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Review

Learning as a Skill to Be Learned: A Campus-Wide Framework to Support Student Learning and Success

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Abstract

A primary expectation of college is that students in all majors and disciplines will learn content, skills, and knowledge that support individual growth, job placement, or continued academic endeavors. In short, being a student implies an expectation to learn. Effective learning directly impacts student academic success, and this success has downstream effects on student retention and graduation rates. However, the process of learning is often taken for granted, and, too often, student learning is not successful because students have not received any guidance on the methods of effective learning. Across higher education, students are often left on their own to learn about learning, and their improvised methods frequently involve ineffective techniques such as cramming for exams or rereading assigned materials without deeper engagement. To counter such observations, the University of Iowa implemented a campus-wide learning framework, *Learning at Iowa*. The initiative is grounded in empirically validated practices from the cognitive and learning sciences, which have been organized around the Three Ms: mindset, metacognition, and memory. This article briefly reviews the relevant literature supporting each of the Three Ms and then discusses the implementation of the framework with students, student-facing staff, and instructors and how the framework supports effective educational practices.

Keywords: higher education; student success; learning and teaching; growth mindset; metacognition; human memory

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1. Introduction

Although higher education attendance is high and continues to have economic benefits to students (e.g., Hout, 2012), persistence and graduation rates remain challenging for both students and higher educational institutions (National Center for Education Statistics, 2022). Because of these challenges, particularly for students who have educational opportunity gaps, student success efforts remain important. Colleges and universities continue to implement various programs and initiatives that have been shown to support student success or student engagement broadly, and these practices tend to focus on increasing first to second year persistence, academic success (grades), and graduation rates. These high impact practices are generally well known in higher education and have been the focus of intensive research (e.g., Kuh et al., 2010; Mayhew et al., 2016).

These widely known approaches to supporting students tend to fall within two broad and related categories. One category documents the positive influence of institutional-level supports or programs, such as first-year seminars, learning communities, capstone experiences, and undergraduate research (Brownell & Swaner, 2011; Finley, 2019; Kuh,

2008). Other validated practices that prove impactful at a broader, institutional level include learning assistants (e.g., Barrasso & Spilios, 2021; Williams & Fowler, 2014) and supplemental instruction (e.g., Arendale, 1994), where students support and facilitate the learning of other students. Across all of these supports, generally, student involvement tends to be associated with increased persistence and academic success.

Another category of approaches to student support identifies psychological variables, typically social and motivational factors, that are associated with student success outcomes in higher education. The two factors that have received the most research focus are a student's sense of belonging and a student's mindset, or lay beliefs, about intelligence.

Sense of belonging is broadly defined as one's beliefs and perceptions of a connection to social groups, including family, friends, and school or work environments (e.g., Allen et al., 2021), although belongingness is transmitted by many other factors (Ahn & Davis, 2020; Covarrubias, 2024). A sense of belonging has been long considered important for a student's persistence in college and other outcomes (e.g., Hurtado & Carter, 1997). Recent approaches to creating a positive college experience have drawn on sense of belonging to advocate for "relationship-rich education" (Felten & Lambert, 2020), with relationships between students and others on campus—including other students—providing the connections that foster belongingness.

A sense of belonging has also been the focus of several educational interventions. In these cases, a belongingness intervention is used to increase students' perception of belonging in a class or at a university, which can then confer an academic benefit or other outcome. For example, several interventions have sought to reduce students' uncertainty of belonging, particularly for students who are under-represented in higher education, by normalizing the academic and social challenges that all students face when transitioning to college (e.g., Murphy et al., 2020; Walton & Cohen, 2007, 2011; see Chrobak, 2024, for a review). Normalizing these challenges and framing them as common, yet transient, for all students provides a non-threatening interpretation of adversities. This interpretation can help minimize negative self-attributions that students often make when transitioning to college and facing academic and social challenges. Compared to control groups that do not experience such social-belonging messaging, groups that receive social-belonging messages show improved academic outcomes (grades) and show higher levels of continued enrollment in college. These same social-belonging interventions also benefit students in introductory-level courses. Similar social-belonging messages can increase persistence and grades in introductory science, technology, engineering, and mathematics (STEM) classes, particularly for student groups that are under-represented in STEM fields (Binning et al., 2020, 2024).

In addition to bolstering students' sense of belonging, another psychological factor that affects student success is a student's mindset, or beliefs, about intelligence. Specifically, having a growth mindset—the belief that one's intelligence can change and develop with experience—as opposed to a fixed mindset, helps motivate learning and results in better academic outcomes (see C. S. Dweck & Yeager, 2019). The initial research on growth mindset demonstrated that learners' mindset was associated with academic outcomes. For example, in transitioning to junior high, students who viewed intelligence as malleable had higher grades after the transition (Henderson & Dweck, 1990). In elementary school students, fixed mindset beliefs were associated with lower academic performance (Stipek & Gralinski, 1996).

Studies on the influence of lay theories of intelligence have also used interventions to promote growth mindset beliefs in college or in the transition to college. In an early intervention study (Aronson et al., 2002), one group of college students wrote about intelligence being malleable. Another, control group was prompted to write about different

types of intelligence (multiple intelligences). The college students who conveyed a growth mindset internalized this message and exhibited higher grade point averages (GPAs) than students in the control group. Subsequent work with large sample sizes investigated growth mindset interventions for college students with fewer educational opportunities (e.g., first-generation college students or under-represented students). For these students, a growth mindset intervention increased the proportion of students completing full-time enrollment at a 4-year, high-quality public university compared to students in a control condition (Yeager et al., 2016, Study 2). In this same study, a social-belonging intervention, similar to those discussed above, provided similar benefits to students who had fewer educational opportunities. Mindset interventions also appear effective with other populations, such as community college students, where in-class interventions can improve grades for nontraditional students (Fink et al., 2023). As with most active areas of research, the boundary conditions and replicability of mindset interventions are a focus of ongoing debate and discussion (e.g., Macnamara & Burgoyne, 2023).

