



Theory and Research-based Principles of Learning

The following list presents the basic principles that underlie effective learning. These principles are distilled from research from a variety of disciplines.

1. Prior knowledge can help or hinder learning. Prior knowledge is the lens through which we view all new information. If that lens is inaccurate, incomplete, or naïve, it can interfere with or distort the integration of incoming information (Clement, 1982; NRC, 2000). Consequently, it is important for us to know and address the misconceptions students hold, and to connect new information to accurate information they already possess.

2. Motivation generates, directs, and sustains learning behavior. Motivation influences the amount of time and effort students devote to learning and supports their continued engagement when difficulties arise. Motivation may be influenced by a number of factors, such as students' interests, goals, and expectations (Hidi and Renninger, 2004; Bandura, 1989; Carver and Scheier, 1990), students' beliefs about learning (Schommer, 1994, Dweck, 2002), and emotional experiences surrounding the learning context. In addition, students learn best when the classroom environment provides a balance between support and challenge (Kuh et.al., 2005). Finally, knowledge itself can be a powerful motivator – the more students know, the more they want to know.

3. The way students organize knowledge determines how they use it. Knowledge representations that accurately reflect the concepts, the relationships among them and the contexts of use, enable students to retrieve and apply knowledge both effectively and efficiently. Our knowledge representations in turn shape further learning (diSessa, 1982; Holyoak, 1984; NCR, 2000). When knowledge is organized according to superficial features, when the connections are inaccurate, or if the representation is a set of disconnected and isolated concepts, students can fail to retrieve or appropriately apply their knowledge. We need to help students learn to organize knowledge the way experts do, around core concepts or big ideas that guide expert thinking about our domain, and we need to identify and correct students' disconnected information and inaccurate links.

4. Meaningful engagement is necessary for deeper learning. Meaningful engagement, such as posing and answering meaningful questions about concepts, making analogies, or attempting to apply the concepts or theories to solve problems, leads to more elaborate, longer lasting, and stronger representations of the knowledge (Craik and Lockhart, 1972). By forming more connections to related ideas, these activities increase the likelihood that students will be able to retrieve and use the concepts and skills when they are relevant.

5. Mastery involves developing component skills and knowledge, and synthesizing and applying them appropriately. Many activities that faculty believe require a single skill (for example, writing or problem solving) actually involve a synthesis of many component skills Anderson et al. (1989). To master these complex skills, students must practice and gain proficiency in the discrete component skills (for writing this may involve identifying an argument, enlisting appropriate evidence, organizing paragraphs, etc; for problem solving it may require defining the parameters of the problem, choosing appropriate formulas, etc.) To perform complex tasks, students must also practice and gain proficiency in synthesis, in other words organizing and integrating component skills into a coherent whole. Finally, students must understand the conditions and contexts of application and must practice applying skills and knowledge appropriately in new contexts, otherwise they may have difficulty transferring knowledge and skills learned in one context or another (Singley, 1989).

6. Goal-directed practice and targeted feedback are critical to learning. Goal-directed practice involves working toward a specific level of performance and continually monitoring performance relative to clearly define goals. When these goals are explicitly communicated to students, they guide and support students' purposeful practice and help students monitor their progress. In addition, students' practice is more effective when instructors (a) provide feedback that explicitly relates students' performance to the criteria, (b) ensure that the feedback is timely, frequent, and constructive, and (c) provide opportunities for them to incorporate that feedback into further practice. (NRC 2001; Wiggins 1998). Instructor feedback can come via formal (e.g., quizzes, papers, exams) and informal (e.g., classroom activities) assessments.

7. Students must learn to monitor, evaluate and adjust their approaches to learning to become self-directed learners. In other words, students must become conscious of their thinking processes. This is called metacognition (Matlin, 1989; Nelson, 1992). One way to do this is to require students to explicitly monitor, evaluate, and reflect on their own performance, and provide them with feedback on these processes. To help students develop these skills we can model the process for students, by showing them how we approach problems, question our strategies, and monitor our performance. Alternatively, we can provide a series of explicit prompts or questions that ask them to monitor and evaluate their performance. With sufficient practice students should eventually internalize these processes and use them without the need for external aids.

8. Students develop holistically and their learning is affected by the social and emotional aspects of the classroom climate. Students are not only intellectual but also social and emotional beings, and all these dimensions interact to impact learning and performance (Pascarella & Terenzini, 2005). The social and emotional aspects of the classroom climate affect some students in ways that enhance or hinder learning (Ford, 1992). For example, students will be more likely to take intellectual and creative risks if they feel supported and respected. By the same token, when students fear ridicule or persecution, or feel marginalized or stereotyped (Steele & Aronson, 1995; Walton & Cohen, 2007), they may disengage from classroom participation and learning opportunities.

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