Best Teaching Practices

CUNY Office of Academic Affairs

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The following instructional practices are supported by a substantial amount of empirical evidence and are applicable to any subject area. They are recommended for use by college faculty.

The recommended practices are divided into three categories:

I Presentation of Materials

II Student Assignments and Testing

III Strategies that Students Can Use to Enhance Learning

Each recommendation is followed by a description of the practice and relevant reference(s).

These practices are also described at:
www.cuny.edu/teachingpractices

General References:

American Psychological Association. (2011). Modules for teachers. Retrieved from http://www.apa.org/education/k12/curricular-materials.aspx

Bransford, J. D., Brown, A. L., & Cocking, R. R. [Eds.]. (2000). How People Learn. Washington, D.C.: National Academy Press.

Carey, B. (2011, September 6). Forget what you know about good study habits. The New York Times. Retrieved from http://www.nytimes.com

Halpern, D. F., Graesser, A., & Hakel, M. (2007). 25 Learning principles to guide pedagogy and the design of learning environments. Washington, DC: Association for Psychological Science. Retrieved from http://psyc.memphis.edu/learning/whatweknow/index.shtml

Mayer, R. E. (2011). Applying the science of learning. Boston, MA: Pearson.

Pashler, H., Bain, P. M., Bottge, B. A., Graesser, A., Koedinger, K. R., McDaniel, M., & Metcalfe, J. (2007). Organizing instruction and study to improve student learning. (NCER 2007-2004). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/practiceguides/20072004.pdf

I Presentation of Materials

To present material effectively:

1. Present material that is at the right level of difficulty for students' current knowledge
2. Provide overall organization of the lesson
3. Present closely in time and space ideas that need to be associated (Contiguity Effects)
4. Present coherent, well-connected representations of the ideas to be learned
5. Present information in manageable segments to regulate cognitive load
6. Present materials in formats that require effortful cognitive processing by students
7. Present materials that precipitate cognitive conflict
8. Interleave worked example solutions with problem-solving exercises
9. Ask deep explanatory questions
10. Connect and integrate concrete and abstract representations of concepts
11. Combine graphics with verbal descriptions
12. Help students to correct their subject-matter misconceptions

1 Present material that is at the right level of difficulty for students' current knowledge

- Instructors need to be aware of students' current knowledge and understanding when presenting new materials so as to present material at the "right level." The "right level of difficulty" means that students cannot grasp the material on their own (indicating that it is not too easy), but can successfully do so with some help and support (indicating that it is not too difficult). This is also known as scaffolding the material.
- If the materials are too easy, students are not challenged enough. If they are too difficult, they may give up easily. Either way, these materials will decrease student motivation, attention, and engagement.

References:

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M K. (2010). How learning works: Seven research-based principles for smart teaching. Jossey-Bass: San Francisco, CA.

Metcalfe, J., & Kornell, N. (2005). A region or proximal of learning model of study time allocation. Journal of Memory and Language, 52, 463-477.

Wolfe, M. B. W., Schreinder, M. E., Rehder, B., Laham, D., Foltz, P., Kintsch, W., & Landauer, T. (1998). Learning from text: Matching readers and texts by latent semantic analysis. Discourse Processes, 25, 309-336.

2 Provide overall organization of the lesson

- Before starting a lesson, instructors should highlight the organization of the lesson. Called "signaling," this technique includes the use of outlines and section headings.
- By providing cues or signals such as outlines and headings, instructors will signal to learners what to attend to.

References:

Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. Journal of Educational Psychology, 90, 414-434.

Mautone, P. D., & Mayer, R. E. (2001). Signaling as a cognitive guide in multimedia learning. Journal of Educational Psychology, 93, 377-389.

Mayer, R. E. [Ed.]. (2005). The Cambridge handbook of multimedia learning. New York: Cambridge University Press.

3 Present closely in time and space ideas that need to be associated (Contiguity Effects)

- Instructors should design learning materials so that elements and ideas that need to be related are presented near each other in space and time.
- Association will be stronger when corresponding printed words and pictures are near rather than far from each other on the screen or page. Likewise, association will be stronger when corresponding spoken words and pictures are presented simultaneously rather than successively.

