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Brain Based Learning

Sousa, D. (2001). *How the Brain Learns*, 2nd Edition. Corwin Press.

Some assumptions:
a. Learning requires both retention and recall
b. Retention is made permanent with formation of new neural pathways
c. Repetition is required for new neural pathways

Twenty-one findings:

1. Meaning helps retention
2. Humor is an excellent focus device and adds novelty
3. Short lesson segments have proportionally less down time than longer ones
4. Motivation and novelty increase interest and accountability
5. Rote and elaborative rehearsal serve different purposes
6. Maximum retentions occurs during the prime-times
7. Minimum retention occurs during down-time
8. Wait time is critical to allow for student recall to occur
9. Chunking increases the number of items working memory can handle at one time
10. Distributed practices increases long term retention
11. Positive transfer assists learning; negative transfer interferes
12. Critical attributes help distinguish one concept from all others
13. Concepts and skills that are too similar should not be taught together
14. The prospect of future transfer increases motivation and meaning
15. Metaphors enhance transfer, hemispheric integration, and retention
16. Using many senses increases retention
17. Concept maps help hemispheric integration and retention
18. Imaging and imagining help establish meaning, promote novelty, and increase retention
19. Some music assists processing and cooperative learning activities
20. Bloom's taxonomy's upper levels involve higher-order thinking and are more interesting
21. Emotions play a key role in student acceptance and retention of learning

Ambrose, S., Bridges, M., DiPietro, M., Lovett, M., Norman, M. (2010). *How learning works: 7 research-based principles for smart teaching*. Wiley.

Chapter 1: How Does Students' Prior Knowledge Affect Their Learning?

Methods to Gauge the Extent and Nature of Students' Prior Knowledge

22. Talk to colleagues.
23. Administer a diagnostic assessment.
24. Have students assess their own prior knowledge.
25. Use brainstorming to reveal prior knowledge.
26. Assign a concept map activity.
27. Look for patterns of error in student work.

Methods to Activate Accurate Prior Knowledge

28. Use exercises to generate students' prior knowledge.
29. Explicitly link new material to knowledge from previous courses.
30. Explicitly link new material to prior knowledge from your own course.
31. Use analogies and examples that connect to students' everyday knowledge.
32. Ask students to reason on the basis of relevant prior knowledge.

Methods of Address Insufficient Prior Knowledge

33. Identify the prior knowledge you expect students to have.
34. Remediate insufficient prerequisite knowledge.

Methods to Help Students Recognize Inappropriate Prior Knowledge

35. Highlight conditions of applicability.
36. Provide heuristics to help students avoid inappropriate application of knowledge.
37. Explicitly identify discipline-specific conventions.
38. Show where analogies break down.

Methods to Correct Inaccurate Knowledge

39. Ask students to make and test predictions.
40. Ask students to justify their reasoning.
41. Provide multiple opportunities for students to use accurate knowledge.
42. Allow sufficient time.

Chapter 2: How Does the Way Students Organize Knowledge Affect Their Learning?

Strategies to Reveal and Enhance Knowledge Organizations

43. Create a concept map to analyze your own knowledge organization.
44. Analyze tasks to identify the most appropriate knowledge organization.
45. Provide students with the organizational structure of the course.
46. Explicitly share the organization of each lecture, lab, or discussion.
47. Use contrasting and boundary cases to highlight organizing features.
48. Explicitly highlight deep features.
49. Make connections among concepts explicit.
50. Encourage students to work with multiple organizing structures.
51. Ask students to draw a concept map to expose their knowledge organizations.
52. Use a sorting task to expose students' knowledge organizations.
53. Monitor students' work for problems in their knowledge organization.

Chapter 3: What Factors Motivate Students to Learn?

Strategies to Establish Value

54. Connect the material to students' interests.
55. Provide authentic, real-world tasks.
56. Show relevance to students' current academic lives.
57. Demonstrate the relevance of higher-level skills to students' future professional lives.
58. Identify and reward what you value.
59. Show your own passion and enthusiasm for the discipline.

Strategies That Help Students Build Positive Expectancies

60. Ensure alignment of objectives, assessments, and instructional strategies.
61. Identify an appropriate level of challenge.
62. Create assignments that provide the appropriate level of challenge.
63. Provide early success opportunities.
64. Articulate your expectations.
65. Provide rubrics.
66. Provide targeted feedback.
67. Be fair.
68. Educate students about the ways we explain success and failure.
69. Describe effective study strategies.

