Helping Instructors Teach Students "How to Learn"

A Center for Teaching & Assessment of Learning HANDBOOK

The Team
Written by **Stephanie N. Del Tufo**, Assistant Professor of Education and the Interdisciplinary Neuroscience Graduate Program; and **Chrystalla Mouza**, School of Education Director and Distinguished Professor of Teacher Education; with contributions from **Matthew Trevett-Smith**, Center for Teaching & Assessment of Learning Director; **Rose Muravchick**, CTAL Associate Director for Educational Development; and **Stacie Larkin**, CTAL Faculty Developer.

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CONTACT INFORMATION
Center for Teaching & Assessment of Learning
Phone: (302) 831-2027
Email: ctal-info@udel.edu

Introduction

Look around you. You are likely reading this in a room full of individuals with Ph.Ds., M.Ds., M.B.As., M.F.As., or another advanced degree. Each an expert in their own domain. However, the path to achieving expertise is paved differently for each individual. Some walked through garden paths, neat as the hedgerows that surrounded them. Others had some kind of guardian to guide them along a thorny trail. Still, others will tell you of oceans crossed, traps eluded, or traveling mountainous terrain with inadequate supplies. These paths are often describing what is referred to as the "Hidden Curriculum," becoming a successful learner requires an understanding of hidden expectations, skill-sets, knowledge, and social processes (e.g., Martin, 1976). In this handbook, we aim to explicitly address only one of the hidden expectations of the college curriculum: What skills do students need to be successful learners?

The transition from high school to college is challenging for many students because it requires that they become more independent learners (van der Meer et al., 2010). First-generation students and those from underrepresented backgrounds, in particular, are less prepared for college compared to peers coming from families with college degrees. Further, they are more likely to experience challenges adapting to college because of sociocultural differences in the norms, values, and expectations between their home environments and college campuses (Stephens et al., 2012). As students engage with college work they need to learn how to manage their time, develop effective study skills, optimize their study environments, and monitor their learning - in other words, they must ***learn how to learn***. These skills are generally captured under a conceptual framework known as self-regulated learning. Self-regulated learning refers to the manner in which learners achieve their personal learning goals by systematically activating and sustaining their cognition, motivation, behaviors, and emotions (Schunk & Greene, 2018). It includes three distinct phases focusing on processes prior to learning (planning), during learning (progress monitoring), and after learning (self-reflection) (Zimmerman, 2002).

Self-regulated learners exhibit characteristics of learning how to learn: "They are able to pursue valued academic goals via planning, monitoring, controlling, and evaluating their cognition, motivation, behavior, and emotions, such as by using effective strategies and knowing how to self-motivate" (Greene et al., 2020, p. 949). Research has established a clear connection between self-regulation and academic performance (e.g., Dent & Koenka, 2016). Importantly, the knowledge, skills, and dispositions needed to enact self-regulated learning are not innate but can be learned (Bjork et al., 2013). In fact, all students can learn how to self-regulate independent of age, gender, motivation, and other individual characteristics (Pintrich, 1995). As a result, instructors need to help students become self-regulated learners by incorporating strategies across courses and contexts and providing students with practice opportunities (Pintrich, 1995).

Self-regulated learning interventions for college students have revealed positive outcomes. Greene et al. (2020) investigated the impact of a first-year semester-long course focusing on self-regulated learning on first-generation college students. The course provided direct instruction on self-regulated learning and strategies as well as opportunities in class to practice various aspects of self-regulated learning during course activities. Improvement in conceptual knowledge was

seen even when students only received access to the course materials. Further, the course helped students acquire monitoring and strategy-use knowledge that could be applied across contexts. Instead of using a semester-long course, Bernacki et al. (2019) examined whether brief, digital training modules aimed at helping students apply learning strategies and self-regulated learning principles in STEM courses can impact students' behaviors as well as performance in a large biology course. Results indicated that even a short digital training module on "learning-how-to-learn" had a positive impact on students' use of resources for planning, monitoring, and strategy use. Further, the training helped improve students' scores on content area quizzes and exams. Similar learning-to-learn programs were implemented at various institutions both in the U.S. and abroad with positive outcomes for students, including first-generation students and those on academic probation (e.g., Bowering et al., 2017). In other words, teaching students "how to learn" using evidence-based best practices works.

