Principle 1
New Learning is Connected to Prior Learning and Experience

Prior knowledge is a critical variable in learning (Dochy, Segers, & Buehl, 1999; Shapiro, 2004), 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 (1972) found that prior knowledge was an important factor in both learning and memory. 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 Branford and Johnson's findings, especially in the area of text comprehension in various subject areas (e.g., Chiang & Dunkel, 1992; Clifton & Slowiaczek, 1981; Dochy et al., 1999; Johnston & Pearson, 1982; Matthews, 1982; McKeown, Beck, Sinatra, & Loxterman, 1992; McNamara, Kintsch, Songer, & Kintsch, 1996; Siegler, 1983; Siegler & Klahr, 1982; Willoughby, Waller, Wood, & MacKinnon, 1993).

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 (Woolfolk, 1987). Piaget theorized that when knowledge is acquired, schemata adapt to incorporate and organize the new learning. In a further elaboration, Jerome Bruner (1966) proposed a theoretical framework developed from research on cognition and child development. 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 (Anderson, 1977; Rumelhart & Norman, 1978; 1982).

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 (Chase & Simon, 1973; Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, Feltovich, & Glaser, 1981; Chi, Glaser, & Rees, 1982; Chi & Roscoe, 2002; Chi, Slotta, & deLeeuw, 1994; Chi & VanLehn, 1991; Glaser, 1984; Ferrari & Chi, 1998; Larkin, McDermott, Simon, & Simon, 1980; Newell, 1990). 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 (NRC, 2001). It is this "organization of knowledge that underlies experts' abilities to understand and solve problems" (NRC, 2005, 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 (Good & Brophy, 1990). 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 (Glaser, 1984; Good & Brophy, 1990; NRC, 2001). For the expert, these aspects of knowledge principles, abstractions and applications- are organized in tightly connected schemata (Glaser, 1984). In the same vein, Good and Brophy (1994) argued that knowledge should be viewed as being "composed of networks structured around key ideas" (p. 416).

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., Alvermann & Hague, 1989; Alvermann & Hynd, 1989; Hynd & Alvermann, 1989). Because inaccuracies, misconceptions, or naïve understandings in students' prior knowledge can be detrimental to future learning if they are not identified and directly addressed (Chinn & Brewer, 1993; Cohen, 1981; Guzzetti, Snyder, Glass, & Gamas, 1993; Mestre, 1994; Perkins & Simmons, 1988; Wandersee, 1983), 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 (Beimans & Simmons, 1994; Guzzetti et al., 1993; Spires,

Donley, & Penrose, 1990), 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 (Pintrich, Marx, & Boyle, 1993). 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 (NRC, 2000).

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 (Cazden, 2001; Gee, 1989; Lave, 1988; Rogoff, 1998). Prior knowledge learned from social roles can both support and conflict with students' learning in schools (Greenfield & Suzuki, 1998). For example, Heath (1983) found that everyday family habits can be ignored or reinforced in schools by teachers, which in turn, affects how students learn. 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.

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 (Chiang & Dunkel, 1992; Chiesi, Spilich, & Voss, 1979; Dochy, 1996; Dochy, Segers, &Buehl, 1999; Hasselhorn & Korkel, 1986; Lambiotte & Dansereau, 1992; Sanbonmatsu, Sansone, & Kardes, 1991). In their study, Valencia, Stallmand, Commeyras, Pearson, and Hartman (1991) used four different methods to assess student prior knowledge and found that different assessment methods revealed different amounts and types of information. 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* (NRC, 2000), 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 (1986) states, "Learning is cumulative in nature; nothing is learned in isolation" (p. 416).