Reference:

Mayer, R. E. [Ed.]. (2005). The Cambridge handbook of multimedia learning. New York: Cambridge University Press.

4 Present coherent, well-connected representations of the ideas to be learned

- Instructors should design the learning materials so that the main points requiring attention and to be learned are prominent. It is important to remove distracting, irrelevant information, even when such information is artistically and aesthetically appealing.
- Interesting but irrelevant text and graphics run the risk of consuming learners' attention and effort at the expense of their missing the main points.

Reference:

Kalyuga, S., Chandler, P., Tuovinen, J., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. Applied Cognitive Psychology, 13, 351-371.

5 Present information in manageable segments to regulate cognitive load

- Students learn better when a new and complex lesson is broken into smaller, manageable parts in multimedia learning environments. For example, narrated animation should be presented in learner-controlled, bite-size segments, rather than one continuous unit. It allows the learner to process information better at his/her own pace.
- By planning the amount of new and complex information to be presented in discrete units, instructors may avoid overwhelming learners with too much information at once.

References:

Mayer, R. E. [Ed.]. (2005). The Cambridge handbook of multimedia learning. New York: Cambridge University Press.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38, 43-52.

6 Present materials in formats that require effortful cognitive processing by students

- Instructors should present the information to be learned in formats that require effortful processing. Such "desirable difficulty" will make the information less forgettable. For example, rather than presenting materials in class in the same order as information in a textbook, some variation in terms of material presentations across these two information sources (where logically and conceptually feasible) will facilitate learners' active integration of the information.
- Learning is enhanced when learners have to organize the information themselves or put additional effort during acquisition or retrieval rather than when the information to be learned or retrieved does not require effort. Although learners' putting this effort in can slow initial learning, it promotes long-term recall of the information.

References:

Bereiter, C., & Scardamalia, M. (1985). Cognitive coping strategies and the problem of "inert knowledge". In S. F. Chipman, J. W. Segal, & R. Glaser (Eds.), Thinking and learning skills: Vol. 2. Current research and open questions (pp. 65-80). Hillsdale, NJ: Erlbaum.

Bjork, R. A. (1988). Retrieval practice and maintenance of knowledge. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), Practical aspects of memory: Current research and issues: Vol. 1 (pp. 396-401). NY: Wiley.

7 Present materials that precipitate cognitive conflict

- Deeper learning in student thinking is often achieved by presenting students with information that is unexpected, anomalous, and/or contradictory to their current knowledge, which can be limited and/or incorrect. When students encounter experiences that they are not able to assimilate or that are incongruous with their current cognitive structures/conceptions, this causes cognitive conflict. Such conflict can lead to knowledge change (instead of merely growth).
- Instructors can generate cognitive conflict in student thinking in a number of ways. These include presenting anomalous data, refutational texts, and asking students to predict an answer, where instructors know that student predictions will run counter to the actual answer.

References:

Chinn, C. A., & Brewer, W. F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. Review of Educational Research, 63, 1-49.

Chinn, C. A., & Brewer, W. F. (1998). An empirical test of a taxonomy of responses to anomalous data in science. Journal of Research in Science Teaching, 35(6), 623-654.

Eryilmaz, A. (2002). Effects of conceptual assignments and conceptual change discussions on students' misconceptions and achievement regarding force and motion. Journal of Research in Science Teaching, 39(10), 1001-1015.

Guzzetti, B. J. (2000). Learning counter-intuitive science concepts: What have we learned from over a decade of research? Reading & Writing Quarterly, 16(2), 89-98.

Hynd, C. R. (2001). Refutational texts and the change process. International Journal of Educational Research, 35(7), 699-714.

8 Interleave worked example solutions with problem-solving exercises

- Instructors should alternate between worked-out examples that demonstrate and model one possible solution path and problems that students are to solve on their own. Worked-out examples are especially beneficial for learners with lower levels of knowledge.
- Fading (or gradual elimination) of worked-out examples depending on student performance (adaptive fading) leads to better retention, rather than fading of worked-out examples in the same manner/schedule for all students (fixed fading).