Foundational Learning Outcomes

The foundational learning outcomes are broad, discipline-agnostic outcomes that individual faculty can use to refine Specific Learning Outcomes (SLOs) tailored to their specific pedagogical style, program goals, and disciplinary expectations. Upon successful completion of a course with these foundational learning outcomes, students will be able to:

1. Understand Self-Regulated Learning

Students will be able to articulate the role of self-regulated learning in their own academic performance. Self-regulated learning is an umbrella term to describe learner autonomy and control of their learning approaches and outcomes. Self-regulated learning is characterized by learners' control of their motivation, behavior, and metacognition in pursuit of their learning goals (Zimmerman, 2000). Self-regulated learners actively engage with their learning through a cyclical process consisting of three phases (see Zimmerman, 2013):

- *Forethought Phase*: This phase precedes performance. Students analyze the task, set goals, and plan strategies to reach them. This task analysis requires self-motivation/values.
- *Performance Phase*: This phase involves processes during the learning stage. Students execute the task while monitoring progress and using self-control strategies to secure resources and remain attentive and motivated to complete the task (Panadero, 2017).
- *Self-Reflection Phase*: This phase follows performance. Students use reflection to self-assess their performance and identify attributions to the results of their learning. Self-attributions lead to self-reactions including self-satisfaction. Learners use the results of self-reflection to identify adaptations that can influence the manner in which they approach subsequent tasks.

Learning Outcome: Students will be able to explain the relationship between key components of self-regulated learning.

2. Enact Self-Regulated Learning

Students develop an awareness of self-regulation strategies they can utilize before, during, and after course activities. While certain strategies may be course-specific, many strategies are course agnostic (e.g., note-taking). Further, students need to develop an awareness of which strategies will best serve them during each phase of self-regulation, including *Forethought* (e.g., planning, organization), *Performance* (e.g., progress monitoring, task shifting, cognitive flexibility), and *Self-reflection* (e.g., evaluation of outcomes) (Greene, 2018). Finally, students need to develop an awareness related to the different types of self-regulation strategies including:

- Motivational strategies involve changing beliefs about students' ability to perform a task, the importance and interest of the task, and their emotional reactions (e.g, test anxiety) (Pintrich & De Groot, 1990)
- Behavioral strategies involve use of resources available to learners, including time, study environment, and help-seeking from peers and faculty (Zimmerman & Martizen-Pons, 1986).
- Cognitive strategies involve rehearsal, elaboration, and organization.
- Metacognitive strategies involve planning, goal setting, monitoring learning, and self-evaluation.

Learning Outcome: Students will be able to enact strategies that lead to the development of learning-how-to-learn competencies across all three phases: forethought, performance, and self-reflection.

3. Assimilate & Provide Feedback

Students develop the ability to evaluate, analyze, integrate, and communicate information essential to learning. The process of learning rests heavily on understanding what information is relevant to learning, and students' ability to access that information. Feedback provides access to the information students need to learn. Critically, feedback not only provides learning-relevant information but also has an evaluative dimension (positive vs. negative) that influences students' motivation and performance. By holding a positive view of the evaluative aspect of feedback and prioritizing the information that is relevant to learning, students become better learners, integrating information and minimizing future errors. Notably, the value of peer feedback lies not only in receiving feedback but in the role that students play in giving feedback (MacArthur, 2017). This allows students to become more adept at evaluating, analyzing, and communicating learning outcomes.

Learning Outcome: Students will be able to evaluate the quality of information and/or ideas through feedback, including the ability to analyze peers' work, apply feedback to improve the quality of work, and develop a greater conceptual understanding of the material at hand.

4. Evaluate Reliability of Information

Students develop the ability to seek and evaluate information from multiple sources and media. Powerful technologies put a plethora of information at our fingertips, including text, images, audio, and video. The wealth of information available, however, raises concerns about student capacity to find, evaluate and critically think about the information (Athreya & Mouza, 2017). Research indicates that students have difficulty developing effective research strategies, identifying search keywords, and sorting through information (Metzger et al., 2015). They tend to spend more time on finding rather than evaluating information and settle for top results rather than high-quality resources (Nicholas et al., 2011). Students need to develop the capacity to formulate search queries, find and evaluate credible information, and synthesize this information to support learning.

