



STANDARD 1: NEW LEARNING IS CONNECTED TO PRIOR LEARNING AND EXPERIENCE

Prior knowledge is a critical variable in learning [1, 2], and its influence on learning is well documented in the research literature. In particular, research in cognition has shown that what learners know and the extent to which their prior knowledge is activated during new learning has important implications for whether new information will make sense to them.

In their classic study, Bransford and Johnson found that prior knowledge was an important factor in both learning and memory [3]. Researchers presented all study participants with cryptic text; some participants were given appropriate information before they heard passages, while others were given the same information after hearing the passages. Comprehension scores were significantly higher for participants who received information prior to listening to the passage. The authors concluded that prior knowledge itself does not guarantee its usefulness for comprehension unless it is activated in an appropriate context prior to the presentation of new knowledge. Numerous studies have supported Bransford and Johnson's findings, especially in the area of text comprehension in various subject areas (e.g., [1, 4-12]).

Share with a colleague two ways that you can activate students' prior knowledge.

SCHEMA THEORY

Schema theory is strongly represented in the prior knowledge literature. The term schema (plural schemata) was first used in 1926 by Piaget, who viewed schemata as the building blocks of thinking that included both a category of knowledge and a process for acquiring the knowledge [13]. Piaget theorized that when knowledge is acquired, schemata adapt to incorporate and organize the new learning. In a further elaboration, Jerome Bruner proposed a theoretical framework developed from research on cognition and child development [14]. A major theme of his framework was that learners construct new concepts based on their current and prior knowledge. Learners select and transform information using existing cognitive structures – schemata – that enable them to organize knowledge and experiences, and apply their knowledge to new situations. In further developments of schema theory, scholars have identified qualitatively different phases of the learning process [15-17].

Still in the context of schema theory, research on novice-expert performance, and of what constitutes expertise in a subject area, have helped to define the characteristics of knowledge and thought at advanced stages of learning and practice [18-27]. This body of research shows that experts have extensive stores of knowledge and skills, but most importantly they have efficiently organized this knowledge into well-connected schemata [28]. It is this "organization of knowledge that underlies experts' abilities to understand and solve problems" [29](p. 15). For example, when confronted with a mathematics or



physics problem, novice students will try to relate it to a memorized theorem or formula [30]. In contrast, experts identify the problem as a particular instance of the application of general principles, and are able to activate existing schemata organized around those principles and abstractions [28, 30, 31]. For the expert, these aspects of knowledge – principles, abstractions and applications- are organized in tightly connected schemata [31]. In the same vein, Good and Brophy argued that knowledge should be viewed as being “composed of networks structured around key ideas” [32] (p. 416).

What is the biggest difference between an expert and a novice when learning new information?

MISCONCEPTIONS AND DIFFERENCES IN PRIOR KNOWLEDGE

Prior knowledge also includes the incorrect understandings a student may bring to new learning. Misconceptions in prior knowledge and their effects on learning have been well documented, especially in the area of science learning. Of particular note is students’ resistance to altering their views in light of new information when it is inconsistent with their prior knowledge, even when the new information provides a better, more accurate account of the phenomenon (e.g., [33-35]). Because inaccuracies, misconceptions, or naïve understandings in students’ prior knowledge can be detrimental to future learning if they are not identified and directly addressed [36-41], researchers have suggested instructional techniques to promote conceptual change. Some techniques involve explicitly addressing misconceptions so students recognize differences between new information and existing knowledge [38, 42, 43], or encouraging students to restructure knowledge and revise existing conceptions through the use of metacognitive and motivational factors, such as developing learning goals, self-efficacy, and control beliefs [44]. In situations where students’ prior knowledge is not engaged and preconceptions are not revealed, students often retain new information long enough to perform well on tests, and then revert back to their preconceptions, correct or not [45].

Prior knowledge also includes the knowledge that learners acquire outside of school settings, such as in their homes and communities. This type of prior knowledge develops as a result of learners’ social roles, including their race/ethnicity, culture, gender, and class [46-49]. Prior knowledge learned from social roles can both support and conflict with students’ learning in schools [50]. For example, Heath found that everyday family habits can be ignored or reinforced in schools by teachers, which in turn, affects how students learn [51]. To connect new learning with prior knowledge, teachers need to be able to take account of the social and cultural prior knowledge with which students enter schools.