References:

Kalyuga, S., Chandler, P., Tuovinen, J., & Sweller, J. (2001). When problem solving is superior to studying worked examples. Journal of Educational Psychology, 93, 579–588.

Salden, R. J. C. M., Alaven, V. A. W. M. M., Renkl, A., & Schwonke, R. (2009). Worked examples and tutored problem solving: Redundant or synergistic forms of support? Topics in Cognitive Science, 1, 203-213.

Schworm, S., & Renkl, A. (2002). Learning by solved example problems: Instructional explanations reduce selfexplanation activity. In W.D. Gray & C.D. Schunn (Eds.), Proceedings of the 24th Annual Conference of the Cognitive Science Society (pp. 816-821). Mahwah, NJ: Erlbaum.

Trafton, J.G., & Reiser, B.J. (1993). The contributions of studying examples and solving problems to skill acquisition. In M. Polson (Ed.), Proceedings of the 15th Annual Conference of the Cognitive Science Society (pp. 1017-1022). Hillsdale, NJ: Erlbaum.

9 Ask deep explanatory questions

- These questions are given after students have acquired basic knowledge about a particular topic of study, and are ready to build a more complex understanding of a topic.
- Deep explanatory questions include those that inquire about causes and consequences of events, motivations of people involved in events, scientific evidence for particular theories, and logical justifications for the steps of a mathematical proof. Some examples are "why," "why-not," "how," "what-if," "how does X compare to Y," and "what is the evidence for Z?"
- Instructors should encourage students to "think aloud" by speaking or writing their explanations as the students try to answer these questions (See Recommendation 23).

References:

Craig, S.D., Sullins, J., Witherspoon, A., & Gholson, B. (2006). The deep-level-reasoning-question effect: The role of dialogue and deep-level-reasoning questions during vicarious learning. Cognition and Instruction, 24, 565-591.

Graesser, A. C., & Person, N. K. (1994). Question asking during tutoring. American Educational Research Journal, 31, 104-137.

Pressley, M., Wood, E., Woloshyn, V. E., Martin, V., King, A., & Menke, D. (1992). Encouraging mindful use of prior knowledge: Attempting to construct explanatory answers facilitates learning. Educational Psychologist, 27, 91-109.

10 Connect and integrate concrete and abstract representations of concepts

- Students may initially learn a concept with concrete examples (e.g., slices of pizza, measuring cups). However, the examples should be switched gradually into abstract representations (e.g., numbers, symbols), so the students are better able to apply the knowledge to new examples.

References:

Goldstone, R.L, & Son, J.Y. (2005). The transfer of scientific principles using concrete and idealized simulations. The Journal of the Learning Sciences, 14, 69-110.

Kaminiski, J.A., Sloutsky, V.M., & Heckler, A.F. (2006). The advantage of abstract examples in learning math. Science, 320, 454-455.

Richland, L.E., Zur, O., & Holyoak, K.J. (2007). Cognitive supports for analogy in the mathematics classroom. Science, 316, 1128-1129.

11 Combine graphics with verbal descriptions

- Use graphical presentations (e.g., graphs, figures, pictures, videos) that illustrate key processes and procedures, along with text presentations or narrations. This integration leads to better learning than simply presenting text alone.
- The graphics and accompanying text/verbal description should be presented close in space and time (See Recommendation 3).
- Depending on the concept or material taught, a well-chosen sequence of still pictures with accompanying text can be as effective in enhancing learning as narrated animations.

References:

Clark, R.C., & Mayer, R.E. (2003). E-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia Learning. San Francisco: Jossey-Bass.

Mayer, R. E. (2001). Multimedia learning. NY: Cambridge University Press.

Mayer, R.E., Hegarty, M., Mayer, S., & Campbell, J. (2005). When static media promote active learning: Annotated illustrations versus narrated animations in multimedia instruct. Journal of Experimental Psychology Applied, 11, 256-265.

