a challenging exercise with feedback from self-recording. However, Ericsson and Pool (2016) note that deliberate practice is effective across domains, provided it embodies key characteristics:

- The student is motivated to pay attention and improve.
- The practice is targeted on a particular component of activity at an appropriate level of challenge based on the learner's existing abilities.
- The practice is carefully designed by a teacher or coach to maximize improvement.
- The student receives immediate informative feedback on their performance to incorporate into further, repeated attempts.

Consider a computer science student learning to code, a nursing student learning to conduct a patient exam, or a law student learning to analyze cases. Each skill can be broken down into component pieces to be practiced mindfully and repetitively with feedback. Deliberate practice helps students identify and correct bad habits, erroneous thinking, and the misunderstanding or misapplication of content. It has been identified in a range of studies as a predictor of success and contributor to expertise (Duckworth et al., 2011; Ericsson, 2006; Macnamara, Hambrick & Oswald, 2014). Focus and feedback can teach students to notice and correct errors on their own, putting them on the path to self-regulated learning. Self-regulated learners, in turn, may be more likely to engage in deliberate practice.

Applications in learning design.

- Build in adequate time for students to work on the skills they are learning. This might mean covering less content for the sake of allowing students more time to practice what they have already learned.
- Select targeted practice activities that are at an appropriate level of challenge based on the learners' existing abilities.
- Design coursework that creates opportunities for focused, repeated practice of target skills. This can come in the form of structured homework assignments, in-person activities, or as low-stakes practice quizzes.
- Provide timely, informative feedback on practice activities, or coach students on how to self-assess during individual practice. Coach learners on how to incorporate feedback into further, repeated attempts.

12 Stories and examples.

Stories and examples help students learn and retain complex information (Bower & Clark, 1969; Graesser, Olde & Klettke, 2002). The human mind is naturally adept at remembering stories, while examples make abstract ideas concrete.

Story structure is often particularly effective as a learning aid. As Willingham (2004) notes, "Psychologists have therefore referred to stories as 'psychologically privileged,' meaning that our minds treat stories differently than other types of material. People find stories interesting, easy to understand, and easy to remember." Some stories are deliberately instructional—Aesop's fables and folktales, for example. But even in the absence of such stories it is possible to present case studies and real-world problems with the narrative arc of a story, making them more engaging and memorable.

From a cognitive perspective, stories and examples trigger memory and aid retention. Structurally, stories often feature causality, conflict, complications, and characters. Actions cause events. Challenges and obstacles are present; things aren't always simple or straightforward. Characters and their thought processes are described in detail and observed in action. Observing how others behave in and handle situations is an effective tool for learning. Stories are vehicles for making this observation possible. With case studies—a type of story common in many disciplines—students may observe professionals in action or even be asked to play the role of a professional themselves. They can experience cause and effect, make decisions, face complications, and engage with other characters. Stories and examples that point out misconceptions or errors can be especially effective at helping students learn from those mistakes.

The most important thing about using a story to improve learning is for the story to make abstract concepts concrete. Adding details to the story that serve only to make the material more interesting or emotional might have little to no value for learning (Sadoski, 2001). Additionally, seductive details that make a story interesting but do not add to the learner's understanding of a concept can cause students to focus more on those interesting parts of the story and less on the concepts that they should be learning (Garner, Gillingham & White, 1989). This may explain why sometimes adding narrative stories or interesting details to lessons can actually hinder learning instead of bolstering it (Adams, Mayer, MacNamara, Koenig & Wainess, 2012; Garner et al., 1989).

In addition to stories, examples can make abstract content more concrete. Multiple, varied examples deepen the learner's understanding of the material (Gick & Holyoak, 1985; Hakel & Halpern, 2005). Examples help students learn by illustrating how concepts apply to different situations. As students see more examples, it is easier for them to understand the similarities and differences between each example, and to substantiate when the concept applies and when it doesn't. This can prevent the student from later mistakenly applying the concept to scenarios where it is not relevant, or failing to apply the concept to situations where it is. Over time, as students understand a concept better, they can talk about it abstractly from one particular example or situation. This process is called concreteness fading and has been found to be more effective than explaining a concept in an abstract way first (Fyfe, McNeil, Son & Goldstone, 2014; Goldstone & Son, 2005).

Applications in learning design.