What approach(es) may help your students create long-lasting conceptual change?

ELICITING PRIOR KNOWLEDGE

Research has shown that different ways of eliciting prior knowledge results in students showing different types and levels of prior knowledge. Studies in different content areas have employed a variety of techniques to assess learners’ prior knowledge, such as questioning, free recall, association and recognition tests, and multiple-choice tests



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[1, 4, 52-56]. In their study, Valencia, Stallmand, Commeyras, Pearson, and Hartman used four different methods to assess student prior knowledge and found that different assessment methods revealed different amounts and types of information [57]. They concluded that multiple modes, forms, and methods should be used to get a complete characterization of students' prior knowledge.

In summary, prior knowledge is a critical variable in learning. The National Research Council (NRC) commissioned the report, *How People Learn* [45], to examine and synthesize theoretical and empirical evidence of learning and cognition. A key finding of the report is that teachers must work with students' preexisting understandings in order for them to learn new information. According to theoretical and empirical literature documented in this review, learners construct knowledge by connecting new concepts and information to prior knowledge. As Shuell states, "Learning is cumulative in nature; nothing is learned in isolation" [58](p. 416).

What are three things you learned about the importance of connecting new and prior knowledge?

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REFERENCES

1. Dochy, F., M. Segers, and M.M. Buehl, The relation between assessment practices and outcomes of studies: The case of research on prior knowledge. *Review of Educational Research*, 1999. 69(2): p. 145-186.
2. Shapiro, A.M., How including prior knowledge as a subject variable may change outcomes of learning research. *American Educational Research Journal*, 2004. 41(1): p. 159-189.
3. Bransford, J.D. and M.K. Johnson, Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior*, 1972. 11(6): p. 717-726.
4. Chiang, C.S. and P. Dunkel, The effect of speech modification, prior knowledge, and listening proficiency on EFL lecture learning. *Tesol Quarterly*, 1992. 26(2): p. 345-374.
5. Clifton, C.J. and M.L. Slowiaczek, Integrating new information with old knowledge. *Memory & Cognition*, 1981. 9(2): p. 142-148.
6. Johnston, P. and P.D. Pearson, Prior knowledge, connectivity, and the assessment of reading comprehension (Tech. Rep. No. 245). 1982, Cambridge, MA: Center for the Study of Reading.
7. Mathews, S.R., The impact of prior knowledge on accessibility and availability of information from prose. *Advances in Psychology*, 1982. 8: p. 400-409.
8. McKeown, M.G., et al., The contribution of prior knowledge and coherent text to comprehension. *Reading Research Quarterly*, 1992. 27(1): p. 79-93.
9. McNamara, D.S., et al., Are good texts always better? Interactions of text coherence, background knowledge, and levels of understanding in learning from text. *Cognition and Instruction*, 1996. 14(1): p. 1-43.
10. Siegler, R.S., Five generalizations about cognitive development. *American Psychologist*, 1983. 38(3): p. 263-277.
11. Siegler, R.S. and D. Klahr, When do children learn? The relationship between existing knowledge and the acquisition of new knowledge, in *Advances in instructional psychology*, R. Glaser, Editor. 1982, Hillsdale, NJ: Lawrence Erlbaum Associates. p. 121-211.
12. Willoughby, T., et al., The effect of prior knowledge on an immediate and delayed associative learning task following elaborative interrogation. *Contemporary Educational Psychology*, 1993. 18(1): p. 36-46.
13. Woolfolk, A., *Educational psychology* (3rd ed.). 1987, Englewood Cliffs, NJ: Prentice-Hall.
14. Bruner, J., *Toward a theory of instruction*. 1966, Cambridge, MA: Harvard University Press.