Learning Outcome: Students will be able to demonstrate understanding of seeking information from a variety of sources (textbook, Internet, etc.), including the ability to evaluate the accuracy and credibility of sources.

Guidelines for Incorporating SLOs

In this section, we provide explicit guidelines and steps to support instructors as they incorporate the four student learning outcomes on learning-how-to-learn identified above. In each step, you will find a rationale as well as specific guiding questions for implementation.

Step 1. Consider which aspects of learning-how-to-learn you want to highlight in the context of your course. As noted, self-regulated learning includes the motivation, behaviors, and metacognition that students bring to a learning situation. As you think about your course consider the following questions:

- Which aspects of self-regulated learning best support learner autonomy in your course?
    - For instance, in courses with high attrition instructors may want to consider the motivation aspect of self-efficacy compared to behavior.
- Which phases of self-regulated learning are you most interested in advancing (e.g., forethought, self-reflection)?
    - For instance, if your primary goal is to help motivate students for the work ahead, forethought or preceding activities will be more valuable. If your goal is to help students self-assess outcomes, self-reflection or after-learning activities will be more beneficial.
- What tools can students use to engage in self-regulation tasks?
    - This may include an electronic calendar for planning their time or phone reminders for staying on task.

Step 2. Consider which strategies are most appropriate for the development of learning-how-to-learn in the context of your course objectives and assignments. There are different types of self-regulation strategies, including motivational, cognitive, metacognitive, and behavioral. As you think about your course consider the following:

- Which strategies are most appropriate in the context of your course?
    - One approach is to write a list of strategies that are conducive to learning in your course. Then, write a few sentences about why or how these strategies may help students with your course material.
- Are you explicitly introducing the most applicable strategies to your students?
    - For instance, peer evaluation works well in courses with written assignments while rehearsal of information through flashcards works well in courses where memorization is needed. By exposing students to a repertoire of applicable strategies, they can begin to develop their own "strategy toolbox" to utilize across academic coursework.
- Are you modeling and providing examples of how self-regulation strategies can be applied in the context of your course?
    - Observation and emulation are critical in self-regulation; they help learners acquire the use of a skill on their own and its application in authentic settings.
- Are you prompting students to use self-regulation strategies (e.g., goal setting, avoiding environmental distractions)?
    - Students frequently need prompting to engage with new strategies until the strategies themselves become habits.
- Are you prompting students to self-evaluate and reflect to identify which strategies are most effective for them?
    - Self-reflection provides students with the opportunity to solidify new-found knowledge and engage in appropriate adaptations as they approach new tasks.

Step 3: Consider how students will develop self-regulation through quality feedback. When students receive quality feedback across different disciplines there are expanded opportunities for feedback from different perspectives through multidisciplinary learning activities. In other words, engaging in quality feedback across students' courses will better develop self-regulated learning. It may be helpful to consider the following:

- Are students receiving feedback beyond the evaluative?
    - Feedback provides students with explicit access to the information they need to learn. Often feedback is only evaluative (correct [positive] vs. incorrect [negative]), this means that the feedback students receive regarding information that is relevant to learning is minimal. By holding the evaluative dimension of feedback positive and focusing on providing students with the information that is most relevant to learning students become better learners.
- Are students receiving timely feedback?
    - At the most basic level, timely feedback permits students to utilize the information they receive to improve their performance on subsequent tasks.

Timing can also influence future task and study planning and facilitate social discussion to improve learning.

- Are you engaging in feedback that supports students' development of self-regulated learning?
    - This could include student feedback from peers or the instructor, feedback could also be provided from authentic sources (e.g., Engineering students building a medical device could receive feedback from nurses or physicians.)
- Are your students being provided with feedback on the quality of their self-reflection?
    - Feedback requires that the learner hear the message and make a conscious decision to use (or not use) the feedback. During self-reflection, students should be able to integrate useful feedback to plan for improvement and explain why other pieces of feedback will not improve their learning or final product. Evaluating students on their self-reflection improves both the quality of the self-reflection itself, their learning, and the final product.
- Are students' application of feedback to improve the quality of their work aligned with the instructor's evaluation of the students' performance?
    - After receiving feedback and engaging in self-reflection, students should be able to refine their initial product. This could be evaluated based on the first submission and second submission of an assignment or considered steps that are graded as part of a single assignment.
- Are you providing feedback on help-seeking behaviors?
    - Learners who are given feedback on these behaviors use helpful resources more often than those who do not.