2. Cognition, Learning, and Student Success

Institutional-level supports, such as supplemental instruction, and noncognitive factors, including sense of belonging and lay theories of intelligence, make important contributions to college student success. But, beyond these, cognitive factors that directly impact how effectively (or not) students learn the material in their courses and for their curricular requirements must also influence student success (e.g., Tinto, 2012). A common assumption is that college students in all majors and disciplines will learn content, skills, and knowledge that will support their individual growth, job placement, or continued academic endeavors. The quality and effectiveness of a student's learning necessarily impacts many bottom-line measures in higher education: A student who does not learn effectively will have grades that reflect this, and those grades will impact student retention and graduation rates across the institution, as we review next.

Although relatively little work has investigated the relationship among students' cognitive skills, learning, and persistence, some research does support the relationship between student learning and persistence. Generally, GPA, a proxy for learning, predicts persistence. For example, Hu et al. (2012) used GPA and learning gains to predict student persistence from the first to second year of college. First-year GPA and self-reported learning gains predicted student persistence from the first to second year of college, when controlling for student demographics (also see Wolniak et al., 2012).

Despite the relevance of cognition and learning in higher education, such factors are discussed infrequently (at best) or are overlooked (see Basko, 2023, for example). There are likely several contributing factors to this lack of discussion. First is the possible assumption that students possess at least rudimentary learning skills if they have been accepted to college. Such an assumption encourages instructors, higher education staff, and students to emphasize a course's content rather than the learning processes needed to acquire and understand that content. Second, learning is often perceived as being in the domain of the classroom and of instructors. Consequently, campus-wide efforts to affect student learning may be perceived as challenges to an instructor's academic freedom, leading to a focus on institutional and structural supports for courses or populations of students. Third, learning is often viewed as a highly individualized endeavor (e.g., Chickering & Gamson, 1987), as is evident in references to "learning styles." There is no solid empirical evidence for learning styles (Pashler et al., 2008). Moreover, the pervasive belief of this myth can de-emphasize the view that effective learning practices are empirically validated skills that work across different individuals, courses, and content. Fourth, instructors and higher education staff are specialists in their content areas and, in many cases, are not

trained in how learning works and the methods of effective learning. This situation can encourage a reliance on intuitions about learning or on methods and pedagogies to produce learning. Unfortunately, such intuitions are often unreliable indicators of effective learning (see Bjork, 1994).

There is little evidence to support some of the foregoing factors that de-emphasize or neglect discussions of student learning. Most relevant are assessments of what students know about learning and studying, including students' knowledge about and use of study habits. In Table 1, we have summarized the responses of several of these studies, starting with the initial paper from Kornell and Bjork (2007), who developed a set of questions to examine the effectiveness of students' study habits. Of the common questions surveyed across these studies, perhaps the most relevant for college student success is "Would you say that you study the way you do because a teacher (or teachers) taught you to study that way?" The majority of students answer "no," indicating that they have never been taught to study. This result holds across the published studies cited in Table 1, with responses ranging over a decade of surveying and a variety of institutions and samples. These majority "no" responses imply that students have arrived at studying and learning habits based on personal experience and, quite likely, based on trial and error. Reliance on personal experience, of course, does not guarantee that a student will discover the most effective habits. And reliance on personal experience will likely be to the detriment of students who are academically less well prepared, exactly the students who need additional support using effective learning practices.

Beyond asking students if they have been formally taught to study, these study habit surveys also have asked about specific approaches to studying. The questions related to specific approaches examined whether students used effective, empirically validated studying and learning practices. The responses to Question 2 show that students are deadline driven and generally do not plan out their learning. Planning out learning is critical for spaced practice, which involves distributing learning over multiple sessions (e.g., Cepeda et al., 2006). Students report not returning to course material very often, although at least some of the students' courses are prerequisites for, and therefore relevant to, later courses (Question 3). The memory demands of an exam do not impact students' responses (Question 4); students report studying similarly for multiple-choice and essay exams, although the latter have a higher memory demand because they require retrieval from memory instead of mere recognition. Students engage in frequent rereading (Question 5), although a rereading strategy has a small effect on learning. Finally, one encouraging point is that most students report using some form of self-quizzing or testing (Question 6), which does produce effective learning, although material that is learned is not reinforced by further testing or review (Question 7), where students tend to stop reviewing too soon (e.g., Kornell & Bjork, 2007).[1]

This general pattern of responses supports the notion that students rely on their intuitions of learning. These intuitions extend to the strategies that students report as effective. Blasiman et al. (2017) asked students to rank the effectiveness of several learning strategies and found that the strategies ranked as most effective were "reading notes," "copying notes," and "highlighting notes." Asking students to freely report the study strategies results in similar results, with almost 84% of students reporting that they reread their notes or textbook (Karpicke et al., 2009). Unfortunately, these are ineffective strategies for learning. These strategies are also likely to promote a fluency effect, in which material that has been reread (or copied or highlighted) will produce a higher judgement of learning but not necessarily higher actual learning. In short, rereading and similar strategies can contribute to the feeling of knowing without contributing to actual knowing or learning.

Table 1. Responses from studies that surveyed student learning habits.

	Kornell and Bjork (2007)	Hartwig and Dunlosky (2012)	Yan et al. (2014)	Morehead et al. (2016)	Tetteh (2017)	Geller et al. (2018)
1. Would you say that you study the way you do because a teacher (or teachers) taught you to study that way?						
• Yes	20%	36%	40%	36%	36%	28%
• No	80%	64%	60%	64%	64%	72%
2. How do you decide what to study next?						
• Whatever's due soonest/overdue	59%	56%	75%	63%	20%	58%
• Whatever I haven't studied for the longest time	4%	2%	3%	3%	5%	2%
• Whatever I find interesting	4%	5%	3%	4%	14%	4%
• Whatever I feel I'm doing the worst in	22%	24%	12%	9%	21%	19%
• I plan my study schedule ahead of time, and I study whatever I've scheduled	11%	13%	7%	21%	40%	17%
3. Do you usually return to course material after a course has ended?						
• Yes	14%	23%	32%	28%	59%	22%
• No	86%	78%	68%	72%	41%	78%
4. All other things being equal, what do you study more for?						
• Essay/short answer exams	29%	20%	35%	27%	N/A	21%
• Multiple-choice exams	22%	22%	18%	22%	N/A	24%
• About the same	49%	58%	47%	51%	N/A	55%
5. When you study, do you typically read a textbook/article/other source material more than once?						
• Yes, I reread whole chapters/articles	16%	19%	40%	17%	25%	15%
• Yes, I reread sections that I underlined/highlighted/marked	60%	64%	47%	58%	43%	52%
• Not usually	23%	17%	13%	25%	32%	33%
6. If you quiz yourself while you study (either using a quiz at the end of the chapter, or a practice quiz, or flashcards, or something else), why do you do so?						
• I learn more that way than I would through rereading	18%	27%	22%	31%	20%	28%
• To figure out how well I have learned the information I'm studying	68%	54%	52%	49%	38%	46%
• I find quizzing more enjoyable than rereading	4%	10%	12%	9%	13%	13%
• I usually do not quiz myself	9%	9%	15%	12%	28%	13%
7. Imagine that in the course of studying, you become convinced that you know the answer to a certain question (e.g., the definition of a term in psychology). What would you do?						
• Make sure to study (or test yourself on) it again later	36%	46%	52%	38%	61%	38%
• Put it aside and focus on other material	64%	54%	48%	62%	38%	62%