15. Anderson, R.C., The notion of schemata and the educational enterprise, in *Schooling and the acquisition of knowledge*, R.C. Anderson, R.J. Spiro, and W.E. Montague, Editors. 1977, Hillsdale, N.J.: Lawrence Erlbaum Associates Inc.
16. Rumelhart, D.E. and D.A. Norman, Accretion, tuning and restructuring: Three modes of learning, in *Semantic factors in cognition*, J.W. Cotton and R.L. Klatzky, Editors. 1978, Hillsdale, NJ: Erlbaum. p. 335-360.
17. Rumelhart, D.E. and D.A. Norman, Simulating a skilled typist: A study of skilled cognitive-motor performance. *Cognitive Science*, 1982. 6: p. 1-36.
18. Chase, W.G. and H.A. Simon, Perception in chess. *Cognitive Psychology*, 1973. 4(1): p. 55-81.
19. Chi, M.T.H., et al., Self-explanations: How students study and use examples in learning to solve problems. *Cognitive Science*, 1989. 13(2): p. 145-182.
20. Chi, M.T.H., P.J. Feltovich, and R. Glaser, Categorization and representation of physics problems by experts and novices. *Cognitive Science*, 1981. 5(2): p. 121-152.
21. Chi, M.T.H., R. Glaser, and E. Rees, Expertise in problem solving, in *Advances in the psychology of human intelligence*, R.J. Sternberg, Editor. 1982, Hillsdale, NJ: Erlbaum. p. 1-75.
22. Chi, M.T.H. and R.D. Roscoe, The processes and challenges of conceptual change, in *Reconsidering conceptual change: Issues in theory and practice*, M. Limon and L. Mason, Editors. 2002, The Netherlands: Kluwer Academic Publishers. p. 3-27.
23. Chi, M.T.H., J.G. Slotta, and N. deLeeuw, From things to processes: A theory of conceptual change for learning science concepts. *Learning and Instruction*, 1994. 4(1): p. 27-43.
24. Chi, M.T.H. and K.A. VanLehn, The content of physics self-explanations. *The Journal of the Learning Sciences*, 1991. 1(1): p. 69-105.
25. Ferraria, M. and M.T.H. Chi, The nature of naive explanations of natural selection. *International Journal of Science Education*, 1998. 20(10): p. 1231-1256.
26. Larkin, J., et al., Expert and novice performance in solving physics problems. *Science*, 1980. 208(4450): p. 1335-1342.
27. Newell, A., *Unified theories of cognition*. 1990, Cambridge, Massachusetts: Harvard University Press.
28. National Research Council, *Knowing what students know: The science of design and educational assessment*. 2001, Washington, DC: National Academy Press.
29. National Research Council, *How students learn: History, mathematics, and science in the classroom*, 2005, National Academies Press: Washington D. C.
30. Good, T.L. and J.E. Brophy, *Educational psychology: A realistic approach* 4th ed. 1990, White Plains, NY: Longman.
31. Glaser, R., Education and thinking: The role of knowledge. *American Psychologist*, 1984. 39(2): p. 93-104.
32. Good, T.L. and J.E. Brophy, *Looking in classrooms*. 6th ed. 1994, New York: Harper Collins College Publishers.
33. Alvermann, D.E. and S.A. Hague, Comprehension of counterintuitive science text: Effects of prior knowledge and text structure. *Journal of Educational Research in Science Teaching*, 1989. 82(4): p. 197-202.
34. Alvermann, D.E. and C.R. Hynd, Effects of prior knowledge activation modes and text structure on nonscience majors' comprehension of physics. *The Journal of Educational Research*, 1989. 83(2): p. 97-102.
35. Hynd, C.R. and D.E. Alvermann, Prior knowledge activation in refutation and non-refutation text, in *Solving problems in literacy: Learners, teachers and researchers*, J.A. Niles and R.V. Lalik, Editors. 1989, Rochester, NY: National Reading Conference. p. 55-60.
36. Chinn, C.A. and W.F. Brewer, The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research*, 1993. 63(1): p. 1-49.
37. Cohen, C., Person categories and social perception: Testing some boundaries of the processing effects of prior knowledge. *Journal of Personality and Social Psychology*, 1981. 40(3): p. 441-452.
38. Guzzetti, B.J., et al., Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. *Reading Research Quarterly*, 1993. 28: p. 117-155.
39. Mestre, J.P., Cognitive aspects of learning and teaching science, in *Teacher enhancement for elementary and secondary science and mathematics: Status, issues and problems*, S.J. Fitzsimmons and L.C. Kerpelman, Editors. 1994, Arlington, VA: National