Step 4: Consider the sources of information students will need to complete your course (e.g., textbooks, the Internet, videos). As you think about your course, consider the informational needs of the students, particularly in relation to course assignments. It may be helpful to consider the following:

- Are you communicating to students the sources of information they will need to complete the course?
    - In courses that include writing, for instance, are you communicating where the information should come from (e.g., course materials, peer-reviewed journals, primary sources)?
- Are you communicating to students what sources of information are acceptable in the context of your course?
    - Students tend to rely on a few familiar sources such as course readings, search engines, and Wikipedia. Consider providing a clear explanation to students regarding which of these sources may or may not be acceptable course-related research.
- Are you modeling how to form search queries?
    - Novice students and students whose native language is not English may have difficulty coming up with different terms to facilitate their search.

    - Consider inviting colleagues from University libraries to help students learn how to access library databases, use reference management tools, and become familiar with a citation system (e.g., APA, MLA).
- Consider introducing students to evaluation criteria for selecting content from the Internet (e.g., Do Your Sources Pass the CRAP Test?).
    - Evaluation criteria for selecting content must emphasize critical thinking, to ensure that students do not blindly apply evaluation criteria without a full understanding of the purpose underlying the rationale for the evaluation (Metzger et al., 2015).
    - Sample questions are available at the UD library website: Evaluating Sources - Research Guides at University of Delaware
- Are you encouraging students to engage in note-taking as they search for information?
    - This is important for avoiding plagiarism (see: Defining and Avoiding Plagiarism: The WPA Statement on Best Practices) and appropriately citing sources (see: Citing Sources - Research Guides at University of Delaware).
    - The Cornell Note-Taking System is one way of keeping notes. This system centers on five Rs (record, reduce, recite, reflect and review). You can learn about and try the Cornell Note-Taking System.

Example Assignments

Once instructors develop an understanding of self-regulation and the types of strategies that can be used to teach students "how-to-learn," it's time to develop specific assignments. In this section, we present specific examples organized by a goal as well as the self-regulation process.

Please note that *Goal 1. Understanding Self-Regulated Learning* is conceptual and focuses on developing an understanding of key components of self-regulated learning. No specific assignments focus on Goal 1. Instructors can use a lecture to introduce self-regulated learning or a brief course, such as the one here or the one here.

Instructors must explicitly address with students the types of self-regulated strategies they will need to develop to be successful in the course.

Goal	Forethought (Pre)	Performance (During)	Self-Reflection (Post)
Goal 2 - Enact	Students engage in a whole-class discussion on what makes good Sketch Notes (notes that include text, diagrams, and arrows illustrating main ideas) based on a Sketch Note sample shared by the instructor.*	Students are asked to create a Sketch note where they reconceptualize key components of a lecture using text, drawings, and symbols.	Students share their Sketch Note with a partner. They discuss similarities & differences and reflect on the Sketch Note strategy for facilitating understanding of lectures as well as opportunities to apply this strategy in future lectures. They may also compare their Sketch Note to an instructor-prepared one.
	Students are asked to maintain a journal where they reflect and analyze how course concepts apply in the real-world (e.g., education students may journal on their classroom observations and how they reflect concepts covered in their coursework). Students must make a plan for how frequently they reflect and what tools they will use to record their reflections (e.g., blog, word document).	Students compose journal entries using a series of prompts that help them connect course readings to real-world issues.	Students review reflections from peers identifying similarities & differences. They also reflect on the tools used to maintain their journals and their role in helping their understanding of course materials in relation to real-world issues.