12 Help students to correct their subject-matter misconceptions

- Present new concepts or theories in such a way that students see them as plausible, high-quality, intelligible, and generative.
- Build on students' correct conceptions by creating a bridge of examples to the new concept/theory that students are having trouble learning due to their misconceptions.
- Use model-based reasoning, which helps students construct new representations that vary from their intuitive theories.
- Use "diverse instruction," wherein the teacher presents a few examples that challenge multiple assumptions, rather than a larger number of examples that challenge just one assumption.
- Help students become aware of their own misconceptions.
- Present students with experiences that cause cognitive conflict in the student's mind. Experiences (as in the third strategy above) that can cause cognitive conflict are ones that get students to consider their misconception side-by-side with, or at the same time as, the correct concept or theory.

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- Engage in Interactive Conceptual Instruction (ICI), which incorporates several key pedagogical aspects (Savinainen & Scott, 2002):
  - *use of interactive approaches that entail ongoing teacher-student dialogue that focuses on developing conceptual understandings and wherein students have the opportunity to talk through their understandings with teacher support*
  - *teacher use of research-based instruments (questionnaires/assessments/inventories) that afford quick and detailed formative assessments of students' knowledge in a subject area*
  - *teacher development of a detailed map of the conceptual terrain of the subject area, including knowledge of the canonical information in the subject, student misconceptions, and the representations (understandings) between these two*

- Develop students' epistemological thinking, which incorporates beliefs and theories about the nature of knowledge and the nature of learning, in ways that will facilitate conceptual change. The more naïve students' beliefs are about knowledge and learning, the less likely they are to revise their misconceptions.

- Help students "self-repair" their misconceptions.

- Once students have overcome their misconceptions, engage them in argument to help strengthen their new knowledge .

References:

Savinainen, A., & Scott, P. (2002). The Force Concept Inventory: A tool for monitoring student learning. Physics Education, 37(1), 45-52.

American Psychological Association. (2011). Modules for teachers: How do I get my students over their alternative conceptions (misconceptions) for learning. Retrieved from http://apa.org/education/k12/misconceptions.aspx

II Student Assignments and Testing

In-class and homework assignments, quizzes, and exams are important components of teaching. They, too, can help students learn when implemented according to these recommendations.

13. Have students work on problems that vary in content and complexity
14. Schedule studying over time and over several sessions (Spacing Effect)
15. Use assignments that are goal-directed
16. Use assignments that are at the right level of difficulty for students' current knowledge
17. Have students work collectively on challenging, real world problems in the topic area
18. Include requirements that involve the student engaging in reading and writing
19. Use quizzes/tests frequently to re-expose students to key content and require them to actively recall/generate information (Generation Effect)
20. Provide students with advance notice that there will be a final/comprehensive exam
21. Give clear, explanatory, and timely feedback on responses, assignments, and quizzes

13 Have students work on problems that vary in content and complexity

- By working on problems that vary in content and complexity, students will establish multiple viewpoints about a topic. Such viewpoints about various topics will create multiple layers of knowledge including facts, rules, skills, procedures, and plans. Through this practice, students will also connect these layers.
- For example, arithmetic/mathematics consists of different topics including addition, subtraction, fraction, percentage, geometry, etc. Instructors can have students look at each topic from various perspectives and practice to connect the layers within a topic. A simple equation such as 5 + 2 = 7, for instance, may be connected to other equations such as 2 + 5 = 7 and 7 – 5 = 2, and also to questions 7 – 2 = ___ and x + 5 = 7.

References:

Rouet, J. (2006). The skills of document use: From text comprehension to web-based learning. Mahwah, NJ: Erlbaum.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. C. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. Educational Technology, 31, 24-33.

14 Schedule studying over time and over several sessions (Spacing Effect)

- Students learn better when they spread their studying over several shorter practice sessions, rather than concentrating their study into one longer session.
- Arrange to review key elements of a topic multiple times with a delay of several weeks to several months after initial presentation. Research indicates that this distributed learning, or spaced practice, results in better retention of materials than cramming.

References:

Capeda, N. J., Vul, E., Rohrer, D., Wixted, J. T., & Pashler, H. (2008). Spacing effects in learning: A temporal ridgeline of optimal retention. Psychological Science, 19, 1095-1102.