3. Learning at Iowa: Supporting Student Learning and Cognition

Against the backdrop of this evidence suggesting a need to support student learning, we have developed a campus-wide learning framework, Learning at Iowa, to provide students, student-facing staff, and faculty with resources to support effective learning. As with many initiatives on campuses, Learning at Iowa emerged from a university committee. The committee, co-chaired by the first author, was charged with supporting the university's strategic plan by exploring how to best support student success. The committee came to focus on how to support student learning based on the first-author's course, Learning

About Learning, a course that provides students with research-validated approaches to more effective studying and learning. The initiative distills relevant research on learning from the cognitive sciences, with the primary goal of providing consistent language and recommendations around student learning. The purpose of this consistency was twofold: first, to minimize student confusion caused by recommendations from various sources (e.g., instructors, advisors, and peer tutors), and second, to emphasize the use of empirically validated learning practices, such as those reviewed above, that students have had little exposure to. A secondary goal is to assess the use of the framework, and its effects on student learning, as it is used in classes and campus support offices.

We have presented the Learning at Iowa approach at several national and regional conferences, and the initiative has been presented informally in higher education outlets (e.g., Supiano, 2023). The current paper was motivated by a need to introduce the initiative and its underlying research foundation to a broader higher education audience. In describing the Learning at Iowa initiative, we first discuss the core principles that we use to summarize the extensive literature on cognition and learning. This summary also serves to provide the foundation for the consistent language and recommendations that are central to the initiative. We then discuss some of initiative's central campus partners and the resources that were developed to support the project. Finally, we discuss the initial results from Learning at Iowa, focusing on our implementation and the number of students exposed to the content and the number of staff and instructor partners. This discussion of our implementation is intended to provide a starting point for other campuses, instructors, or academic support units that might be interested in using the framework in their own institutional contexts.

3.1. The Three Ms for Student Learning

The framework's core principles are summarized as the Three Ms: mindset, metacognition, and memory. Although these are not the only factors that support effective learning, these three concepts capture many of the major factors that have been identified and verified in the cognitive sciences. Below, we review each of the Ms and describe the relevant research that we share across campus audiences. These concepts were chosen based on our experience with a long-running Learning About Learning course, offered by the first author's academic department. More important, the concepts have a logical progression that we convey explicitly to emphasize the components of effective learning: First, mindset, specifically, having a growth mindset, is necessary for students and other learners to be motivated to learn. That motivation is driven by a student's attitude that learning occurs with practice and effort. Second, metacognition is necessary for students to monitor and regulate their learning: in short, knowing when they have learned and when they have not. Metacognition also provides a framework for students to understand specific learning processes, such as anticipating the time a learning task will take. Third, memory introduces students to the validated memory practices that many students are unaware of, including those assessed by the studies reviewed in Table 1. These practices provide students with specific, actionable approaches for learning material in their classes.

As reviewed earlier, holding the attitude that one's intelligence can change and develop with experience (that is, having a growth mindset) helps motivate learning and contributes to positive outcomes in college. Students are often familiar with growth mindset because of their exposure in middle or high school, although often this exposure results in misconceptions (e.g., C. Dweck, 2016), such as confusing a growth mindset with having a positive attitude about learning. Students should have an accurate view of a growth mindset that emphasizes that skills are developed through practice that is guided by input and feedback from instructors and others.

3.1.1. Mindset

Presenting an accurate view of growth mindset helps emphasize the role of the individual in learning. Individual learners need to recognize that learning is not passive and requires effort. In many cases, students perceive learning as something that happens to them rather than viewing learning as an active process (e.g., Ruohoniemi & Lindblom-Ylänne, 2009) in which they must engage. Emphasizing the role of students in their own learning makes connections to deliberate practice, which is the purposeful, structured practice aimed at improving a skill (Ericsson et al., 1993). Deliberate practice is critical to the development of expertise, such as becoming an expert musician or chess player, but novice learners must understand that how they study—that is, which skills they practice—are central to learning. Devoting more time to an ineffective learning practice is unlikely to produce the results a student desires.

Understanding a growth mindset is also important for instructors and student-facing staff because effective learning is the product of the individual learner and the learning environment (i.e., classroom). A highly motivated student with a growth mindset nevertheless may struggle in a "weed-out" class, where an instructor explicitly conveys that existing individual talent will determine which students are successful and which are not. Recent research has demonstrated the role of an instructor's mindset in establishing a supportive classroom environment (see Murphy, 2024, for an overview). Instructors who are perceived to have a fixed mindset contribute to negative classroom experiences that put students at risk for lower grades, less class engagement, and reduced attendance (e.g., Muenks et al., 2020). In STEM fields, fixed mindset instructors show larger gaps between majority students and students under-represented in STEM fields (Canning et al., 2019, 2022). In contrast, instructors who modeled a growth mindset by communicating the importance of effort and help seeking contributed to higher course grades for first-generation college students (Canning et al., 2024).

Beyond the instructor's mindset, other components of mindset can benefit students when delivered by instructors or student-facing staff. For example, deliberate practice is important for instructors and others to understand so that they can make effective recommendations when working with students who may be struggling. Simply recommending that a student spend more time on a course is too vague and may not help if a student is not practicing the right skills or is using a less effective learning method.

