

Learning, Creating, and Using Knowledge

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Concept Maps as Facilitative Tools in Schools and Corporations

Second Edition

Joseph D. Novak

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Learning, Creating, and
Using Knowledge

The field of learning and creating knowledge has become a central focus of research in education and business. This book provides a comprehensive overview of the field, including a history of learning and creating knowledge, a review of current research, and a discussion of the implications for practice. The book is divided into three parts: Part I, Learning and Creating Knowledge; Part II, Learning and Creating Knowledge in Schools; and Part III, Learning and Creating Knowledge in Corporations. The book is written for researchers, practitioners, and students in the field of learning and creating knowledge.

Changes in the Second Edition

- The author has updated the book to reflect the latest research in the field of learning and creating knowledge.
- The author has added a new chapter on learning and creating knowledge in corporations.
- The author has revised the chapters on learning and creating knowledge in schools and corporations to reflect the latest research.
- The author has added a new appendix on learning and creating knowledge in schools and corporations.
- The author has revised the index to reflect the latest research.

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The Need for a Theory of Education

My thesis in this book is the same as it was in the first edition and in my earlier book, *A Theory of Education* (Novak, 1977a): Education, in any setting, is an enormously complex human endeavor; there are more ways to make changes that will be harmful or of little value than ways to make constructive improvements in education. A comprehensive *theory* of education is needed to give vision and guidance for new practices and research leading to steady improvement of education. The ideas in this book should apply to all educational settings, including schools, universities, corporations, technology-mediated education, and non-formal education, such as museums or hobbies.

Theories are ideas that *explain why* some set of phenomena in the universe behave as they do. The sciences have been enormously successful in devising theories, and though even the best theories evolve and change over time, these still make possible a steady advance in knowledge about how the natural world works and in prediction and control over an ever-widening range of events or phenomena. The theory of education presented in this book will explain why educational experiences we judge as effective are effective, and why those experiences we judge as ineffective are ineffective. For example, the theory of learning I will present explains why learning by *rote* is ineffective for long-term retention and application of knowledge and why *meaningful* learning is effective and necessary for creative thinking. As with all theories, there are no simple, direct answers (consider, for example, the theory of evolution), and yet I hope to explain, on a theoretical basis, what is in the ballpark of being “better” and what appears to be outside of this ballpark. The theory of education presented will be a composite of a theory of learning, a theory of knowledge, and a theory of teaching and management, each of which complements and supports the others.

Educating is more than science; it is also an art. It requires personal judgments, feelings, and values. Increasingly, of course, we are coming to recognize that the latter are also involved in science. Keller (1983) chose to title her biography of Nobel Laureate biologist Barbara McClintock, *A Feeling for the Organism*, expressing not only the careful research done by her but also her commitment and sensitivity to understanding plants. Issues of sensitivities

and values are becoming increasingly important in the sciences also, especially with the growing application of scientific ideas and tools for manipulating plant and animal (including human) genes. Throughout this book I shall make reference to issues that concern both the science of educating and the art of educating.

I will claim that *the central purpose of education is to empower learners to take charge of their own meaning making*. Meaning making involves thinking, feeling, and acting, and all three of these aspects must be integrated for significant new learning, and especially in new knowledge creation. In some ways, this is not a new idea. In the monograph published by the Educational Policies Commission (EPC), this statement was published in 1961:

The purpose which runs through and strengthens all other educational purposes—the common thread of education—is the development of the ability to think. This is the central purpose to which the schools must be oriented . . . the development of every student’s rational powers must be recognized as centrally important. (p. xiv)

One of the shortcomings of the EPC report is that it failed to recognize the central role that meaningful learning and acquisition of powerful conceptual frameworks in basic disciplines play in the ability to engage in rational thought. It also failed to recognize that students need explicit guidance in learning about learning and in the use of tools and strategies to facilitate meaningful learning. This guidance in learning and the use of tools to facilitate learning and understanding is becoming especially important in the corporate world. Learning and integrating new knowledge in collaborative settings is especially important in the highly competitive global markets in which corporations are operating. These will be some of the issues focused upon in this book.

Successful education must focus upon more than the learner’s thinking. Feelings and actions are also important. We must deal with all three forms of learning. These are acquisition of knowledge (*cognitive* learning), change in emotions or feelings (*affective* learning) and gain in physical or motor actions or performance (*psychomotor* learning) that enhance a person’s capacity to make sense out of their experiences. A positive educational experience will enhance a person’s capacity for thinking, feeling, and/or acting in subsequent experiences. A maleducative or miseducative experience will diminish this capacity. Humans engage in thinking, feeling, and acting, and these combine to form the *meaning* of experience (Figure 2.1). Recent research indicates that emotions are involved in an important way as we organize and retain experiences (Niedenthal, 2007). This book will focus on how to enhance the meaning of experience for any person.