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- Science Foundation. p. 3-1 - 3-53.
40. Perkins, D.N. and R. Simmons, Patterns of misconceptions: An integrative model for science, math, and programming. *Review of Educational Research*, 1988. 58(303-326).
 41. Wandersee, J.H., Students' misconceptions about photosynthesis: A cross-age study, in *Proceedings of the international seminar on misconceptions in science and mathematics*, H. Helm and J.D. Novak, Editors. 1983, Ithaca, NY: Cornell University. p. 441-465.
 42. Biemans, H.J.A. and P.R.-J. Simons, How to use preconceptions? The contact strategy dismantled. *European Journal of Psychology of Education*, 1995. 10(3): p. 243-359.
 43. Spires, H.A., J. Donley, and A.M. Penrose, Prior knowledge activation: Inducing text engagement in reading to learn, in *Annual meeting of the American Educational Research Association 1990*: Boston, MA.
 44. Pintrich, P.R., R.W. Marx, and R.A. Boyle, Beyond cold conceptual change: The role of motivation beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, 1993. 63(167-199).
 45. National Research Council, et al., *How people learn: Brain, mind, experience, and school*. 2000, Washington, DC: National Academies Press.
 46. Cazden, C., *Classroom discourse: The language of teaching and learning*. 2001, Portsmouth, NH: Heinemann.
 47. Gee, J.P., What is literacy? *Journal of Educational Psychology*, 1989. 171: p. 18-25.
 48. Lave, J., *Cognition in practice: Mind, mathematics and culture in everyday life*. 1988, New York, NY: Cambridge University Press.
 49. Rogoff, B., Cognition as a collaborative process, in *Handbook of child psychology: Cognition, perception, and language*, W. Damon, D. Kuhn, and R.S. Siegler, Editors. 1998, New York, NY: Wiley and Sons. p. 679-744.
 50. Greenfield, P.M. and L.K. Suzuki, Culture and human development: Implications for parenting, education, pediatrics, and mental health, in *Handbook of child psychology*, I.E. Sigel and K.A. Renninger, Editors. 1998, New York, NY: Wiley and Sons. p. 1059-1109.
 51. Heath, S.B., *Ways with words: Language, life, and work in communities and classrooms*. 1983, New York, NY: Cambridge University Press.
 52. Chiesi, H.L., G.J. Spilich, and J.F. Voss, Acquisition of domain related information in relation to high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior*, 1979. 18: p. 257-273.
 53. Dochy, F., Assessment of domain-specific and domain-transcending prior knowledge: Entry assessment and the use of profile analysis, in *Alternatives of assessment in achievements, learning processes, and prior knowledge*, M. Birenbaum and F. Dochy, Editors. 1996, Boston, MA: Kluwer Academic. p. 227-265.
 54. Hasselhorn, M. and J. Korkel, Metacognitive versus traditional reading instructions: The mediating role of domain-specific knowledge on children's text-processing. *Human Learning*, 1986. 5: p. 75-90.
 55. Lambiotte, J.G. and D.F. Dansereau, Effects of knowledge maps and prior knowledge on recall of science lecture content. *Journal of Experimental Education*, 1992. 60(189-201).
 56. Sanbonmatsu, D.M., C. Sansone, and F.R. Kardes, Remembering less and inferring more: Effects of time on judgment on inferences about unknown attributes. *Journal of Personality and Social Psychology*, 1991. 61(4): p. 546-554.
 57. Valencia, S.W., et al., Four measures of topical knowledge: A study of construct validity. *Reading Research Quarterly*, 1991. 26: p. 204-233.
 58. Shuell, T.J., Cognitive conceptions of learning. *Review of Educational Research*, 1986. 65(4): p. 411-436.

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