CHAPTER 1

Developing the Foundations to Help People Learn

Why Young Children Learn So Quickly

If you have had the experience of interacting with a child between the ages of one and four, you have witnessed how quickly these children acquire the names for objects and events they are experiencing. They also demonstrate their ability to pronounce these names, albeit their pronunciation may not be perfect at first. Usually, mommy and daddy are among the first words learned, but a dog's name or the name of a favorite toy might also be learned very early. The name of a favorite food or drink may appear very early. Children add about ten to twenty new words a week between the ages of 18 to 24 months. By age four the average child can use about 4,000 words correctly. Most adults know the meanings of 20,000 to 35,000 words.

The most difficult thing any person will have to learn in their lifetime is to speak and understand the language. And yet, all normal children do this by age four! Why then do so many children have trouble learning in school when they were so successful as young children? This book will help to answer this question and to provide some solutions to this problem. We will also discuss what we can do to help people learn in any setting, from the classroom to the job setting to the research laboratory.

In my work as an educator and researcher for the past sixty plus years, I have found that it is critically important for teachers and learners to understand that most words are names for concepts. We define a concept as a perceived regularity or pattern in events or objects, or records of events or objects, designated by a word or symbol. When children learn the meaning of most new words, they are really learning the meaning of concepts. They are learning what pattern or regularity they are for. Concepts are the building blocks of knowledge in every domain of knowledge.

When young children acquire names for concepts, they are almost always observing the events or objects to which the word label is being applied. They are seeing and experiencing things such as dogs, or liquids,

birds, or trees. Or they may be experiencing events such as running, fishing, cooking, or bathing. These concept labels have *meaning* for the children. They are engaged in *meaningful learning*. By contrast, so much of school learning involves rote memorization of definitions of words or statements for which the child has no direct experience. We label this kind of learning *rote learning*, and this kind of learning can lead to many kinds of educational problems. A continuing theme in this book will be that we must find better ways to enhance and facilitate meaningful learning in schools or work settings, and to minimize as much as possible engaging people in rote learning.

New concepts are created by creative people who observe a new pattern or regularity in some specific kind of thing or event. They describe and define this regularity and give it a name. For example, I am typing this book on a laptop computer. These had not been invented when I was a student.

Macnamara (1982) saw in his studies of how children acquire "names for things" that either the perception of a regularity or the name (word) for a regularity may come first, but facility in proper use of the word requires that both the word label and its associated meaning be integrated. Since meaning is always context-dependent, the meaning of a concept label will always have some idiosyncratic elements, for no two people experience an identical sequence of events (contexts) in which a given concept label is applied. Whorf (1956) was one of the first and most prominent researchers to recognize that the cultural context in which a person lives shapes the meaning of that person's concepts. (Novak, 2010, p. 43).

Important as it is to understand the meaning of concepts in any domain of knowledge, learning a set of concept names does not lead to an understanding of the meaning of these concepts. We also must learn valid propositions that incorporate these concepts. *Propositions* are two or more concepts connected with linking words to form a meaningful statement. Thus, we really never learn the meaning of a concept in isolation but, rather, through learning sets of propositions that include that concept. So, the young child learns that sky is blue, water is wet, dogs can bark, etcetera, etcetera.

We might compare the world of language with the world of chemistry. The universe is made up of about 100 kinds of atoms or elements. Two or more atoms may combine to form a molecule. The possible combinations of atoms are essentially infinite, and there is no end to the number of new molecules a chemist may invent. Similarly, there are just twenty-six letters in the English language, and words are made up of one or more letters. When creative people see or invent some new pattern or regularity, they

make up a word to label this new concept. Consider for a moment all the new words invented to describe new patterns in objects and events in the digital world.

So, the fundamental challenge we face in helping people learn in any domain of knowledge is to help people build an understanding of the key concepts and propositions of that discipline. We also want to help them to understand how new knowledge can be created in that discipline. There has been so much written about how to help people learn that we also need to sort out which ideas are valid and may be powerful, and which ideas are of little value or just plain wrong. For me, this has been a lifelong journey – and the journey will continue as long as I am able to pursue it. We are continuing to find better ways to help people learn. And new technologies are opening up new possibilities that we need to consider.

We are usually at our best in new learning when we are also engaged in some physical activity. If we are progressing well with our learning, we also experience strong positive feelings. Recall your experience when you figured out how something works or a winning strategy for a game. Thinking, feeling, and acting are all integrated in a positive way in any successful learning experience.

Figure 1.1 The author's three children, Barbara (7), William (6), Joseph (8), 1965. Raising children was a joy for me; they also taught me so much!