Kornell, N. (2009). Optimising learning using flashcards: Spacing is more effective than cramming. Applied Cognitive Psychology, 23, 1297-1317.

Rohrer, D., & Taylor, K. (2006). The effects of overlearning and distributed practice on the retention of mathematics knowledge. Applied Cognitive Psychology, 20, 1209-1224.

15 Use assignments that are goal-directed

- Learning is more enhanced when students engage in practice that focuses on a specific goal or criterion. Goals provide students with a focus for their learning, which leads to more time and energy going to that area of focus. In addition, a goal allows a student to monitor his/her progress toward that goal (Recommendation 24), and adjust strategies to achieve the goal along the way.
- Goal-directed practice, coordinated with targeted feedback, promotes greater learning gains (See Recommendation 21).

References:

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M K. (2010). How learning works: Seven research-based principles for smart teaching. San Francisco, CA : Jossey-Bass.

Ericsson, K. A., Krampe, R. T., & Tescher-Romer, C. (2003). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100, 363-406.

Rothkopf, E. Z., & Billington, M. J. (1979). Goal-guided learning from text: Inferring a descriptive processing model from inspection times and eye movements. Journal of Educational Psychology, 71, 310-327.

16 Use assignments that are at the right level of difficulty for students' current knowledge

- Assignments should not be too hard (students make many errors) or too easy (students complete the assignments without any effort), but at the "right" level of difficulty. The "right level of difficulty" means that students cannot complete the assignment effortlessly (indicating that it is not too easy), but can successfully do so with some cognitive effort and/or external support (indicating that it is not too difficult). This is also known as scaffolding assignments. Such assignments give students challenge, which increases motivation. If assignments are too hard or too easy, students may get frustrated or get bored.

References:

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M K. (2010). How learning works: Seven research-based principles for smart teaching. Jossey-Bass: San Francisco, CA.

Metcalfe, J., & Kornell, N. (2005). A region or proximal of learning model of study time allocation. Journal of Memory and Language, 52, 463-477.

Wolfe, M. B. W., Schreinder, M. E., Rehder, B., Laham, D., Foltz, P., Kintsch, W., & Landauer, T. (1998). Learning from text: Matching readers and texts by latent semantic analysis. Discourse Processes, 25, 309-336.

17 Have students work collectively on challenging, real-world problems in the topic area

- Working with others to learn, in a group of two to several, is known as cooperative learning. A common group goal, individual accountability (to prevent social loafing from occurring), and group cohesion are some variables that influence the effectiveness of cooperative learning.
- Instructors should consider using structured collaborative problem-solving activities in which each member has a role in working toward a group goal.
- When the group problem-solving activity is linked to student background knowledge on an interesting topic, such as real-world problems, learning is facilitated. The problem-solving activity should be challenging, so the students need to engage in it by recruiting multiple levels of knowledge and skills.

References:

Johnson, D. W., & Johnson, R. T. (1999). Learning together and alone (6th ed.). Englewood Cliffs, NJ: Prentice Hall.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. Educational Researcher, 38, 354-379.

Karau, S., & Williams, K. (1993). Social loafing: A meta-analytic review and theoretical integration. Journal of Personality and Social Psychology, 65, 681-706.

Hodara, M. (2011). Reforming mathematics classroom pedagogy: Evidence-based findings and recommendations for the developmental math classroom. Community College Research Center, New York, NY. Working Paper No.27.

18 Include requirements that involve the student engaging in reading and writing

- Having reading and writing requirements in courses is associated with improvement in students' critical thinking, complex reasoning, and writing skills.
- Specifically, instructors should include requirements in their courses of both reading more than forty pages a week and writing more than twenty pages for the course. When students are required to read and write extensively in their courses, they perform better on tests measuring skills such as critical thinking and writing.

Reference:

Arum, R., & Roska, J. (2011). Academically adrift: Limited learning on college campuses. Chicago, IL: University of Chicago Press.