- Illustrate concepts from the lecture or textbook with stories or examples in recorded videos or synchronous live sessions.
- Highlight causality, conflict, complications, and character in case studies when possible.
- Keep stories and examples concise. Leave out seductive details that are irrelevant to the content being taught or fail to make the abstract content concrete.
- Use multiple examples whenever possible, pointing out similarities and differences. For example, students might review examples individually in asynchronous coursework and discuss similarities and differences in discussion forums or live sessions.
- Consider using examples first, and then have students talk about concepts abstractly once they have a relatively robust understanding of when to apply and when not to apply that concept to a situation.

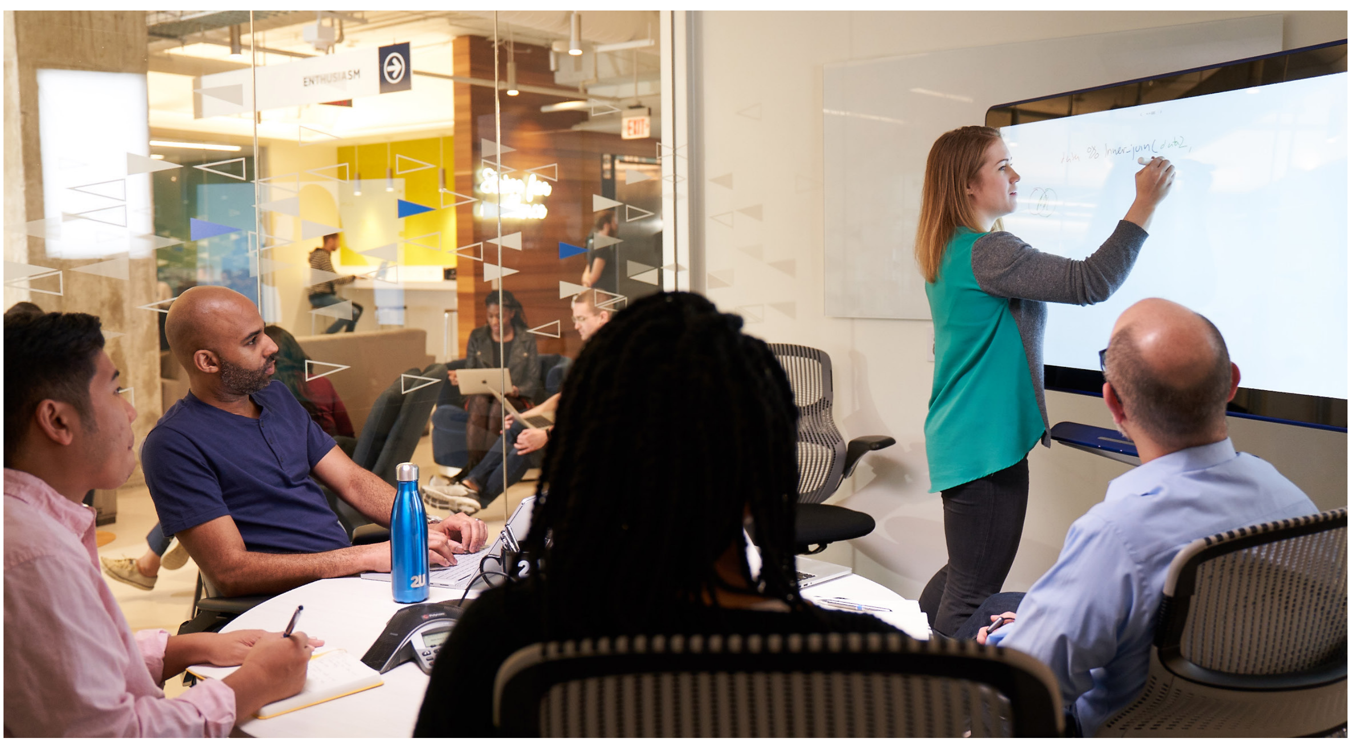
⓭ Expert thinking.

Students learn from exposure to how experts think about approaching problems and making decisions. Expert explanations and demonstrations alone are often not enough for a student to learn how to do something well. To achieve mastery, learners must also be exposed to the invisible thought processes of experts.