I have discussed in some detail in my biography three things that have been helpful in my search for understanding how people learn and how to facilitate learning.[1] First, my experiences as a parent raising three children have not only been a great joy but have helped me discern those ideas I was taught that made sense from those perspectives that did not. Second, my wife for more than six decades has been both a constant supporter and the best critic of my work. Third, as a child, my dad played a very important role in building my confidence. He insisted that his son Joe was capable of doing anything he sought to do. I will also indicate in this book instances where these people helped me discern sense from nonsense – and there is much of the latter in the literature!

Can Education Become a Science?

I majored in science as an undergraduate and also completed classes and intern teaching to become a certified science teacher. As a graduate student, I was a research and teaching assistant in the Botany Department at the University of Minnesota. I also completed the requirements for a Ph.D. degree in Science Education. I was fascinated by the methods scientists used to create new knowledge and the important role that theories play in the advance of science. By contrast, I learned of no real theories or major principles that could guide educational practice and knowledge creation in education that would lead to better educational practices. It was my conviction that human learning and educational practices could be considered as belonging to the class of animal behavior and therefore should be amenable to the same kinds of tools and theory building that have been so successful in the sciences. I came to believe that if education were ever to become a science, it must be based on a valid theory of learning. I was convinced that behavioral psychology was not viable as a theory to guide education and educational research.

Throughout my undergraduate and graduate education at the University of Minnesota from 1948 to 1957, the only theory of learning I was taught was behavioral psychology. The fundamental idea of behavioral psychology is that since we cannot observe directly what is occurring in the brain, we must study only the manifest behaviors of animals and humans. We cannot therefore attempt to speculate on what is going on in their brains. Furthermore, behavioral psychology largely ignores the important role that feelings play in everything that people choose to do.

[1] This biography is available at no cost at: www.ihmc.us/joseph.

Any theory that ignored the role of feelings, in my view, was quite simply inadequate at best and possibly dead wrong!

In the sciences, many kinds of studies deal with phenomena that we cannot observe directly, but only through the use of instruments. For example, almost everything we know about the structure and function of atoms is derived through observations with instruments. So, concepts in this field are created primarily from patterns in records we make, not from observing events and objects with our own eyes. From my perspective, behavioral psychology simply did not make sense as a theoretical model, nor did I think it was a viable theory to guide research on human learning. One lesson I learned from my dad's teaching was that if something just does not make sense, it is probably wrong. For a few years, I and my graduate students searched for a better theory of human learning to guide our work.

Learning to Understand and to Implement Ausubel's Assimilation Theory of Learning

My first job was in the Biology Department at Kansas State Teachers College. I taught undergraduate and graduate biology courses and supervised a small group of master's degree students interested in research on biology teaching and learning. In 1959, I accepted a joint position as Assistant Professor in the Biology and Education Departments at Purdue University. My primary responsibilities were to build a nationally recognized program for training biology teachers and to conduct research with MS and Ph.D. graduate students interested in improving biology education. I inherited a few Ph.D. students from my predecessor who held this position before he was killed in an automobile accident. Within two years, I had built a team with eight–ten Ph.D. students.

Not only was behavioral psychology the dominant theory for learning during my school years, but it remained the dominant theory until the late 1980s. I saw no value in behavioral psychology as a theory of learning for a science education research program. I and my team of graduate students were delighted when we learned about David Ausubel's Assimilation Theory of Learning first published as a journal article in 1962, and as a book in 1963. So, beginning in 1963, we finally had a theory of learning that made sense to us! Much of the success my students and I achieved in coming to understand human learning and finding new ways to facilitate such learning derived from rejecting behavioral psychology and embracing Ausubel's new Assimilation Theory of Learning.

Although Ausubel's learning theory contained only seven major principles, it was not easy to understand, since each of the principles is closely connected with the meanings of the other six principles. I discussed earlier in this chapter the differences between rote learning and meaningful learning. Ausubel has written more precisely than any other cognitive psychologist I have studied. His theory includes the important differences that occur when a learner acquires information by meaningful learning as contrasted to learning by rote memorization. His theory includes the principle of *subsumption* that occurs in meaningful learning when new examples of concepts are *subsumed* and integrated into a *relevant* existing, more general concept. For example, this is the case when a child learns that another kind of animal they never saw before is also a member of the dog family. Repeated subsumption of new instances or examples of a concept lead to a refinement and enhancement over time of this subsuming concept. Ausubel called this process *progressive differentiation.* The subsuming concept becomes more complex and inclusive, but also more explicit and more precisely understood. A young child might confuse a cat as another kind of dog. But she/he will soon differentiate these kinds of animals and recognize that while they can both be *pets* (another concept), they are distinctly different. Even as a young child, these kinds of subsumptions and progressive differentiations take place effectively with all normal children.