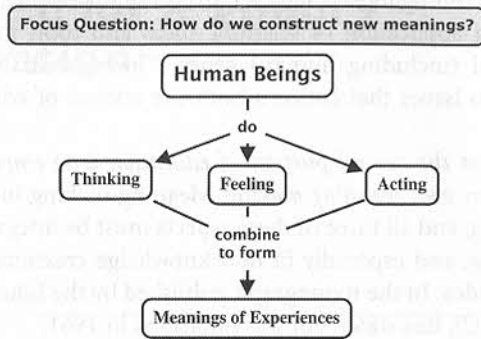


Figure 2.1 The meanings we construct from our experiences are a composite of our thinking, feeling, and acting during the experience.

The Five Elements of Education

In 1973, Joseph Schwab proposed that education involved what he called “four commonplaces.” His “commonplaces” were learner, teacher, subject matter, and social matrix. Each commonplace was necessary to consider and could not be “reduced” into one of the others (analogous to finding the lowest common denominator in fractions). Schwab’s commonplaces, and many of his other ideas, have proven to be of value to educators. They provide a kind of “check list” to assure that we are covering all the key checkpoints necessary to understand or to design an effective educational intervention.

Our studies in schools and other settings, notably corporate settings, however, have shown that much of what happens in teaching and/or learning depends upon the forms of appraisal used. Therefore, I wish to propose *evaluation* as a fifth *element* in education. I prefer the term *elements* to commonplaces because it connotes the idea that each is a building block for myriads of combinations that form educational events, much as the 100 or so elements of chemistry form an infinite variety of molecules.

My five elements are: (1) learner; (2) teacher; (3) knowledge; (4) context; and (5) evaluation. I add the last element because so much of what happens to people in life is based upon evaluation. For better or worse, the evaluations we are subjected to determine whether or not we can drive an automobile, graduate with “honors” or enter a university or graduate program or succeed in a corporate or other work setting. Unfortunately, so much of the “testing” that is done is really poor at evaluating human competencies, and I will deal with this issue throughout the book. Nevertheless, I see evaluation as an additional key element in education. Figure 2.2 shows a concept map with these elements. Concept maps, a knowledge representation tool that was developed in 1972 in our research program (Novak & Musonda, 1991), will be used extensively in this book. Strategies for developing and using concept maps have been

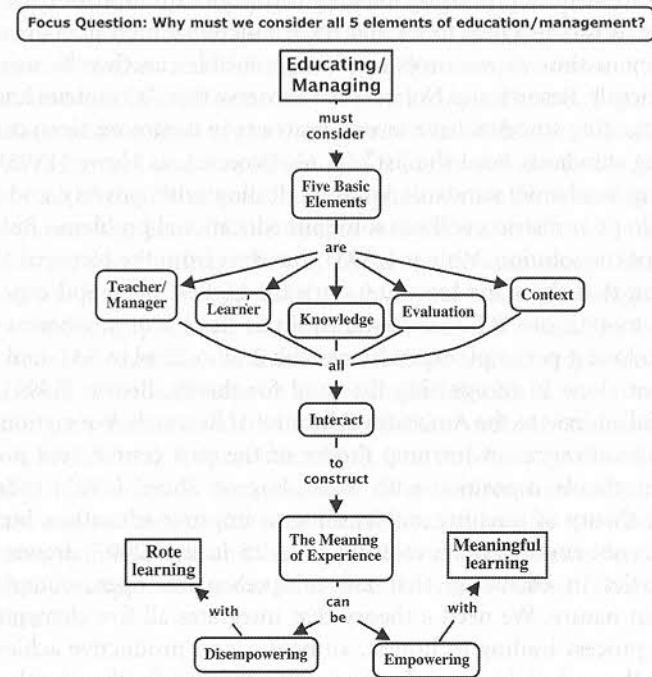


Figure 2.2 The Five Elements that comprise any educational event: learner, teacher, knowledge, evaluation, and context. All elements are present in an educative event and combine to construct or reconstruct the meaning of experience.

described in numerous publications and in *Learning How to Learn* (Novak & Gowin, 1984). As we shall see, concept maps and Vee diagrams (see Chapter 6) can also be powerful tools to aid learning as well as tools for evaluation.