Clearly, possessing a growth mindset is important for a student's learning. But, beyond the motivation to learn that is supported by a growth mindset, students must have cognitive skills that help translate motivation into learning. To engage in deliberate practice, students need to recognize which skills they need to practice, and this requires students to monitor and evaluate their learning and performance. Also, one of the main messages from the early mindset research was that students with such a growth mindset tend to respond to learning challenges by changing strategies or seeking help. However, to recognize that they are facing a challenge, students need to have the ability to monitor and evaluate their learning and performance. Monitoring and regulating learning are key metacognitive skills that are used by effective learners.

3.1.2. Metacognition

Metacognition involves thinking about and directing one's thinking (Flavell, 1979; Bransford et al., 2000), colloquially referred to as "thinking about thinking." Metacognition is critical in producing self-directed, self-regulated learners (Lovett et al., 2023; Zimmerman, 2015). Self-directed learning has been reported as one of the major cognitive challenges facing first-year college students, with Pintrich (2002) noting that most students arrive at col-

lege with little understanding of metacognitive knowledge and regulation and concluding that students should be taught about metacognition.

Metacognition allows learners to control and guide their learning and is subdivided into metacognitive knowledge and metacognitive regulation (e.g., Brown, 1978; Jacobs & Paris, 1987). Metacognitive regulation is particularly relevant for college-level learning because this regulation involves how learners monitor and control cognition during the learning process. Metacognitive regulation is divided into three processes—planning, monitoring, and evaluating (Pintrich, 2000; Schraw, 1998, 2001)—which nicely map on to most of the learning tasks that students face in college. These processes involve students assessing their learning task (planning), monitoring their progress and understanding, and determining the effectiveness of their learning (evaluating). Learners who employ these metacognitive processes reap academic benefits (e.g., Stanton et al., 2021). For example, writers who plan a composition and understand the writing prompt produce better essays (Hayes, 1989); readers who monitor their comprehension and self-explain have higher reading comprehension (Wiley et al., 2016); and learners who evaluate their learning via self-quizzing create stronger memories and guide their subsequent learning (Karpicke, 2012).

Despite the importance of metacognition to effective learning, training metacognition is challenging. Mere exposure to the concept may be insufficient for students to put metacognitive skills into practice. For example, several studies have investigated how to reduce students' overestimates of their exam performance. Overestimating exam performance is a metacognitive error, where the learner makes an incorrect prediction about their knowledge. Even when extra credit is provided as an incentive for students to make accurate exam predictions, students continue to overestimate their exam performance and perform worse than they predict (Miller & Geraci, 2011). These exam score predictions are especially problematic for the students who are the least prepared for the exam. These students—those who earn Ds or Fs on an exam—exhibit the Dunning–Kruger effect (Kruger & Dunning, 1999) by overestimating their performance by more than students who are better prepared, those who get As on an exam (e.g., Serra & DeMarree, 2016).

More encouragingly, students' use of metacognition appears trainable or teachable when students are given practice with metacognitive planning, monitoring, and evaluating. In a meta-analysis, Donker et al. (2014) reported that general metacognitive training produced large statistical effects on academic performance compared to no-training controls; more specific training on metacognitive planning, monitoring, and evaluating also produced medium to large statistical effects. Such metacognitive training appears to produce academic benefits that last beyond the initial intervention period (de Boer et al., 2018).

Beyond predicting broad academic benefits, metacognitive training improves student problem solving in a variety of domains. For example, Zepeda et al. (2015) demonstrated that direct, explicit metacognitive instruction and the use of metacognitive regulation during problem solving improved performance in middle-school students. Students who learned about metacognitive planning, monitoring, and evaluating produced more accurate problem solutions than did a group of control students. Moreover, the students who learned to use metacognitive skills transferred these skills to solving novel problems, understanding the new problems better than the control group. In college STEM courses, metacognitive instruction also shows beneficial results for student learning: metacognitive instruction increases performance on assessments (e.g., Casselman & Atwood, 2017; Mutambuki et al., 2020) and increased learning gains (Mathabathe & Potgieter, 2014; Sabel et al., 2017).

The explicit instruction of metacognitive skills is especially important because explicit instruction produces larger learning benefits for students than implicit metacognitive instruction (Zohar & Dori, 2012). Beyond explicit instruction on metacognition, students

need regular practice using metacognitive skills to produce sustainable learning outcomes. Without appropriate training and use, students' metacognitive abilities are likely to remain stagnant over time (e.g., Casselman & Atwood, 2017; Nietfeld et al., 2006). Despite the importance of metacognition and training in metacognition for effective learning, few higher ed instructors know of or use metacognition in their teaching. Dennis and Somerville (2023) reported that among STEM faculty in their sample, only 37.5% of those instructors reported hearing of metacognition. None of the instructors interviewed reported explicitly teaching metacognition or metacognitive strategies. These findings indicate a sizeable theory–practice gap around metacognition: Although there is ample theory and empirical support for metacognitive skills as critical for learning, these skills are not used explicitly in practice.

3.1.3. Memory

The goal of learning is to create long-term memories that can be retrieved and used at a later time. Long-term memories can store explicit, declarative knowledge (e.g., the formula for the area of a sphere or the name of the fourteenth president) but also the knowledge of sequences or procedures (e.g., the steps to solve a calculus problem). The information stored in long-term memory is not merely factual information to be recalled for exams and trivia contests. Long term memories establish the basis for adapting to new situations and for use in higher-order learning, such as that proposed in Bloom's taxonomy (Krathwohl, 2002). For example, new problems can be solved by analogy with a familiar problem (e.g., Gick & Holyoak, 1980), and characteristics of that familiar problem would be stored in long-term memory. Prior knowledge stored in long-term memory also exerts a powerful influence on learning new information (e.g., Witherby & Carpenter, 2022).

As we have already reviewed, most students do not know how to use memory effectively and often report using nonoptimal strategies for learning. One reason for the use of nonoptimal strategies is due to a connection between metacognition and memory: most learners' subjective experience is that nonoptimal learning strategies, such as rereading, feel productive, whereas optimal strategies feel unproductive (Bjork, 1994; Bjork et al., 2013). For example, Kornell and Bjork (2008) reported that when learning to classify paintings by the artists who created them, most learners report subjectively more effective learning when paintings are grouped, or blocked, by the artist (e.g., when all of Artist 1's paintings appear together, followed by all of Artist 2's paintings, etc.). The objective learning findings, however, run counter to the subjective impression of learning. Overwhelmingly, learners perform better on a test when the paintings have been intermixed or spaced across artists (e.g., a painting by Artist 1 is followed by a painting from Artist 5, followed by a painting from Artist 4, in a random, intermixed fashion).