We learn a lot from observing others. Throughout our lives, we watch parents, siblings, and more advanced peers model skills and behavior, and we learn through imitation. In traditional hands-on apprenticeships, the novice apprentice learns by observing a master craftsman model skills in the workplace. However, much of what students need to learn in modern education is cognitive and, thus, not easily observable. Moreover, behind the skills we're trying to teach, there is often a series of decisions and reasoning that is critically important to success. As part of an approach called cognitive apprenticeship, we aim to "make thinking visible" and expose students to the thought processes of experts (Collins, Brown & Hollum, 1991). This way, in addition to learning in theory how to do something, and seeing a demonstration of it, students learn the valuable cognitive skill of how to think while doing that thing as well.

We can encourage this learning how to think via "cognitive annotation" or "think-aloud" strategies—explicitly explaining or narrating the decision-making and thought process that the teacher is going through while performing a skill (Bereiter & Bird, 1985; Quinn, 2005; Schoenfeld, 1992). Consider a financial accounting professor thinking aloud as he shows students how to analyze a company's balance sheet in a screen-capture demonstration, or a social work professor narrating a filmed interaction with a client, explaining what she was thinking as she modeled a particular counseling technique. Exposure to thinking can also come from interviews or panels, where experts and professionals in the field tell stories and explain their thought processes. Bringing these expert perspectives into a learning experience can also help shed light on the professional relevance and value of material, which can increase learner motivation and engagement.

Experts may have many complex thoughts as they perform a skill. To avoid overwhelming learners and to sustain motivation, it can be helpful to maintain a sharp focus on the learning objectives and to keep in mind the learner's existing level of knowledge and skill. For introductory courses, you may want to narrate selectively, focusing specifically on the basic skill you want students to acquire, and stay at an appropriate level of challenge. The social work professor may draw on multiple techniques and theories of counseling



in that single interaction, but beginner students benefit from a focused narration of what's important at that moment in their educational journey. In more advanced courses, the narration may be appropriately more complex.

Narrating one's thought processes can be surprisingly hard for an expert. What makes you an expert—and as such a prime candidate for teaching—may actually hinder you as an instructor. As expertise grows, actions become more and more automatic, and it can be increasingly difficult to break down your work into its component knowledge, skills, and decisions (Heath & Heath, 2007). Teachers often have an "expert blind spot" for what students need to know and for how difficult it is for students to learn the skills that they themselves are experts at (Nathan & Petrosino, 2003). Studies have shown that even experts who talk explicitly about their thought process may miss including up to 70% of what they do, suggesting that much of the thinking process of experts is subconscious (Clark, 2009).

Teachers can counteract the expert blind spot in many ways. Simply spending the time to be mindful and think carefully about exactly how you do what you do can help, as can consulting with someone less knowledgeable to help break things down and spot details and links that you may be inadvertently omitting. When narrating your thought processes, mention not only the final decision but also the options you weighed and alternatives you considered along the way. Consider including examples of when things go wrong or mistakes commonly made by novices. Modeling mistakes and errors and exposing the thought processing around recognizing and correcting errors can be as valuable as modeling perfect performance (Loibl & Rummel, 2014). Things go wrong in the real world, even for experts. Being transparent about that—and about how to fix things—can help students maintain a growth mindset and stay motivated when inevitably they make their own mistakes.

Applications in learning design.

- When modeling skills or conducting demonstrations—whether in asynchronous videos, live sessions, or in-person learning experiences—consider thinking aloud and narrating your thought process along the way.
- Stay focused on the learning objectives and the existing knowledge of your audience to target your narration appropriately.
- Include examples of mistakes and errors made by experts and novices, narrating the faulty thought process and how the error was identified and fixed.
- As you design and develop content, engage a less knowledgeable thought partner to help you understand the perspective of a novice and spot missing links in your narration.
- Ask students to reciprocate the narration, surfacing their own thought processing so you can spot errors and misconceptions and offer a comparative expert perspective.
- Consider conducting interviews with experts and professionals, asking questions that help them expose their thought processing and decision-making. Include these interviews as recorded videos or transcripts in your course.
- For expert interviews, consider drawing on recent alumni who may be very relatable to the online student.

Think.

Students learn best when they think about what they are doing. More beneficial than just “doing” alone, getting feedback, learning with others, and reflecting on the process of learning helps students succeed. This category of principles refers to the input students must receive throughout the process of learning—whether from the instructor, their peers, or themselves—in order to grow and improve.

14 Formative feedback.

Students learn better when they receive input that helps them gauge and improve their performance. Formative feedback throughout the process of learning helps students understand their own progress and what they need to do in order to successfully achieve the intended learning objectives (Ambrose, Bridges, DiPietro, Lovett & Norman, 2010).