19 Use quizzes/tests frequently to re-expose students to key content and require them to actively recall/generate information (Generation Effect)

- Learning is enhanced when learners produce answers compared to recognizing answers. “Closed-book” quizzes or tests are good to use. Quiz/Test questions of the fill-in-the-blank or short-answer format facilitate learning better than multiple choice items.
- A delayed re-exposure to course content helps students remember key information longer (See Recommendation 14).
- After each quiz or test, correct-answer feedback should be provided (See Recommendation 21).

References:

Butler, A. C., & Roediger, H. L. (2007). Testing improves long-term retention in a simulated classroom setting. European Journal of Cognitive Psychology, 19, 514–527.

Dempster, F. N. (1997). Distributing and managing the conditions of encoding and practice. In E. L. Bjork & R. A. Bjork (Eds.), Human Memory (pp. 197-236). San Diego, CA: Academic Press.

Pyc, M. A., & Rawson, K. A. (2010). Why testing improves memory: Mediator effectiveness hypothesis. Science, 330, 335.

Roediger, H.L., & Karpicke, J.D. (2006). The power of testing memory: Basic research and implications for educational practice. Perspectives on Psychological Science, 1, 181-210.

Roediger, H.L., & Karpicke, J.D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. Psychological Science, 17, 249-255.

20 Provide students with advance notice that there will be a final/comprehensive exam

- Teachers should create the expectation that there will be a final or comprehensive examination that will be administered at some future date. Students benefit more from repeated testing when they expect such exams than when they do not expect them. That is, students will retain materials better when they expect to need the materials later than when they do not.

Reference:

Szupnar, K. K., McDermott, K. B., & Roediger, H. L. (2007). Expectation of a final cumulative test enhances long-term retention. Memory & Cognition, 35, 1007-1013.

21 Give clear, explanatory, and timely feedback on responses, assignments, and quizzes

- Feedback should be given as a formative assessment provided to improve student learning, as opposed to summative assessment conducted to evaluate what students have learned.
- Clear learning goals are prerequisites of effective feedback (See Recommendation 15).
- Effective feedback provides a student with information about his/her current state of knowledge and performance. The feedback should in turn guide him/her in working toward the learning goal. That is, effective feedback should tell students what they are or are not understanding, whether their performance is going well or poorly relative to the goal, and what they should do in the future to achieve the goal. Feedback should be given at a time and frequency that allows it to be useful.
- Feedback (particularly for incorrect responses, by providing the correct answer or allowing the student to discover the correct answer), particularly on quizzes and practice tests, is helpful to students and seems to improve their classroom examination performance. Providing the feedback in a timely way (e.g., as quickly as possible after a quiz) is effective for learning and usually more effective than delayed feedback.

References:

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M. K. (2010). How learning works: Seven research-based principles for smart teaching. San Francisco, CA : Jossey-Bass.

Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2003). Assessment for learning: Putting it into practice. Buckingham, UK: Open University Press.

Dihoff, R. E., Brosvic, G. M., Epstein, M. L., & Cook, M. J. (2004). Provision of feedback during preparation for academic testing: Learning is enhanced by immediate but not delayed feedback. Psychological Record, 54, 207-231.

Kulik, J. A., & Kulik, C. C. (1988). Timing of feedback and verbal learning. Review of Educational Research, 58, 79-97.

Wiliam, D. (2007). Keeping learning on track: Formative assessment and the regulation of learning. In F. K. Lester, Jr. (Ed.), Second handbook of mathematics teaching and learning (pp. 1053-1088). Greenwich, CT: Information Age Publishing.

III Strategies that Students Can Use to Enhance Learning

Faculty can also recommend to their students the following strategies that optimize students' learning experience in and out of the classroom.

22. Actively process the information to be learned
23. Explain the material you are studying to yourself
24. Monitor your own studying activities
25. Study in different environments
26. Study various materials/problems within a study session

22 Actively process the information to be learned

- Outlining, integrating, and synthesizing information produces better learning than rereading materials or engaging in other more passive strategies. These strategies that require learners to be actively engaged with the material to-be-learned produce better long-term retention than the passive act of reading.
- Students may develop their own testing situations as they review materials, such as stating the information in their own words without viewing the text (See Recommendation 23) and synthesizing information from multiple sources, such as from lecture notes and textbooks.