There are many learning strategies that produce effective learning while being nonintuitive. These strategies have been termed desirable difficulties (Bjork, 1994). Such learning strategies are desirable in that they produce successful learning but also difficult because they introduce difficulties into learning, difficulties such as adding variability during learning by interleaving learning material or spacing learning across many sessions. There is a sizeable researchliterature on the learning strategies, the desirable difficulties, that produce effective learning and the factors that lead to greater test performance following a study or learning session (see Dunlosky, 2013; Dunlosky et al., 2013).

Among the most effective learning strategies—effective in that they produce accurate memory retrieval and less forgetting—are spaced practice, interleaving, and retrieval practice. Spaced practice, also called distributed practice, involves distributing studying across different sessions and re-visiting the to-be-learned material. There is ample evidence for the spacing effect, the finding that the accuracy of memory recall is better for items

learned by spacing across sessions compared to items learned by massing learning in a single session. Long-term memories acquired through spaced practice are also more robust and resistant to forgetting and produce better generalization to new information (for reviews of spaced practice, see Carpenter et al., 2022; Cepeda et al., 2006; Kornell & Bjork, 2008; Wiseheart et al., 2019).

Related to spaced practice, interleaved practice also benefits memory retrieval accuracy. Interleaved practice involves shuffling or intermixing content material or problems. In general, introducing variability during learning, as interleaving does, benefits learning and later memory performance (see Schmidt & Bjork, 1992). Intermixing produces better performance in mathematics problem solving (Rohrer & Taylor, 2007; Rohrer et al., 2015; Sana & Yan, 2022), in undergraduate physics problem solving (Samani & Pan, 2021), and in learning the grammar of a foreign language (Schweppe et al., 2025). Interleaving also improves motor skill learning, such as learning to toss beanbags accurately at a target (Kerr & Booth, 1978) and learning to search optimally for a visual target while disregarding distracting items (Vatterott et al., 2018).

Memory accuracy is also improved by retrieval practice, the active recall of memories. The retrieval practice effect refers to the robust finding that memories that are retrieved or recalled frequently are more durable than those that are only restudied (Agarwal et al., 2021; Carpenter et al., 2022; Roediger & Butler, 2011). In many classroom settings, retrieval practice involves practice testing, testing that is either self-imposed by students on themselves as a learning strategy or imposed by instructors with low-stakes formative assessments. Retrieval practice improves memory recall when the same questions are used in practice testing and final testing but also when questions differ but involve the same material between practice and final testing (Butler, 2010). However, retrieval practice may show the greatest memory benefit when practice and final tests use the same kinds of questions, for example, when both practice and final tests assess memory for factual information or both assess memory for the application of information (Thomas et al., 2020). That is, retrieval practice is boosted when the kinds of questions (factual or applied) are of the same kind between practice testing and final testing, although even mismatching question types benefit from retrieval practice when compared to no practice testing. Retrieval practice also has close ties to metacognition because practice tests and other forms of retrieval practice provide an explicit check on metacognitive evaluating by showing the learner what they have learned and what they have not yet learned.

Spacing, interleaving, and retrieving show the strongest evidence for producing accurate memory recall. Beyond these strategies, though, there are many other learning strategies that may be advantageous to learners. There is less empirical research around these other learning procedures, and many taxonomies of learning strategies will describe these as "promising, but in need of more research" (e.g., Dunlosky, 2013; Dunlosky et al., 2013). For example, learners may benefit from explaining material to themselves or to others (e.g., Berry, 1983); learners might also benefit from summarizing information, particularly from texts or during note taking (e.g., Bretzing & Kulhavy, 1979; also see Mueller & Oppenheimer, 2014).

3.2. Implementation and Supporting Use of the Three Ms

The primary goal of the Learning at Iowa initiative was to develop and implement a campus wide learning framework, with emphasis on disseminating information about effective learning. Our approach aligned nicely with practices recommended from the implementation sciences (for relevant frameworks, see Cullen et al., 2022; Powell et al., 2015). The main implementation practices we used to develop and disseminate Learning at Iowa included the following:

- Identifying early adopters (those likely to use the framework);
- Identifying and preparing "champions" and building a coalition (campus partners);
- Developing and distributing educational materials;
- Creating a learning collaboration (for instructors).

The initiative was developed and implemented over a three-year period, beginning in 2021. The initiative was supported through a campus public–private partnership program, which funded a program manager, graduate assistants, and undergraduate teaching assistants. We should note, however, that we would not expect that substantial funds would be required to replicate our efforts on other campuses because of our existing resources and approach described later and available on the Learning at Iowa website. With an end to our funding, we have migrated to other models to continue the work, such as academic credit for undergraduate teaching assistants. The initiative has also facilitated grant applications for specific projects and content areas, such as NSF Improving Undergraduate STEM Education (IUSE) proposals.

Because the effective learning strategies captured by the Three Ms are not intuitive, our implementation focused on explicit instruction on these strategies. But, for effective behavioral change—specifically, a change to using more effective approaches to studying and learning—instruction should be accompanied by structural supports in meaningful educational contexts. For the Three Ms, such structural supports would include their use in classes and in recommendations from advisers and others who students might seek out for academic help and support.

To facilitate these structural supports, the Learning at Iowa initiative has partnered with several important campus units to share the Three Ms and to help implement these principles in ongoing work. The initiative also has supported work with campus partners by developing materials to facilitate the campus-wide awareness and use of the Three Ms. Here, we describe our key campus partners, the audiences targeted through those partnerships, and some of the key resources and supports developed through the initiative. We should acknowledge that although our efforts have focused on a broad implementation on our campus, we expect that such a broad implementation is not necessary to benefit student learning. The Three Ms and the resources we have developed are also useful when used in individual classes or in individual campus offices or resources, such as academic advising or supplemental instruction programs.