Strategies That Address Value and Expectancies

70. Provide flexibility and control.
71. Give students an opportunity to reflect.

Chapter 4: How Do Students Develop Mastery?

Strategies to Expose and Reinforce Component Skills

72. Push past our own expert blind spot.
73. Enlist a teaching assistant or graduate student to help with task decomposition.
74. Talk to your colleagues.
75. Enlist the help of someone outside your discipline.
76. Explore available educational materials.
77. Focus students' attention on key aspects of the task.
78. Diagnose weak or missing component skills.
79. Provide isolated practice of weak or missing skills.

Strategies to Build Fluency and Facilitate Integration

80. Give students practice to increase fluency.
81. Temporarily constrain the scope of the task.
82. Explicitly include integration in your performance criteria.

Strategies to Facilitate Transfer

83. Discuss conditions of applicability.
84. Give students opportunities to apply skills or knowledge in diverse contexts.
85. Ask students to generalize to larger principles.
86. Use comparisons to help students identify deep features.
87. Specify context and ask students to identify relevant skills or knowledge.
88. Specify skills or knowledge and ask students to identify contexts in which they apply.
89. Provide prompts to relevant knowledge.

Chapter 5: What Kinds of Practice And Feedback Enhance Learning?

Strategies Addressing the Need for Goal-Directed Practice

90. Conduct a prior knowledge assessment to target an appropriate challenge level.
91. Be more explicit about your goals in our course materials.
92. Use a rubric to specify and communicate performance criteria.

93. Build in multiple opportunities for practice.
94. Build scaffolding into assignments.
95. Set expectations about practice.
96. Give examples or models of target performance.
97. Show students what you do <u>not</u> want.
98. Refine your goals and performance criteria as the course progresses.

Strategies Addressing the Need for Targeted Feedback

99. Look for patterns of errors in student work.
100. Prioritize your feedback.
101. Balance strengths and weaknesses in your feedback.
102. Design frequent opportunities to give feedback.
103. Provide feedback at the group level.
104. Provide real-time feedback at the group level.
105. Incorporate peer feedback.
106. Require students to specify how they used feedback in subsequent work.

Chapter 6: Why Do Student Development and Course Climate Matter for Student Learning?

Strategies That Promote Student Development and Productive Climate

107. Make uncertainty safe.
108. Resist a single right answer.
109. Incorporate evidence into performance and grading criteria.
110. Examine your assumptions about students.
111. Be mindful of low-ability cues.
112. Do not ask individuals to speak for an entire group.
113. Reduce anonymity.
114. Model inclusive language, behavior, and attitudes.
115. Use multiple and diverse examples.
116. Establish and reinforce ground rules for interaction.
117. Make sure course content does not marginalize students.
118. Use the syllabus and first day of class to establish the course climate.
119. Set up processes to get feedback on the climate.
120. Anticipate and prepare for potentially sensitive issues.
121. Address tensions early.
122. Turn discord and tension into a learning opportunity.
123. Facilitate active listening.

Chapter 7: How Do Students Become Self-Directed Learners?

Assessing the Task at Hand

124. Be more explicit than you may think necessary.
125. Tell students what you do <u>not</u> want.
126. Check students' understanding of the task.
127. Provide performance criteria with the assignment.

Evaluating One's Own Strengths and Weaknesses

128. Give early, performance-based assessments.
129. Provide opportunities for self-assessment.

Planning an Appropriate Approach

130. Have students implement a plan that you provide.
131. Have students create their own plan.
132. Make planning the central goal of the assignment.

Applying Strategies and Monitoring Performance

133. Provide simple heuristics for self-correction.
134. Have students do guided self-assessments.
135. Require students to reflect on and annotate their own work.
136. Use peer review/reader response.

Reflecting on and Adjusting One's Approach

137. Provide activities that require students to reflect on their performances.
138. Prompt students to analyze the effectiveness of their study skills.
139. Present multiple strategies.
140. Create assignments that focus on strategizing rather than implementation.

Beliefs About Intelligence and Learning

141. Address students' beliefs about learning directly.
142. Broaden students' understanding of learning.
143. Help students set realistic expectations.