Goal 3 - Feedback	Students engage in a conversation about how to best complete a writing assignment. This includes goal setting and strategic planning with weekly milestones. Weekly milestones are scaffolded by the instructor to prevent students from picking unrealistic milestones.	Students are asked to submit their weekly writing. Their writing is graded (complete vs. incomplete) based on alignment with their strategic planning milestones. For example, a student planned to write 200 words 3 times this week and wrote over 200 words 3 times this week.	Students reflect briefly on their ability to reach writing milestones each week. This includes reflection on successes as well as obstacles that arose. Peer feedback is used to identify additional obstacles and learn from each other's successes. Weekly reflections and peer feedback are graded *ad-hoc* throughout the semester.
	Students are given a screening assessment on the first day of class to establish their baseline background knowledge. The assessment questions are then broken out into categories for a discussion about which categories of background knowledge were the most difficult or least remembered.	The class then engages in a case study discussion with each category of background knowledge required for course success linked to a case that connects to new course knowledge. For example, why was a field of endangered species not protected?	The students are then asked to identify and complete the background knowledge virtual learning modules before the section of the course where that knowledge will be needed. For example, they complete the module on plant identification before a discussion on why certain plant species are endangered.
	Students are asked to create a lesson plan for teaching and to give the lesson to both their partner and a “professional learning group” of their classmates.	Students are asked to complete peer coaching forms that include detailed questions regarding their partner's lesson.	Students are asked to complete a 1-page reflection that includes an action plan for integrating feedback and commentary on why feedback was or was not used.

Goal 4 - Digital	Students are asked to consider what distinguishes a fact from an opinion. They are asked to list down questions/criteria they use to differentiate fact from opinion.**	Students are asked to read an article, newspaper story, or other document and identify facts and opinions based on the criteria they identified.	In pairs, students are asked to share their criteria and findings and revise them as needed. They are also asked to reflect on their confidence in distinguishing facts from opinions. This will help them consider whether they feel prepared for future assignments.
	Students are asked to consider what criteria they use to identify high-quality online resources for course assignments. They are asked to list down their criteria. They are also asked to identify tools they will use to search and save online resources (e.g., library databases, Internet, online bookmarking).***	Students are engaged in an online scavenger hunt that requires them to use online resources to answer course prompting questions (e.g., What is digital literacy? Why is it important?). They prepare a 1-page response using at least 4 online resources.	In small groups, students present their responses and the criteria and tools they used to identify high-quality online sources. They discuss what worked, what did not work, and how they may modify their list of criteria. They are also asked to reflect on their confidence in identifying high-quality online resources to consider their preparedness for future assignments.
*Notes. * Sketch notes: kpcrossacademy.org; ** Fact vs. opinion: kpcrossacademy.org; *** Online scavenger hunt: kpcrossacademy.org*			

Myths, Misnomers, & Misconceptions

Myth: First-Year Post-Secondary Students Are Independent Learners

The assumption that first-year college students can be autonomous and independent learners is demonstrably false (e.g., Christie et al., 2013; Noyens et al., 2017; Räisänen et al., 2016). While

researchers actually agree on the importance of self-regulated learning skills in higher education, lower education, and beyond education, we often forget that university students did not arrive on campus with these skills (e.g., Bjork et al., 2013; Nugent et al., 2019). The vast majority of our students require educator co-regulation to learn effectively (Räisänen et al., 2016). Co-regulation requires that we, as instructors, *gradually* shift self-regulatory ownership to the learner (i.e., gradual release of responsibility). It is important to remember that retaining control over self-regulation causes "destructive friction" for students (Vermunt & Verloop, 1999), resulting in decreased learning and thinking when instructions are too prescriptive (Vermunt, 2006). Put simply, **students must be taught to become independent learners**.

Learning Misnomers

To use proper learning strategies, learners must first understand what those strategies are and what they are not. Thus far, proper learning strategies have been the sole focus of this handbook. Here, we aim to dispel some myths that appear to be prevalent in education circles. And, we aim to provide some guidance on dispelling these myths in your classroom.

First, there is **no evidence to support learning styles** (e.g., visual, auditory learners). While learners differ in their ability to comprehend different modalities, teaching students in their preferred modality does not lead to better performance (Howard-Jones, 2014). The Smithsonian has created a video titled, "Sending learning styles out of style" that aims to debunk this neuro-myth. Rather, evidence supporting the Universal Design for Learning suggests that learning is best supported through multiple means of representation (Meyer, Rose, & Gordon, 2012, 2014).

Second, **learners cannot multitask without performance cost.** You can listen to the late Clifford Nas, Ph.D.'s interview on NPR titled, "The Myth of Multitasking" where he focuses on the cost of multitasking for creativity and concentration. Multitasking refers to the act of performing several tasks within a limited window of time, inclusive of both task-switching and dual-tasking (Koch, 2018). Often when we think we are multitasking, we are instead switching attention rapidly from task to task (e.g., task-shifting). In contrast, dual-task situations are those in which tasks are performed more or less simultaneously due to the temporal overlap of cognitive processes. Evidence suggests that studying, doing homework, learning during lectures, grades, and GPAs are all negatively affected by multitasking (Carrier et al., 2015). Learners need to be proactive participants. Learning is something that they choose to make happen, not something that "happens to them" as a reactionary response to teaching.