As a child's learning progresses, she/he may learn that some people have parrots or canaries as pets, and maybe hamsters and white rats. A new superordinate concept of household pet may be forming, perhaps including cold-blooded animals such as turtles, fish, and snakes. Over time, some details of these expanded concepts may be forgotten in the process Ausubel called *obliterative subsumption*. There is a difference between obliterative subsumption that may occur after meaningful learning and *forgetting* that occurs after rote learning. In the case of obliterative subsumption of concept details, the contributions that obliteratively subsumed concepts had made to the meaning of the superordinate concept largely remain and these can be quickly relearned. No such cognitive benefit occurs in the *forgetting* that occurs after rote learning. Figure 1.2 summarizes these seven Quasiabelian learning principles, shown in shaded ovals.

One way to move toward better understanding of these principles of learning is to try placing examples of concepts of objects or events that interest you as specific examples of each principle. For example, you might use cars as another example, or events such as parties or travel.

When we memorize new information, that is when we learn by rote, that information can be stored almost anywhere in our frontal cortex (see

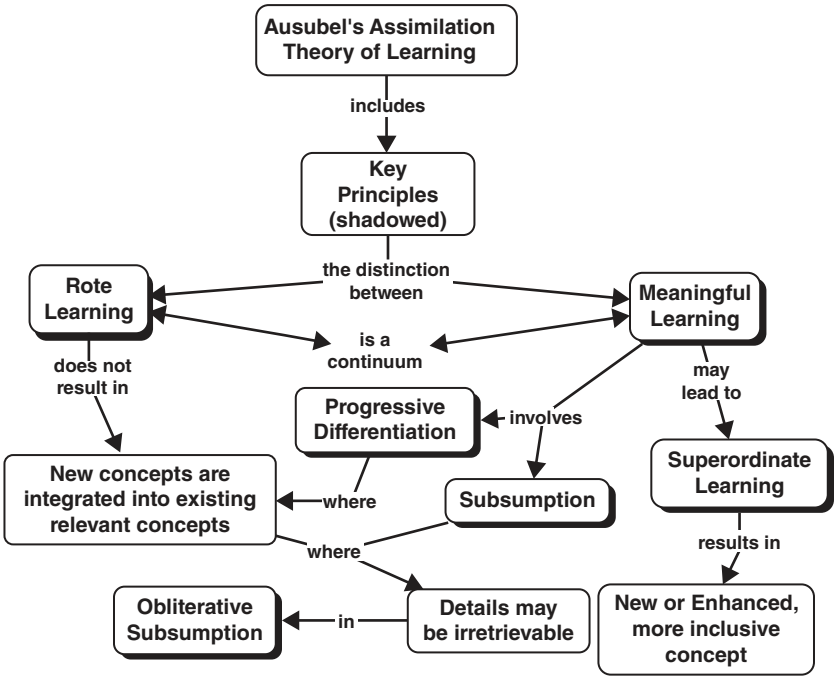

Figure 1.2 A concept map showing the relationship of key principles in Ausubel's Assimilation Theory of Learning. The key ideas in Ausubel's theory are shown in the shaded concept cells of the map.

Figure 1.3). When we learn information meaningfully, this new information becomes integrated with related concepts and propositions stored in our cortex. Ausubel called this a subsumption process. When this occurs, both the original anchoring concept and the added subsumed concept are modified in a positive way. Ausubel describes this as assimilating new knowledge into existing relevant concepts. Thus, his theory of learning is often called Ausubel's Assimilation Theory of Learning. For the young child, almost all learning takes place when they are interacting with objects or events and thus most of their learning is meaningful. By contrast, so much of school learning involves memorization or rote learning of information that has few or no ties to the real world of objects and events already known by the learner.

I recall when my son Joe was about two years old and we were driving in the countryside. My son saw a cow in a field that we passed and he shouted out: "doggy, doggy." I said no – it is really a cow that is much bigger than a

Figure 1.3 The brain. Information we learn is stored in the outer convoluted folds of the frontal cortex of our brain. Feelings and actions, we experience during meaningful learning are stored in lower regions of the brain, but all are connected by nerve cells and blood vessels.

dog. It only looks smaller because it is far away. I guess this explanation made sense to my son; he never made this mistake again – and he assimilated a new idea about dogs and other animals that might look like dogs when viewed from a distance. The idea that things viewed some distance away look smaller than they really are is a pretty powerful concept, and we have observed this often in our work with children.