The largest partnerships and target audiences are listed in Table 2. The units or offices and programs represented are common on most campuses and work with students in a variety of contexts. The partnership with academic advising is for professional advisors in both the university advising center (who advise first-year students) and in academic colleges (who advise for specific academic programs or majors). Through academic support and retention, our partnership has involved workshops for undergraduate peer learning assistants across a variety of programs, including our campus-wide supplemental instruction program. This program is similar to many at other institutions and uses supplemental instruction peer readers who work with students in specific courses. The courses are introductory-level courses, selected because they have large enrollments of first-year students. We have partnered with and developed workshops with most of the large peer learning programs on our campus, allowing peer tutors or learning assistants to understand the Three Ms and to tailor their use to the classes that they are supporting. Similarly, we have worked with our campus first-year seminar program and our campus seminar for first-generation college students to provide content and exercises that can be used in these seminars. One example is an assignment for students to "plan their study week," which highlights metacognitive planning and connects back to the Three Ms.

Table 2. Overview of the Learning at Iowa campus partners and audiences.

Unit/Office/Program	Target Audience	Content
Academic Advising	Professional advisers	Workshops; printed resources
Academic Support and Retention		
• Supplemental instruction leaders	Student peer leaders for various classes	Training workshops; printed resources
• Tutor training	Student tutors for various classes	Training workshops; printed resources
• First-generation student community	First-generation student seminars	Seminar content for instructors
• First-year seminar program	Students in first-year seminars	Seminar content for instructors
On Iowa (campus welcome program)	New incoming students	Video introducing the Three Ms
Success at Iowa (onboarding course)	New incoming students	Online class module on the Three Ms
Course-Based Content		
• Learning About Learning course	Any student enrolled in course	Course focused on learning to learn
• The Three Ms: Strategies for Success course	Any student enrolled in course	Course focused on learning to learn
University Housing	Residence hall assistants (RAs)	Training workshops; scripts for floor meetings
	Students living in residence halls	Bulletin board content; floor meetings
Center for Teaching	Faculty learning community New graduate teaching assistant training	Workshops; printed resources

The largest audiences for Learning at Iowa material come through our campus welcome program, On Iowa, which students attend for the few days before the start of the Fall semester. One of the required sessions, led by a faculty member, focuses on academic expectations in college. The session attracts the vast majority of each incoming class (4500–5000 students typically) and includes a video introduction to the Three Ms. The session script also includes a memory demonstration that engages students to illustrate that memory can be fallible and produce both forgetting and illusory memories, highlighting concepts of both metacognition and memory. The other large audience event is our campus onboarding course, Success at Iowa, which is an online, asynchronous required course that covers campus information and resources. Learning at Iowa has a module in the course that students complete once arriving on campus, typically around the third week of the Fall semester. The module is strategically timed to appear before the first set of midterm exams but after courses have started and have moved beyond introductory course material. The module includes three videos that discuss each of the Three Ms individually, with examples on how to apply the principles in classes. At the end of the module, students answer some basic questions about the content, including recalling each of the Three Ms. Our partnership with University Housing compliments the student-facing presentations at our campus welcome program and orientation course. Later in the Fall semester, residence halls have static, bulletin board information on the Three Ms as a reminder of the content that students heard previously. Students in the residence halls also have regular floor meetings and individual meetings with resident assistants (RAs), who are peers that live on residence hall floors. Learning at Iowa helped develop scripts and talking points around student academics and the Three Ms for these meetings, in addition to providing workshops during the resident assistant training sessions. As the Learning at Iowa initiative has continued, most of the resident assistants have already heard about the Three Ms before

becoming an RA, which helps establish these practices as part of the campus culture around effective learning.

Exposing students to the Three Ms is useful for promoting effective learning, but passive exposure does not guarantee the use of effective learning practices. Support for these practices should also come from instructors who can implement the Three Ms and similar practices into their courses. We have two courses that support students' learning generally. Both of these courses have taught learning how to learn, and similar courses appear on other campuses (see Cleary & Rhodes, 2023; McDaniel et al., 2021; Pintrich et al., 1987; Wolters et al., 2023). One of these courses, Learning About Learning, taught by the first author, predated the Learning at Iowa initiative and has given students practice using the Three Ms in their other courses. However, it is also critical for students to learn effective learning approaches in disciplinary courses. Although not listed in Table 2, we have several partnerships with faculty instructors who use the Three Ms and other validated learning supports in their courses. Many of these faculty participate in a faculty learning community, developed with a partnership with our campus center for teaching. Individual instructors tailor learning content for their courses, but most connect this content back to the Three Ms. Several instructors assign the Success at Iowa videos, mentioned above, as material for students to review before a class discussion of learning. Other classes develop assignments to help promote effective learning, such as keeping metacognitive journals for students to track their learning through planning, monitoring, and evaluating.

One course that has used metacognitive journals effectively is our campus college algebra course. College algebra is a developmental course for students who did not master this material in high school. The course has a relatively high number of students who earn a D or F grade or who withdraw, which is common for this course on other campuses. Despite this challenge, many students will need to take additional math after college algebra because of their major.

The college algebra class has undergone many updates and revisions on our campus for several years, and recently the course developed learning reflections—metacognitive journals—to help students reflect on their learning. In short, these assignments help students learn how to learn math. An important component of these journal entries is feedback from peer "metacognition mentors," who are versed in Learning at Iowa and the Three Ms. These mentors provide asynchronous feedback through the course LMS to reinforce effective learning and to make recommendations when students struggle or ask for help. These reflections are modeled on "exam wrappers" (Lovett, 2013) or "cognitive wrappers," which are typically post-exam reflections on performance. Our college algebra course not only includes post-exam reflections but also reflections on exam preparation, which helps students engage with better metacognitive planning and time management ahead of exams (Levtov & Farthing, 2023).

To support these partnerships, we met with groups regularly and gave presentations and workshops, often updated and revised to address specific needs of an office or instructor. We also developed several resources for students, staff, and faculty. Many of these resources are available on our website (learning.uiowa.edu). The resources are available freely and include the following:

- The videos shown in the Success at Iowa onboarding course to introduce the Three Ms;
- A student self-assessment of metacognition (the Metacognition Awareness Inventory; Schraw & Dennison, 1994);
- Exam wrappers to promote metacognitive evaluation; we include formats for different class types (lectures, discussion based, and project based);
- Prompts for metacognition, connected to planning, monitoring, and evaluating (also see Tanner, 2012).