Two additional factors operate in education: money and time. These are factors that influence any human enterprise and are not uniquely relevant to education. In general, we can improve any endeavor if we have more money and/or more time to pursue that endeavor. Moreover, the past few decades have illustrated that simply spending more money on education may not lead to significant improvement in student achievement (Hanushek, 1981; 1989; 1996). Lengthening the school day and/or the school year might lead to improvement in achievement; while I favor a 12-month school calendar, evidence for this is equivocal. It would certainly increase the cost of education. My thesis is that more money and time are not the primary needs for improvement of education. The debate on whether or not expenditures are related to student achievement is one that has gone on and will continue (cf. Hanushek, 1981; 1989; 1996; Hanushek, et al., 2008); Hedges, et al., 1994; Wainer, 1993). What is needed are promising new ideas and determination to apply these ideas and to set standards. A viable theory of education can help to

generate and identify promising ideas and strategies to improve education in any setting. It can also help to set and reach functional high standards. Whatever money or time or resources are made available can then be used much more efficiently. Resnick and Nolan (1995) observe that, "Countries known for their outstanding students have several practices in common; clear, consistent demanding standards head the list" (p. 6). However, as Howe (1995) points out, setting academic standards without dealing with poverty and limited resources in poor districts will not solve our educational problems. But money alone is not the solution. Wainer (1993) cites data from the National Heritage Foundation that show the ten states with the highest per pupil expenditure rank 31st to 49th on SAT (Scholastic Aptitude Test) scores, whereas the ten states with lowest per pupil expenditure rank 2nd to 22nd in SAT rank.

I am not alone in recognizing the need for theory. Brown (1994), in her presidential address to the American Educational Research Association, points out that the advances in learning theory of the past century are not being applied in schools, a position with which I agree. Shuell (1993) calls for an integrated theory of teaching and learning to improve education, but I contend this is not enough. More recently, Villarini-Jusino (2007) argues that we need theories in education that are comprehensive, open, complex, and scientific in nature. We need a theory that integrates all five elements of the educative process leading to honest, authentic, and productive achievement, and this is the goal of this book. In spite of these early calls, there has been little progress evident in most educational literature in recent years that we are moving toward more theory-based educational research and practice.

In the corporate world, similar problems prevail. While corporations recognize that continued change in the ways in which manufacturing and marketing are done to meet the competition requires continued education of employees, they tend to look for short-term solutions that *train* employees in new methods or techniques. What they seldom do is to *educate* employees to understand the ideas that underlie the new methods or techniques. This training usually takes the form of memorizing new rules, procedures, or rationales, without the requisite *conceptual* understanding necessary for employees to take command of their work—and to contribute their own creative ideas. The result in a rapidly changing market environment can at times be ineffective at best and disastrous in worst cases.

Theory of Education for Human Beings

Human beings do three things: they *think*, *feel*, and *act*. A theory of education for human beings must consider each of these and help to explain how to improve the ways in which humans think, feel, and act. Throughout this book I will consider each of these forms of human experience and how they relate to education.

In schooling, work, or any educational setting where we have a teacher, even

if it is a textbook or a computer program serving as a proxy for a teacher, we must recognize that the learner's world and the teacher's world are never the same. Thus, we must recognize that the interplay between learner and teacher involves two different sets of interacting elements. Figure 2.3 shows this relationship. I shall argue throughout this book that businesses need to look at customers and employees in a manner similar to the way teachers should look at their students. I also emphasize that there needs to be *negotiation of meanings* between the teacher and the learner, and the same can be said for businesses dealing with employees or with customers. The interactions suggested in Figure 2.3 apply both to school and business settings.

One emerging potential of technology-mediated education is that faulty ideas or biases that may be introduced by the teacher might be reduced. In earlier work using audiotape as an instructional vehicle, we found that carefully designed lessons could be highly effective without teacher intervention (Novak, 1972; Novak & Musonda, 1991). One disadvantage of technologically-mediated instruction is that machines do not express emotions, the caring, warmth, and excitement that an effective human teacher can share. We must recognize that teaching and learning are interactive events and involve the thoughts, feelings, and actions of both teacher and learner. This is illustrated in Figure 2.3.