From 1963 to this day, Ausubel's Assimilation Theory of Learning has been useful to me and my research groups and to my students. As our work progressed, it became increasingly evident that meaningful learning was not a simple alternative to rote learning. Since meaningful learning requires that the learner must make the effort to integrate new concepts and propositions with relevant concepts and propositions she/he already knows, the quality of meaningful learning is dependent on both the quality of relevant concepts and propositions the learner holds and also the degree to which the learner makes an effort to integrate new knowledge into her/his existing relevant knowledge. Both of these aspects can vary greatly from learner to learner and for different learning tasks. Sitting and listening to a lecture is a very poor way to engage in a high level of meaningful learning. Actively working with and discussing with a team of students a new idea or a new way of doing something can be a great way to engage in high levels

of meaningful learning. Throughout this book I shall try to illustrate that working and thinking with others is a great way to help people learn.

When I began college at the University of Minnesota in 1948, one thing I had hoped to learn was how people learn and create new things. From my readings, it was clear that people who create new things and new ideas are intelligent, and they work very hard. The book that I read in 1949 that had perhaps the most important influence on my thinking was James Conant's, *On Understanding Science*. Conant argued that what makes advances in the sciences is that people invent new conceptual schemes, and then they work to refine, modify, and improve these schemes. Sometimes they see that a given conceptual scheme begins to have too many problems or inconsistencies, and then comes the challenge to create a new, better scheme. Conant also suggested that the process goes on forever, and we will never invent the perfectly correct conceptual scheme!

As a college freshman, I did not know at the time that Conant's ideas were far from the mainstream of the thinking of philosophers and psychologists. Overwhelmingly in these fields, the popular belief was that through careful observations and experimentation, we can eventually establish laws, and these laws will endure forever. These kinds of thinkers were called positivists or logical positivists. The University of Minnesota was the international center for logical positivism. I did a graduate philosophy course with one of the world leaders, Professor Herbert Feigl. Professor Feigl and I had several friendly debates in his office – which he easily won by sheer years of professing. Nevertheless, I thought the kind of philosophy I was searching for would be better than logical positivism.

All the psychology courses I took at Minnesota were based on behavioral psychology, and this psychology was tightly wedded to positivist thinking. For various reasons, I thought that the logical positivists and the behavioral psychologists were just plain wrong in their assumptions, their methodologies, and their thinking! The confidence my dad helped to build in me as a child gave me the guts to insist that the behaviorists and the positivists were just plain wrong and people like Conant in philosophy of science and Ausubel in psychology were on the right track. Be certain of this, my views were far from the mainstream in the 1950s through the 1970s. Fortunately, the tide of thinking had turned in my direction by the mid-1980s. The changes in thinking in psychology in the 1970s and 1980s became what some call the "cognitive psychology revolution," bringing the thinking in psychology much more in line with Ausubel's 1963 ideas.

There were other scholars who were critical of behavioral psychology as early as the 1920s. I simply was not exposed to any of their work in my

psychology courses at Minnesota. Piaget had published several books on children's cognitive development in the 1920s through the 1970s. Noam Chomsky had published his critique of behaviorism and empiricist epistemology in 1959. In 1960, Jerome Bruner and George Miller founded the Harvard Center for Cognitive Studies, the first formal institution committed to cognitive psychology. In 1967, Ulrick Neisser published his book, *Cognitive Psychology*, and this defined cognitive psychology for decades to come.

Almost simultaneously, the thinking about the nature of knowledge and knowledge creation began to shift toward constructivist views, more similar to Conant than to Feigl and other positivist's ideas. The current views are congruent with the kind of thinking my students and I had been using since the early 1960s. I have describe my intellectual journey up to my current work in a book that can be downloaded and read at: www .ihmc.us/joseph-novak/.

In 1977, David Ausubel invited me to collaborate on a revision of his 1968 book, *Educational Psychology: A Cognitive View.* My job was to revise the chapters dealing with Ausubel's Assimilation Theory of Learning, and some other sections of the book. In the course of working on these revisions, I got to know Ausubel very well and we had numerous conversations about his theoretical ideas and possible modifications. The revised second edition was published in 1978. (Ausubel, Novak, and Hanesian, 1978). The sale of the English edition was dropped by the publishers (Holt, Rinehart, and Winston) after five years when annual sales of the book dropped below their required level, but the Spanish translation published by Editorial Trills in Mexico continues to sell today. The international rise of cognitive psychology was yet to come. My colleague, Ulrich Neisser, published his *Cognitive Psychology* in 1967, and this became a classic in the field, but this book did not come to my attention until ten or twelve years later. Anderson's 1983 book became very popular as cognitive psychology began to dominate the field. Ausubel regarded the latter book and similar books as neo-behaviorist, and I saw them as failing to shed the positivistic views of behavioral psychology. The complex interrelationships of the ideas in Ausubel's Assimilation Theory of Learning did not compete well with some of the other books on cognitive psychology mentioned above and the still widely popular behavioral psychology books published in the 1970s and 1980s.

Based on research done by my research teams, and my teaching experiences presenting these ideas to others, I argued that rote learning and meaningful learning should not be viewed as discrete forms of learning,