Educators and designers frequently use the term formative **assessment**. We stress the term formative **feedback** to focus on the feedback that the assessment makes possible. The best feedback focuses on things students can do or correct to improve their learning (Heritage, 2007; Wylie & Lyon, 2012). Helpful feedback is enabled by clear learning objectives, an alignment of assessments and activities to those objectives, and explicit, specific criteria for assessments.

Feedback is considered to be "formative" if it informs the teacher or student of how much the student knows for the explicit purpose of improving teaching or learning. For this reason, formative feedback is most effective when it is clear, actionable, and timely. Students have to be given both the time and the practice opportunity to act on the feedback provided in order for them to effectively benefit from it.

Formative feedback does not always involve laborious tasks like crafting line-by-line comments on student essays. Even low-stakes quizzes with auto-generated feedback or peer-to-peer feedback are beneficial. Informal interactions can also provide opportunities for formative feedback. For example, class discussions can help students articulate their own thinking process, which allows them to subsequently evaluate their own understanding of the material (Ruiz-Primo, 2011).

Peer-to-peer critique is another effective way to provide students with formative feedback. The student receiving the critique benefits from getting some low-level feedback fairly quickly. The student giving the feedback benefits from an opportunity to learn assessment skills, which can be parlayed into self-assessment, which enables self-regulated learning. However, giving feedback constructively is not always immediately easy for students. It is a skill that must be learned and needs to be taught (Lundstrom & Baker, 2009). Like any new skill, it may take practice, supervision, and coaching.

Formative feedback works best when the student gets information on both how well they did and how they can improve. For example, a quiz that explains why an answer is right or wrong is more effective than one that simply displays scores. However, feedback is most useful when students are willing to use it. If students skip feedback with explanation because it is too long, then they may benefit more from simple correct/incorrect feedback, provided they are willing to read it (Maier, Wolf & Randler, 2016).

Applications in learning design.

- Proactively provide explanations about common misconceptions and why the correct answer is different.
- Use automatic grading, peer grading, or other techniques to provide students with consistent and timely feedback on their performance throughout the course.
- Design assessments so that students can get feedback on how well they understand the material they are meant to be learning.
- Follow assessments and assignments with additional opportunities for students to practice applying the feedback they receive.
- Provide students with clear guidelines and criteria for how they should evaluate peers so that peer-to-peer review activities are constructive and positive experiences.
- During peer review or group work, have students pose questions, ideas, or other ways of thinking about a concept or problem to promote deeper thinking and learning. Model good peer tutoring by showing how instructors and collaborators should ask questions, and offer suggestions instead of just explaining concepts.

15 Social learning.

Students learn better when they have opportunities to be exposed to different perspectives by working with others. Social learning provides a forum for cognitive processing, for receiving feedback, and for building community. It allows students to compare what they know to other perspectives and ideas in order to help them refine their own internal mental models.

At a very basic level, student-to-student interaction provides an occasion for cognitive processing (Springer, Stanne & Donovan, 1999). When students collaborate, they bring together different experiences, interpretations, understandings, abilities, and points of view that prompt further processing and elaboration; this deepens learning for an individual (Craik & Lockhart, 1972). Online learning communities in particular can be incredibly diverse, bringing students with a range of backgrounds and experiences together from across the country and around the globe. As such, online classes provide a rich and valuable forum for expanding individual horizons and understanding the range of perspectives that exist.

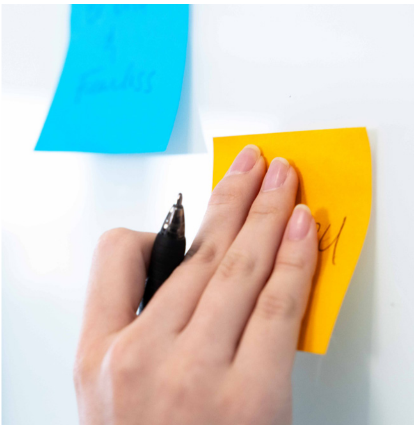
Social learning is most valuable when students work together to build knowledge. Students debating, disagreeing with one another, or offering critiques can help one another amend their own thinking and develop a deeper understanding of the content (Springer et al., 1999). These activities are most effective for learning when students are using their peers' ideas to question and refine their own thinking, and subsequently integrating other students' ideas into their own mental models to create new ideas. This process may help students notice and correct misconceptions as they compare their own knowledge to the knowledge of other people. Over time, this allows students to refine their mental models around concepts, to make them more accurate and more robust. This ability for students to "co-construct knowledge" with one another has been found to be more effective than activities where students learn from an expert like a teacher (e.g., listening to a lecture) or actively construct knowledge on their own (e.g., reading a text and then self-explaining it; Chi & Wylie, 2014).