Third, **students underestimate how long a task will take to complete**. This phenomenon of optimistic time prediction is referred to as the "**planning fallacy**," which is when individuals overestimate how much they can accomplish in a given time period (Kahneman & Tversky, 1979). The planning fallacy occurs due to students focusing on how the future will unfold without integrating evidence from past experiences (Buehler et al., 1994). When students do consider previous instances of completing similar tasks, they consider only those that support an optimistic timeline. Even when confronted with past prediction failures students interpret those instances in diminished relevance to the present prediction. Conversations that implicitly involve the planning fallacy are unsurprisingly frustrating for both students and their instructors (e.g.,

Sanchez-Carracedo et al., 2018). Thus, it becomes pertinent to consider: How can instructors help students combat the planning fallacy?

One answer lies in helping students perceive an assignment as requiring greater effort (e.g., Kruger & Evans, 2004). When a task is perceived as requiring greater effort students estimate longer time frames for completion. To increase perceived effort, instructors can help students move an assignment from the abstract to the concrete. This can be achieved by unpacking the whole task into subtasks. For example, the instructor could model visualizing each of the steps needed to complete a task. The other answer lies in helping students perceive a shorter timeline (Peetz et al., 2010). When a task must be completed in a short time period students demonstrate less optimistic time predictions (e.g., Eyal et al., 2004) and are more likely to accurately perceive potential obstacles to task completion (Peetz et al., 2010). To increase the perception of a shorter timeline, instructors should provide guidelines as to how much time students are expected to spend on different types of assignments and to have students consider realistic obstacles that could impact their task completion.

Misconceptions: The link between the novice and expert

Studies have shown that experts and novices differ in how they experience everything from art (Silvia, 2013) to mathematics (Popescu et al., 2019). While few would argue against the value of expertise in a content area for teaching, expertise can also lead to misalignment of pedagogy. This disconnect is referred to as "**The Expert Blind Spot**" (Nathan & Koedinger, 2000). For example, those with more expertise are worse predictors of novice task performance times (Hinds, 1999). This may be due to expertise leading to automatization of cognitive processes (e.g., Ericsson & Simon, 1984). Moreover, those with no formal educational classes but strong subject matter knowledge demonstrate a mismatch in gauging difficulty (e.g., Nathan et al., 2001). Yet, the phenomenon referred to as the "**Dunning-Kruger effect"** demonstrates that novices also overestimate their abilities (Kruger & Dunning, 1999). Several studies have documented that students overestimate their own skill level because they do not know what they do not know (e.g., Howard et al., 2018). Thus, it is perhaps unsurprising that misconceptions litter the trail from novice to expert.

Beyond a mismatch in gauging difficulty, there is often a discrepancy between our teaching beliefs, teaching intentions, student's expectations and their reactions to teaching practices. For example, if an instructor believes that higher-order thinking skills are essential to a course but relies mainly on lecture-based teaching strategies then a discrepancy exists between learning goals and teaching practices. This **gap between pedagogical teaching beliefs and teaching practices** is found even in those celebrated for their teaching excellence (Owens, 2015). Similarly, alongside the heavily documented biases (e.g., race, ethnicity, sex) in university students' evaluations of instructors (Reid, 2010; Wachtel, 1998), there is a well-documented **gap between classroom pedagogy and students' evaluation** of teaching practices. Indeed, studies have shown that instructors who assign a lot of reading receive poor course evaluation (e.g., Howard et al., 2018). In fact, several studies have shown a negative relation between students' evaluations of teaching and effectiveness of teaching: measured by long-lasting learning (see Kornell & Hausman, 2016 for review). Thus, high course evaluations do not necessarily

indicate that instructors have taught students "how to learn" or that students have learned domain-specific knowledge.