Why Don't Students Like School: A Cognitive Scientist Answers Questions About How the Mind Works and What It Means for the Classroom (Hardcover). by Daniel T. Willingham Jossey-Bass (March 16, 2009). 978-0470279304

Ch.	Cognitive Principle	Req. Knowledge about Students	Classroom Implication
1	People are naturally curious, but they are not naturally good thinkers.	What is just beyond what my students know and can do?	Think of to-be-learned material as *answers*, and take the time necessary to explain to students the questions.
2	Factual knowledge precedes skill.	What do my students know?	It is not possible to think well on a topic in the absence of factual knowledge about the topic.
3	Memory is the residue of thought.	What will students think during this lesson?	The best barometer for every lesson plan is "What will it make the students think of?"
4	We understand new things in the context of things we already know.	What do students already know that will be a toehold on understanding the new material?	Always make deep knowledge your goal, spoken and unspoken, but recognize that shallow knowledge will come first.
5	Proficiency requires practice.	How can I get students to practice without boredom?	Think carefully about which material students need at their fingertips, and practice it over time.
6	Cognition is fundamentally different early and late in training.	What is the difference between my students and an expert?	Strive for deep understanding in your students, not the creation of new knowledge.
7	Children are more alike than different in terms of learning.	Knowledge of students' learning styles is not necessary.	Think of lesson content, not student differences, driving decisions about how to teach.
8	Intelligence can be changed through sustained hard work.	What do my students believe about intelligence?	Always talk about successes and failures in terms of effort, not ability.
9	Teaching, like any complex cognitive skill, must be practiced to be improved.	What aspects of my teaching work well for my students, and what parts need improvement?	Improvement requires more than experience; it also requires conscious effort and feedback.

Utility of Various Learning Techniques

Dunlosky et al. (2013) evaluated the utility and generalizability of the benefits of 10 learning techniques in an attempt to provide evidence that may be used to assist students in regulating their own learning. Among the techniques discussed were: elaborative interrogation, self-explanation, summarization, highlighting (or underlining), the keyword mnemonic, imagery use for text learning, rereading, practice testing, distributed practice, and interleaved practice.

Findings related to the utility of the learning techniques are summarized here.

Low Utility
- *Summarization:* Writing summaries (of various lengths) of to-be-learned texts
- *Highlighting/underlining*: Marking potentially important portions of to-be-learned materials while reading
- *Keyword mnemonic:* Using keywords and mental imagery to associate verbal materials
- *Imagery for text:* Attempting to form mental images of text materials while reading or listening
- *Rereading:* Restudying text material again after an initial reading

Medium Utility
- *Elaborative interrogation:* Generating an explanation for why an explicitly stated fact or concept is true
- *Self-explanation:* Explaining how new information is related to known information, or explaining steps taken during problem solving
- *Interleaved practice:* Implementing a schedule of practice that mixes different kinds of problems, or a schedule of study that mixes different kinds of material, within a single study session

High Utility
- *Practice testing:* Self-testing or taking practice tests over to-be-learned material
- *Distributed practice:* Implementing a schedule of practice that spreads out study activities over time

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013) Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, 14*(1), 4–58. DOI: 10.1177/1529100612453266 http://psi.sagepub.com/content/14/1/4.full.pdf?ijkey=Z10jaVH/60XQM&keytype=ref&siteid=sppsi

Related articles on metacognition, retrieval practice, & effortful retrieval

A. Enhancing visuospatial learning: The benefit of retrieval practice. SHK Kang - Memory & cognition, 2010.
http://link.springer.com/article/10.3758%2FMC.38.8.1009?LI=true#page-1

B. Expanded vs. equal interval spaced retrieval practice: Exploring different schedules of spacing and retention interval in younger and older adults. JM Logan, DA Balota - Aging, Neuropsychology, and Cognition, 2008.
http://www.tandfonline.com/doi/abs/10.1080/13825580701322171#.UchQCJymXIU

C. Expanding retrieval practice promotes short-term retention, but equally spaced retrieval enhances long-term retention. JD Karpicke, HL Roediger III - Journal of Experimental Psychology, 2007. http://psycnet.apa.org/journals/xlm/33/4/704/

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F. Testing the retrieval effort hypothesis: Does greater difficulty correctly recalling information lead to higher levels of memory? MA Pyc, KA Rawson - Journal of Memory and Language, 2009.
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