3.3. Initial Contact Numbers and Impact

Since the start of the Learning at Iowa implementation in Fall 2021, the initiative's largest contact has come from introducing incoming students, both first years and transfers, through On Iowa and Success at Iowa. At the On Iowa session, approximately 24,000 undergraduates have been exposed to the Three Ms and have heard about effective learning practices. The Success at Iowa module has been completed by over 18,000 students since starting in Fall 2022. The Learning at Iowa module included a few short assessment questions about mindset, metacognition, and memory but also about the Learning at Iowa initiative. Students needed to answer these questions correctly before they could proceed in the course. The questions were multiple choice or matching questions. Multiple choice questions asked students to identify specific information from the recorded lectures; for example, "Which of the following accurately lists two effective strategies for producing strong memories?" was correctly answered by choosing "test yourself and spaced practice." Matching questions asked students to identify concepts that corresponded with a Learning at Iowa component; for example, "Challenges and mistakes are learning opportunities" corresponds to a growth mindset, and "if I quiz myself are there parts that I am still unclear on?" corresponds to metacognitive evaluating. Although the module that introduces the Three Ms is too short to provide students with practice using these principles, it nevertheless provides students with a knowledge of the principles that can be useful in help seeking or in connecting to their courses.

Closely connected with our other first-year student contact points, since 2023 approximately 10,000 students living in the campus residence halls have had extensive exposure to effective learning recommendations. This information has included passive programming, such as bulletin boards and table tents, as well as active engagement with students' resident assistants in floor meetings and "Hawk Talks," which are one-on-one meetings between students and their RAs focused on academic resources. From the group floor meetings, a follow-up survey that was used to collect attendance indicated that 92% of the respondents reported that they were somewhat or very familiar with the Three Ms. In an even more powerful demonstration of the initiative's impact, 88% reported that they had sometimes or frequently used the recommended strategies during the semester, and 5% indicated they intended to do so. We acknowledge that such surveys are prone to response biases, but coupled with the Success at Iowa questions, students are indicating that they are aware of the content we have created on successful learning principles.

Beyond exposing students to Learning at Iowa and the Three Ms, it is important to understand students' perceptions of these principles. When students are exposed to and use effective learning practices (e.g., spacing or interleaving), they are more willing to use those practices (Janssen et al., 2023). Qualitative feedback that we have received from students indicates that students are receptive to the Three Ms, making it more likely that students will use these practices. The quotes below are from students who provided feedback or reflections on learning about the Three Ms. Many of these comments, especially from students in classes that use the principles, indicate that students use the recommendations and see value in their use. For example, students in the Success at Iowa course were prompted to list an important concept or idea that they learned in the course. There were numerous mentions of Learning at Iowa from students in the Success at Iowa course, which included these representative comments:

- "I was really interested in the Learning at Iowa model, they became handy when I'm studying for my midterms."
- "One important thing I learned is the importance of spacing out your studying and not cramming for exams."

The latter quote captures many student responses that pointed to specific recommendations, including striving for a growth mindset and practice testing (retrieval practice). Another course that supported use of the Three Ms was a first-year seminar for first-generation students. Although the course had several sections with different instructors, the seminars included additional content on and assignments using Learning at Iowa principles. At the end of the semester, students were asked to share how the Three Ms framework had been beneficial. First-generation students in this first-year seminar were generally positive, with representative responses such as the following:

- "Most of my study techniques haven't been effective. . .. However, after learning that the three M's allowed me to reflect on how I absorb information best, I'm no longer learning just to get a good grade. I'm now learning to genuinely gain knowledge."
- "I was introduced to it initally [sic] through Success at Iowa, but doing it within First Gen Hawks actually allowed me to apply the matieral [sic] in a more personal way."
- "Using the thinking that I haven't learned something YET has helped me to allow myself room to grow and adjust and not expect the absolute most from myself when im [sic] just starting out in college. Learning how to do spaced practice has also helped me with my study strategies."
- "It was beneficial because it actually works."
- "It's actually been beneficial in getting met to not cram. I start the studying process days beforehand and take breaks."
- "I am better able to study now. Instead of just reading what is on my notes, I am engaging myself and trying to write the information down to see if I can get it all and correctly."

Some comments, however, continued to express reliance on techniques that students feel are more effective:

- "I have not used this method of studying as I already have other ways of memorization that I find more effective."
- "I think that trying out the learning framework was beneficial because even though it was not quite what worked for me, it gave me the idea that what I am using it working pretty well for my brain."

Although we would need more information about what learning practices these students used, such statements indicate that some students continue to rely on intuitions about learning, a practice that we know is problematic (Blasiman et al., 2017; also see Janssen et al., 2023). Our ongoing work may need to highlight the fact that effective learning practices—validated practices—work because they produce benefits for individual learners. As a juxtaposition to statements that endorse intuitions about learning, many students in the Learning About Learning course explicitly mention the need to use learning practices that are based on evidence rather than intuition, preference, or perceived effectiveness. For example, representative comments from students in Learning About Learning included the following:

- ". . .after taking this course, my whole mindset about studying has changed. I learned that there are much better ways to actually understand and remember the material, ways that really work."
- "[this class] teaches you skills that will help you break bad habits while also giving you proven successful habits to try."
- "[In this course] I went from a student who barely had an idea of how to study, to a student that had a better understanding of what methods can help me be more of a successful student."

- "...this course surprised me in the best way. It didn't just tell me what to do, it taught me why certain strategies work. . .."
- "[This course] provides you with knowledge as to why and how you can learn information better. Going through this course and being given guided feedback on implementing these learning strategies will allow you to start building learning habits."

Students have not been the only target audience for Learning at Iowa, however. Since the start of the initiative, the Learning at Iowa leadership team has presented over 100 customized presentations to approximately 1200 faculty and staff on campus. These sessions provided the participating instructors, academic advisors, coaches, and others with tools and actionable resources to enhance the support they already provide to the students they collectively serve.

With professional academic advisors, beyond information sessions that introduced the Three Ms, we worked with senior advisors to develop realistic student vignettes for experience applying the Three Ms to situations that advisors addressed regularly. These vignettes were used as small group exercises in staff meetings and similar settings. An advising handout, also created with seasoned academic advisors, provided a summary of each of the Three Ms' concepts and gave guidance on how those concepts could be used in regular advising meetings. For example, on memory, the handout noted that advisors could help students relate their studying to skills and expertise they have built in the past (such as learning a musical instrument or regular practice for a sport). Advisors could then use students' previous experience to highlight the importance of spaced practice and similar memory phenomena. We also adapted exam wrappers for use by advisors (and others) by creating a "midsemester wrapper" and a "semester wrapper" that prompted students to reflect on their learning and course performance so far during the semester. Instead of focusing on exam preparation strategies for specific classes, these wrappers asked specific questions about what students found most challenging and about their typical preparation for assignments and exams. These wrappers could then be used to guide discussions with advisors, peer mentors, teaching assistants, or instructors.