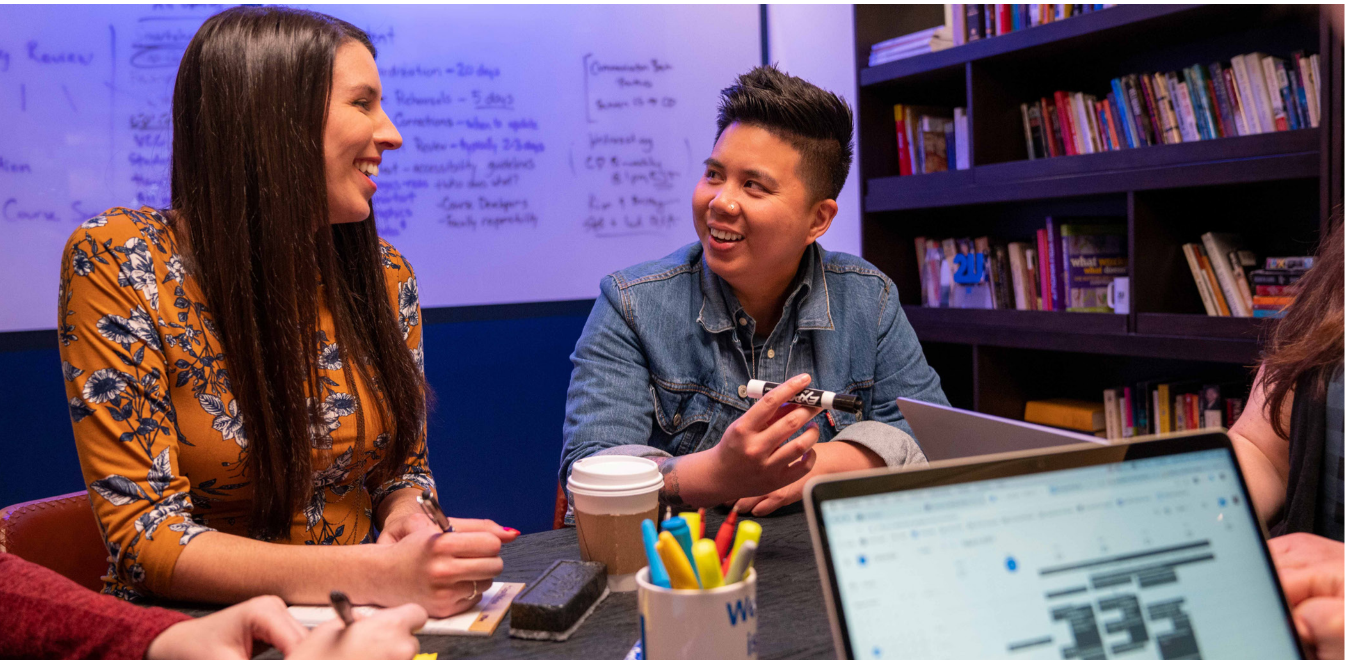
This knowledge-building process explains why activities like peer tutoring can be so effective for learning (Roscoe & Chi, 2007). Peer-to-peer feedback helps both the student who is giving the feedback and the student who is receiving it (Comer & White, 2016; Liu & Carless, 2006; Lundstrom & Baker, 2009) because it gives students practice in making and explaining judgments in relation to other students' work and ideas. In this way, peer feedback activities can encourage students to present and compare ideas as they co-construct knowledge. Peer tutoring has less of a positive effect on learning when these knowledge construction processes do not occur (Roscoe & Chi, 2007).

According to a review of the research (Johnson & Johnson, 1986), student-to-student interaction and collaborative learning can also increase both motivation and positive feelings about the subject matter and classmates. When group work, discussions, or general class culture can increase students' sense of belonging, this can improve students' intrinsic motivation (Freeman, Anderman & Jensen, 2007). In one study of college students taking online courses, the more college students' course grades were based on group discussion, the more they were satisfied with the course, and the more they learned (Shea, Fredericksen, Pickett, Pelz & Swan, 2000). Several other studies have corroborated the findings that improving student interaction improves student satisfaction with a college-level online course (Dziuban & Moskal, 2001; Hartman & Truman-Davis, 2001). Research specifically conducted on 2U students found that an increased sense of learning community in a course was associated with higher student GPAs (Beeson, 2017).