Reference:

Bransford, J. D., Brown, A. L., & Cocking, R. R. [Eds.]. (2000). How People Learn. Washington, D. C.: National Academy Press.

23 Explain the material you are studying to yourself

- Research has demonstrated that students learn better when they explain to themselves the material they are studying. The phenomenon is known as the self-explanation effect.
- Self-explanation is more effective when conducted verbally rather than being typed.
- Self-explanation should not be mere paraphrases. It has to consist of inferences generated by the student.

References:

Ainsworth, S., & Loizou, A. T. (2003). The effects of self explaining when learning with texts or diagrams. Cognitive Science, 27, 669-681.

Chi, M. T. H., Bassok, M., Lewis, M., Reimann, P., & Glaser, R. (1989). Self-explanations: How students study and use examples in learning to solve problems. Cognitive Science, 13, 145-182.

De Bruin, A., Rikers, R., & Schmidt, H. (2007). The effect of self-explanation and prediction on the development of principled understanding of chess in novices. Contemporary Educational Psychology, 32, 188-205.

Griffin, T. D., Wiley, J., & Thiede, K. W. (2008). Individual difference, rereading, and self-explanation: Concurrent processing and cue validity as constraints on metacomprehension accuracy. Memory & Cognition, 36, 93-103.

Roscoe, R. D., & Chi, M. T. H. (2008). Tutor learning: The role of explaining and responding to questions. Instructional Science, 36, 321-350.

24 Monitor your own studying activities

- Students may engage in a variety of metacognitive processes to monitor and control their learning. These processes include: assessing the task at hand, evaluating their own strengths and weaknesses, planning their approach, self-monitoring their performance as applying various strategies, and assessing the degree to which their current approach is working.

- Components of self-monitoring are:
  - *pinpointing planned actions;*
  - *setting goals for those actions; and*
  - *keeping records (e.g., the number of correct answers, frequencies, duration) to track the actions.*

- Self-monitoring can be used to improve various targets including classroom participation and performance on tests. For the procedure to be effective, it is initially important that monitoring is shared by instructors, peers, etc. The attention and responses of others can be social incentives.

References:

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M K. (2010). How learning works: Seven research-based principles for smart teaching. San Francisco, CA : Jossey-Bass.

Blerkom, M. L., & Blerkom, D. L. (2004). Self-monitoring strategies used by developmental and non-developmental college students. Journal of College Reading and Learning, 34, 45-60.

Brown, D., & Frank, A. R. (1990). "Let me do it": Self-monitoring in solving arithmetic problems. Education & Treatment of Children, 13(3), 239-248.

Chang, M. (2007). Enhancing web-based language learning through self-monitoring. Journal of Computer Assisted Learning, 23, 187-196.

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. In B. J. Zimmerman & D. H. Schunk (Eds.), Self-regulated learning and academic achievement (2nd ed., pp. 1-38). Hillsdale, NJ: Erlbaum

25 Study in different environments

- When material is studied in one environment, associations are established between what is studied and contextual factors, impeding transfer of learning.
- When the same material is studied in multiple environments and becomes associated with them, its associations with one or a few particular locations will dissipate. This, in turn, facilitates students' being able to recall the material more easily in new and different environments.

Reference:

Smith, S. M., & Vela, E. (2001). Environmental context-dependent memory: A review and meta-analysis. Psychonomic Bulletin & Review, 8, 203-220.