The initiative had several touchpoints with graduate assistants and instructors, most of whom self-selected for events. The typical contact with instructors was through an informational workshop, introducing the Three Ms to faculty and involving the discussion of how those concepts could be applied in a discipline or course. We targeted many first-year general education courses for such presentations, including audiences of general education literature instructors and rhetoric (composition) instructors. These instructors have contact with large numbers of students in smaller courses, providing an opportunity to reinforce concepts that students heard in other venues. Learning at Iowa also has a partnership with our campus Center for Teaching, which provided the opportunity to develop a faculty learning community (FLC) around supporting student cognition. Many of the instructors who participated in this community teach general education courses that tend to enroll first- or second-year students. A typical FLC meeting involves discussing how instructors have used cognitive supports, such as the Three Ms, in their courses and the successes and challenges of using those supports. The FLC also developed and hosted a campus workshop on supporting student metacognition in courses. Learning at Iowa also supported graduate teaching assistants (TA) by presenting at new TA orientation, which is coordinated through the Center for Teaching. The initiative also worked with departmental TA trainings and presented to graduate courses that are part of the university's college teaching certificate. The initiative also supported instructors by working with the campus learning technology office, who developed a workshop on supporting student metacognition with instructional technology. This workshop continues to be offered and updated to stay current with new instructional technologies adopted on campus. Future efforts will

assess the use and perception of Learning at Iowa by instructors and TAs. Unfortunately, we do not have any assessment reports or approved quotes to share at this time. The use of Learning at Iowa concepts by instructors are being assessed from within individual instructor's classes, and those instructors are leading their own assessment efforts. These assessment efforts are focused on both course improvement and on contributing to the scholarship of teaching and learning (SoTL).

One final example of implementation comes from a recent review of our campus first-year experiences. The committee charged with reviewing these experiences developed a rubric to evaluate various courses and other experiences. As an indicator of Learning at Iowa's adoption across campus, the committee charged with the review asked if each class or experience "Features content promoting metacognitive approaches to studying and learning ('learning to learn')." This was a spontaneous use of Learning at Iowa concepts, as none of the initiative's leadership team members were members of this review committee. Moreover, of the 13 first-year experiences that were reviewed, 10 of the 13 (77%) were identified as promoting metacognitive approaches.

In sum, and in keeping with a main goal of Learning at Iowa, these varied examples have helped communicate effective learning practices using the Three Ms guidelines, reinforcing common language and common recommendations to support student learning. Across different target audiences—students, staff, and faculty—the initiative has not only informed students and campus partners but has also supported the discussion of and use of effective learning practices on campus.

4. Summary and Conclusions

Learning is at the heart of student success in higher education, whether that learning occurs in a classroom, through assignments or projects, or with out-of-class experiential learning opportunities such as undergraduate research. Effective learning practices have a strong empirical foundation in the cognitive sciences, both in laboratory and classroom studies and experiments. However, when surveyed, students seem unaware of these practices. Higher educational professionals also have a mixed understanding of these practices (e.g., McCabe, 2018; Dennis & Somerville, 2023).

The University of Iowa's Learning at Iowa initiative is attempting to focus recommendations—and campus conversations—around effective and specific learning practices. These validated practices, the Three Ms, can be applied to a variety of learning contexts and to different content. Specifically, the principles we have outlined and the resources available on our website[2] should enable other higher education professionals—from instructors to student-facing staff—to make specific and supported recommendations to students about learning. An emphasis on effective learning practices allows for consistent recommendations for students. Validated approaches to learning and the Three Ms broaden and strengthen the range of tools that institutions have to support student learning and affect the institutional metrics that have student learning at their foundation.

We have presented the Three Ms as part of a larger strategy to support consistent recommendations for students when they ask about learning or when they need support in their classes. For a campus-wide implementation, such as we have described, it is critical to have the endorsement and active support from institutional leadership. Our campus partnerships helped facilitate that support, and the initiative benefitted from multiple campus partners that worked in different campus sectors. However, because the Three Ms are rooted in strong research, students' learning will still benefit if these principles are used in a more limited context, such as in an individual course, in supplemental instruction, or in advising meetings.

There are several potential challenges to raising the profile and use of effective learning practices from the cognitive sciences, such as those we have discussed here. Earlier, we raised several factors that likely contribute to the dearth of discussion of student learning, including the assumptions that students already possess effective learning skills, that institutional emphasis on effective learning practices may be perceived as a threat to an instructor's academic independence, that learning is unique to individual students, and the reliance on intuitions around what produces effective learning. We anticipate that these factors will remain ongoing challenges to a wider recommendation of practices such as the Three Ms.

We also acknowledge that disciplinary differences between higher education administration training programs and the cognitive and learning sciences can also contribute to some approaches, such as supplemental instruction or learning assistants, being more readily adopted for student success efforts than other approaches. Another challenge comes when one knows about and understands effective approaches to learning and then assumes others have the same understanding, a metacognitive error in predicting another's knowledge.

Despite these challenges, knowing about effective learning practices, which we have summarized in the Three Ms, provides higher education professionals with unique metacognitive knowledge, specifically around strategy use: the knowledge of strategies (learning strategies, in this case) but also how and when to use those strategies. A broader appreciation of effective learning strategies will help students, instructors, and higher education staff adopt or encourage a growth mindset while more systematically planning, monitoring, and evaluating learning using effective memory practices, including the desirable difficulties of spaced practice, interleaving, and retrieval practice.

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Notes

[1] The student responses in the Tetteh (2017) study diverge from responses in the other studies. This may be the result of different study samples. Students in Tetteh (2017) were advanced (fourth-year) students at an international university. The other studies report responses from students at North American universities. Yan et al. (2014) collected an online sample, and the responses summarized in Table 1 are those from self-identified students (as opposed to non-student professionals).

[2] https://learning.uiowa.edu/learning-iowa-framework (accessed on 15 July 2025).

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