Applications in learning design.

- Use activities like debates, group work, or peer tutoring as platforms where students can share, discuss and argue about ideas so that they can co-create knowledge with one another.
- Provide peer tutoring or peer review activities that encourage students to question and refine their ideas in relation to other students' ideas.
- Use discussions and informal chats as a way to increase a sense of belonging in the student learning experience.





16 Metacognition.

Students learn better when they are aware of their own knowledge, thinking, and learning processes. This metacognition—or "thinking about thinking"—helps students understand their own learning, choose strategies that will lead to success, and transfer learning to new contexts with greater confidence and control.

Metacognition is "the process of reflecting on and directing one's own thinking" (National Research Council, 2001). It is the learner's awareness of what they know and their ability to control their own thought processes (Meichenbaum, 1985). As a student, you would be engaging in metacognitive strategies if you said to yourself, "Wow, I am unfamiliar with a lot of vocabulary in this lesson, but I know testing helps me remember things, so I'm going to make flash cards to help me learn." Metacognitive skills are critical to helping students become lifelong learners, giving them what they need to be successful in learning, even in the absence of any formal instruction or instructor.

As Ambrose and colleagues tell us in *How Learning Works* (2010), students with a high degree of metacognition are able to:

- Assess the task at hand
- Evaluate their own knowledge and skills, identifying strengths and weaknesses
- Plan their approach
- Apply strategies and monitor progress
- Reflect on the success of their approach and adjust as necessary

Instructors can and should help students learn and develop these metacognitive strategies because research shows that they lead to success (Nietfeld & Shraw, 2002; Thiede, Anderson & Therriault, 2003) and help students transfer their skills to different contexts (Bransford, Brown & Cocking, 1999; Aleven & Koedinger, 2002). One way of doing this is to model metacognitive thinking by thinking aloud as you perform a task to help show students how they should be thinking. Be explicit about how you're evaluating the problem at hand, choosing which strategies to use to solve it, and checking to see if you're successful.

Being explicit and deliberate about teaching metacognitive strategies is important because they are internal and invisible. As such, students may not realize how important they are (Pintrich, 2002). By including metacognitive activities in the design of a course, instructors can ensure that students have opportunities to build their metacognitive abilities. For example, pre-assessments can help students evaluate what they already know and identify strengths and weaknesses. Assignments that ask students to expose how they are planning to tackle a big research paper or project force students to slow down and be deliberate about their approach. And reflective journals that ask students to think about which study strategies worked, which didn't, and how their knowledge has changed over time help students monitor and evaluate their own progress and success (Tanner, 2012).

Finally, feedback and how it is delivered can be a strong force in promoting metacognition. Positive feedback on correct answers can help increase a student's metacognitive awareness of what they do know, thus increasing confidence (Butler, Karpicke & Roediger, 2008). And by asking questions in feedback instead of simply making statements, instructors can prompt students to examine and reflect on their thought processes (Hattie & Timperley, 2007). For example, instead of grading an essay and saying "You didn't do enough analysis of the study you explain on page 2," an instructor could say, "Reconsider the analysis you did of the study on page 2—does it sufficiently support your thesis?" This kind of feedback and reflective prompt can scaffold metacognition.

Applications in learning design.

- Model metacognitive thinking to help students understand how they should be thinking about thinking and managing their own learning process.
- Consider pre- and post-assessments that ask students to evaluate their own knowledge and skills to help raise awareness of their own status and progress.
- Provide formative feedback early and often to help students evaluate their own knowledge and skills and understand their own strengths and weaknesses.
- Design activities or assignments that ask students to plan their approach.
- Use reflective journals and "exam wrappers" (quick questionnaires students must complete when they receive their graded exam) to prompt students to reflect on the success of their study habits and evaluate their progress in learning (Lovett, 2013).
- Be explicit about the teaching and learning strategies you're using to help students understand why they are being asked to do something, so that they may successfully apply the strategy independently in the future.

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The best learning experiences are designed to deliver learning that is applied, long-lasting, and transferable.