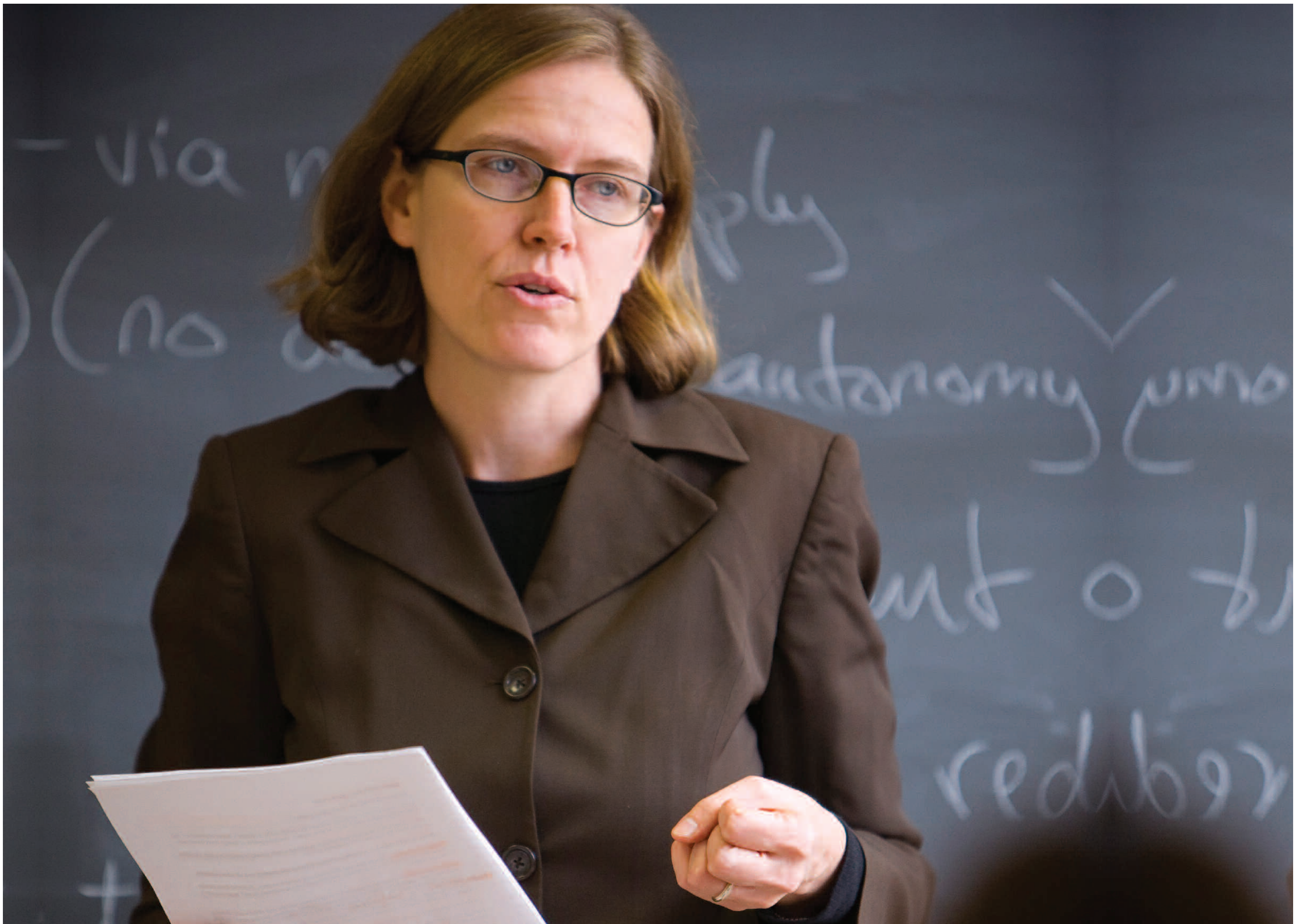
26 Study various materials/problems within a study session

- Learning is enhanced when students study materials with each problem different from the last one. This is called "mixed practice." It contrasts with "blocked practice," in which all materials being studied (or problems solved) are from the same topic. Mixed materials demand students to find the appropriate solution for each question.
- This practice is also recommended for instructors in classroom; for example, mixed materials may be included in quizzes, tests, etc.

References:

Rohrer, D. (2009). The effects of spacing and mixing practice problems. Journal for Research in Mathematics Education, 40, 4-17.

Taylor, K., & Rohrer, D. (2010). The effects of interleaved practice. Applied Cognitive Psychology, 24, 837-848.



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