Select Annotated Bibliography

Bernacki, M. L., Vosicka, L., Utz, J. C., & Warren, C. B. (2020). Effects of digital learning skill training on the academic performance of undergraduates in science and mathematics. *Journal of Educational Psychology*. Advance online publication. http://dx.doi.org/10.1037/edu0000485

The study examined whether brief, digital training modules aimed at helping students apply learning strategies and self-regulated learning principles in STEM courses can impact students' behaviors and performance in a large biology course. Results indicated that the modules had a positive impact on students' use of resources for planning, monitoring, and strategy use. They also helped improve students' scores on content area quizzes and exams.

Bjork, R.A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology, 64*, 417–444.

The article provides a comprehensive review of what learners need to understand to become effective in their own learning, including what they believe about how they learn. The research reviewed in this work identifies principles and practices that can be utilized to support learning.

Greene, J.A., Lobczowski, N.G., Freed, R., Cardiff, B.M., Demetriou, C., & Partner, A.T. (2020). Effects of a science of learning course on college students' learning with a computer. *American Educational Research Journal, 57*(3), 947-978.

The study provided empirical evidence that college success is bolstered by participation in a first-year science of learning course, which focused on self-regulated learning. Improvement in conceptual knowledge was seen even when students only received access to the course materials. Further, the course helped students acquire monitoring and strategy-use knowledge that could be applied across contexts.

MacArthur, C. A., Philippakos, Z. A., & Ianetta, M. (2015). Self-regulated strategy instruction in college developmental writing. *Journal of Educational Psychology,* 107, 855-867. doi:10.1037/edu0000011.

The study demonstrates that effective instruction can help university students develop into proficient writers by increasing their knowledge of writing strategies through the development of self-regulation strategies. Self-regulation strategies, including goal setting, task management, progress monitoring, and reflection, were learned alongside writing strategies for planning, drafting, and revising compositions.

Pintrich, P. & De Groot, E.V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-40. doi:10.1080/00207590500411179

The study provides ecologically valid empirical evidence linking student's motivational orientation, cognitive engagement, and self-regulation to academic performance. Self-regulated learning was connected to students' beliefs that academic learning is interesting and valuable.

Zimmerman, B.J. (2013). From cognitive modeling to self-regulation: A social cognitive career path. *Educational Psychologist, 48*(3), 135-147. doi:10.1080/00461520.2013.794676

A biographical and historical perspective on self-regulation research from a pioneer in the field. The piece includes the evolution of the definition and cognition models of, measurements of, teacher and student beliefs and expectations of self-regulated learning. The article concludes with future research recommendations for investigations into and surrounding self-regulated learning.

Appendix A. Glossary

Behavioral Strategies - students' self-generated actions or conduct that are oriented towards their learning goals.
Conditional Knowledge - knowing when and why a specific learning strategy should be used.
Cognitive Flexibility - changing approaches or perspectives to problem-solving, often this involves adjusting to new rules, priorities, or demands.
Cognitive Strategies - student's mental plans oriented towards their learning goals. Cognitive strategies can be divided into three subcategories including, rehearsal, elaboration, and organization.
Co-regulation - a process of scaffolding that is externally initiated whereby regulatory ownership is gradually shifted from the instructor to the owner (see *Gradual Release of Responsibility*).
Critical Thinking - "the mode of thinking in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them" (Sciven and Paul, 2004, p. 74). In other words, the assessment of authenticity, accuracy, or worth of knowledge or arguments (see *Higher-order thinking*).
Declarative Knowledge - how to use a learning strategy.
Dual Tasking - situations in which tasks are performed more or less simultaneously.
Elaboration - Building connections between what is learned and what already exists in service of learning (see *Cognitive Strategies*).
Evaluation - A qualitative or quantitative description of student behavior combined with a value judgement regarding that behavior. This is used to determine the effectiveness of the learning method and one's own understanding (see *Metacognitive Strategies*).
Executive Functions - a set of domain-general, cognitive processes, linked to the prefrontal cortex in the brain. Across theoretical models, three core processes are emphasized: working memory, inhibition, and cognitive flexibility.
Goal Orientation - a purpose for action or an enduring disposition towards engagement; why and how people are trying to achieve objectives.
Gradual Release of Responsibility - pedagogical model that moves instruction from explicit modeling to guided practice, and finally to activities in which the students become independent learners (see *Co-Regulation*).
Higher-order thinking - thinking beyond basic observations of facts or memorization that occurs when one takes in new information and relates, rearranges, or extends this information to achieve a purpose or solve a problem.
Learning Strategies - "processes (or sequences of processes) that when matched to the requirements of tasks, facilitate performance" (Pressley, Goodchild, Fleet, & Zajchowski, 1989, p. 303).
Metacognition - awareness, and knowledge of one's own thinking.
Metacognitive Strategies - strategies for intentionally examining learners' own thinking. Metacognitive strategies include planning, goal setting, monitoring, and self-evaluation.
Mindset - how much individuals believe they can learn through effort. Dweck (2006) originally conceptualized mindset into two broad categories: growth mindset and fixed mindset. In this