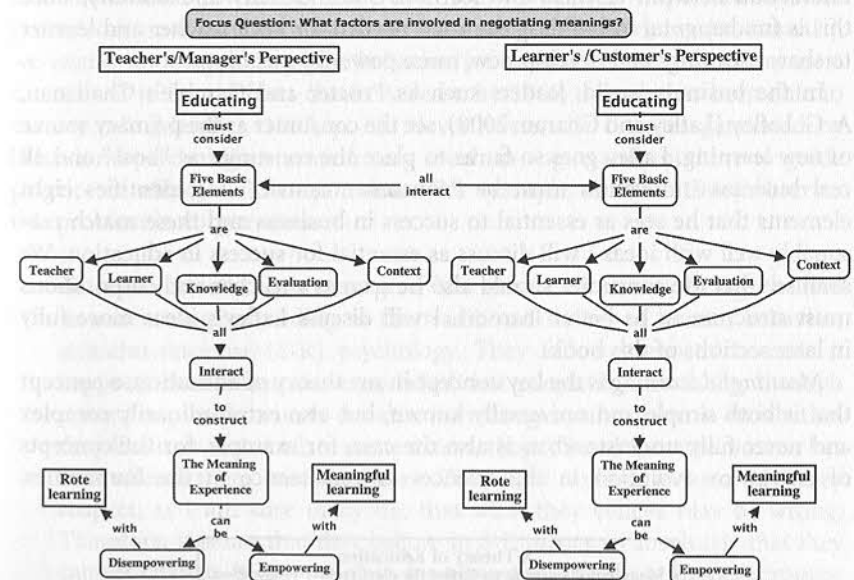


Figure 2.3 Teacher or manager and each learner has his or her own perspectives on the five elements operating in an educative event. The challenge is to negotiate a shared perspective on each element. In the business world, we should also see the consumer as the teacher in this model.

Also shown in Figure 2.3 is a fundamental idea in my theory of education. Any educational event is a shared *action* to seek to exchange *meanings* and *feelings* between the learner and the teacher. This exchange or negotiation will be emotionally positive and intellectually constructive when learners gain in their understandings of a segment of knowledge or experience; conversely, it will be negative or destructive when understanding is obfuscated or feelings of inadequacy emerge. And since learner and mentor share thoughts, feelings, and actions, the teacher will also experience positive feelings and a sense of power over knowledge when the educative event is successful. When learner and teacher are successful in negotiating and sharing the meaning in a unit of knowledge, *meaningful learning* occurs. In its simplest form, my theory of education states: Meaningful learning underlies the constructive integration of thinking, feeling, and acting leading to human empowerment for commitment and responsibility. I show this in Figure 2.4 to give emphasis to this idea. This book will set forth the key concepts, principles and philosophy underlying this theory. It is a book for learners, for teachers, and for managers. Kouzes and Posner (2006) argue at length that the best business leaders are teachers, as they describe them. When education is most effective, managers become teachers, teachers are also learners, and learners are also teachers. This can be especially true where learners are engaged in “cooperative learning activities,” and I will discuss this idea again in later sections. Fundamental to constructive interaction between teachers and learners is authenticity and honesty, since this is fundamental to building the trust needed for both teacher and learner to share meanings and develop new, more powerful meanings.

In the business world, leaders such as Procter and Gamble’s Chairman, A. G. Lafley (Lafley and Charan, 2008), see the consumer as the primary source of new learning. Lafley goes so far as to place the consumer as “boss” and all real business innovation must be “consumer centric.” He identifies eight elements that he sees as essential to success in business and these match reasonably well with ideas I will discuss as essential for success in education. We shall see that the consumer should also be seen as a teacher and corporations must structure to be better learners. I will discuss Lafley’s ideas more fully in later sections of this book.

Meaningful learning is the key concept in my theory of education, a concept that is both simple and universally known, but also extraordinarily complex and never fully understood, as is also the case, for example, for the concepts of energy or evolution in the sciences or renaissance in the humanities.

A Theory of Education
 Meaningful learning underlies the constructive integration
 of thinking, feeling, and acting leading to empowerment
 for commitment and responsibility.
 J. Novak

Figure 2.4 Briefly stated, this is my theory of education.

Throughout this book I will try to add clarity to the idea of *meaningful learning*, and also distinguish this from *memorization* or *rote learning*, so prevalent in much of schooling and business training. So many of the “games” people play in school or work settings are inherently fraudulent and do not lead to enhancement of learner or teacher. In addition, I will seek to show how meaningful learning contrasts with rote learning in terms of the neurobiology of brain functioning, albeit the relationships between learning phenomena and brain structures remain an area of intense research (see Gazzaniga, 1989; 1995; 2008).