framework, individuals with a growth mindset believe that they gain intelligence through effort, while those with a fixed mindset believe that their performance is a stable characteristic.
Monitoring - Regulation of goal-specific strategies often used to check one's understanding or comprehension (see *Metacognitive Strategies*).
Motivation - the processes that catalyze and sustain goal-directed behaviors.
Multitasking - when two or more tasks require the same cognitive or perceptual resources simultaneously.
Organization - the creation of meaningful units of information, such as drawing graphs or pictures (see *Cognitive Strategies*).
Planning - the aspect of executive function focused on determining the goal as well as the steps needed to reach a goal, including the allocation of resources and time (see *Metacognitive Strategies*).
Procedural Knowledge - when to use or apply a known learning strategy.
Reflective Thinking - consideration of what we do during a task or what we have done after completing a task (see *Higher-order thinking*).
Rehearsal - the selection and encoding of information often verbatim (see *Cognitive Strategies*).
Self-control - inhibition aspect of executive function, involving resisting impulsive or premature action.
Self-efficacy - beliefs or perception of one's ability to accomplish or perform a task.
Self-regulation - the ability to regulate behavior in service of goals; processes that enable maintenance of optimal emotion, motivation, and cognitive arousal.
Self-regulated learning - an umbrella term used to describe the processes of learner autonomy and control of their learning approaches and outcomes. Self-regulated learning has been broken down into component strategies such as cognitive, metacognitive, motivation, behavior, and resources (Pintrich, 1999; Zimmerman, 2013). Together these component strategies allow an individual to adjust their actions to achieve the desired outcome.
Task Analysis - control of the allocation expended in carrying out appropriate strategies, including goal setting and strategic planning.
Task-value beliefs - the extent to which students perceive a task as interesting and important.
Task-switching - switching rapidly between two tasks. Task-switching tasks, also referred to as set-shifting tasks, are often used to measure an individual's cognitive flexibility.

Appendix B. Additional Strategies

Research-based evidence demonstrated that the strategies in the table below can be successfully implemented in the classroom. Additional classroom design strategies, as opposed to activity strategies, have also demonstrated some success (e.g., flipped classrooms; O'Flaherty & Phillips, 2015).

Strategy	**Example**	**Category**	**Study Example**
Organization	Graphic organizers are used to structure writing ideas.	Cognitive	Harris, Graham, & Mason, 2006
Goal Orientation	Discussion of the positive and negative attitudes towards mathematics.	Motivational	García-Sánchez and Fidalgo-Redondo, 2006
Help-seeking	Students seek assistance from peers.	Behavioral	Camahalan, 2006
Evaluation	Students were asked to answer questions during and after problem completion (e.g., What is the difference between your response and the one now shown on the screen?)	Metacognitive	Kramarski & Gutman, 2006
Reflection	During this think-aloud study, students were asked to say whatever came to mind as they carried out tasks.	Metacognitive	Ku & Ho, 2010
	Journaling using cognitive (e.g., What are the main points in your opinion?) and metacognitive prompts (Which main points have I already understood well?)	Metacognitive	Nückles et al., 2020

Note-taking	Students take notes while reading materials or watching lecture videos in online environments.	Cognitive	Veletsianos et al., 2015
Comprehension	Self-explanation/testing: students self-explain a complex diagram, procedures, or phenomenon.	Cognitive	Renkl, 2002
	Skimming through a text before reading it.	Cognitive	Duggan & Payne, 2009
Rehearsal	Flashcards to rehearse content/facts.	Cognitive	Sotarsi & Brogt, 2020
Retrieval	Students self-test rather than re-read materials.	Cognitive	Roediger & Karpicke, 2006

Appendix C. Full References

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