Rote learning may be useful on occasions, such as when we memorize a poem, the score for a piece of music, or multiplication tables. But the real value of rote learning comes when we also move to understand the *meaning* of what we have memorized and it is meaning that confers power to our learning. The person who simply plays the notes he or she has memorized is, at best, a technician, whereas the artist understands and interprets the meaning of the music intended by the composer. The good teacher helps to move the learner beyond rote learning by negotiating meanings with the learner.

For almost a century, most of the “scientific” research on learning was done with animals in laboratory settings. The idea was that as “basic knowledge” about learning processes were elucidated through studies with animals, this knowledge could later be applied to improving education of human beings. One of the prominent psychologists who had his early training in this “scientific” behavioral psychology later observed, “What was important was the promissory note that, once we understood simple conditioning [in animals], we would understand complex behavior [of humans]. The promissory note turned out to be a rubber check. At least, by 1966, nobody has been able to cash it in” (Mandler, 1967, p. 6). Nevertheless, the dogmas generated by behavioral psychologists remain very much in vogue and continue to guide practice in schools and corporations. For example, Glasser (1994) observes this problem in corporations:

To review briefly, boss-managers, like almost all human beings, believe in and manage according to the traditional theory of human behavior; stimulus-response (S-R) psychology. They follow it mostly because it supports their common-sense belief that people can be made, through reward or punishment, to do what the manager wants them to do whether they like it or not. And, to some extent, they follow it because no one has ever offered them another theory. They have nothing to turn to if they suspect, as I am sure many do, that what they believe may be wrong. Therefore, it is not that they believe in S-R theory so absolutely that they cannot change. It is more that, for almost all people, stimulus-response theory is all there is. (p. 48)

Glasser suggests a new kind of control theory that is predicated on the need to help people construct new meanings and see value in a new idea, thing, or

procedure. He asserts, “*You cannot make anyone do what he or she does not want to do. You can only teach him a better way and encourage him to try it. If it works, there is a good chance he will continue*” (p. 50, italics in original).

One reason I prefer the word “act” to “behave” is that it implies a conscious, deliberate, and emotion-laden event, not the kind of passive event we associate with a trained rat or bird. Very little human activity is *behavior* in the animal sense. Most of it is deliberate action, and at least in the mind of the actor, the action makes sense. In *Wikinomics*, Tapscott and Williams (2007) claim that we are seeing the rise of a new kind of labor force. “. . . a generation of young people are entering the workforce with a radically different philosophy of work. As eighty million young people in the United States alone enter the workforce they will bring high-technology adoption, creativity, social connectivity, fun, and diversity to the companies they work for, and increasingly to the companies they found” (p. 240). This digital generation will demand that the work they do makes sense, and that it is fun. We need educational practices that better integrate human thoughts, feelings and actions.

Improving Educational Research and Evaluation

Agriculture and medicine are two areas in which we have seen dramatic advances in the last few decades. We spend far more on research in these fields than on research in education, and much of what has been spent on educational research has yielded little of value. Most research in education is *method driven* rather than *theory driven*. That is, researchers have often compared two or more methods of instruction, usually with little or no theoretical justification for the design of the instruction, or they have used a variety of tests or “scales” as methods for assessing achievement, often with little or no theory behind the choice of these instruments. Most of this research has led to the conclusion that “no significant differences were found between methods or groups,” or conflicting results are reported comparing one study to another. Many of the tests used produce not facts, but poor artifacts about human performance.¹ The net result has been that teachers and the public are skeptical at best regarding educational research “findings” and most of the research that has been done has had little or no lasting effect on the improvement of education.

A major limitation of educational research has been the weak or inappropriate evaluation tools employed. Almost all educational research utilizes some form of questionnaire or multiple-choice or true-false test for evaluation of attitudes, knowledge or aptitude. And yet we know that most of the test results have near zero correlation with real-life performance and at

1 For dozens of examples of this kind of research, see Gage, 1963; Richardson, 2001; Saha and Dwarkin, 2009.

best they measure only about 10 percent of the range of human abilities.² Unfortunately, many people’s lives and futures are determined by this kind of evaluation, not only in the United States, but even more so in developing countries. Sternberg (1996), a distinguished professor of psychology at Yale University, observed: “As an elementary school student, I failed miserably on the IQ tests I had to take. I was incredibly test anxious. Just the sight of the school psychologist coming into the classroom to give a group IQ test sent me into a wild panic attack” (p. 17). With strong parental support and a wise fourth-grade teacher, Sternberg did go on to succeed in school and later achieved worldwide recognition for his outstanding work.

As an alternative to typical “testing,” concept mapping is proving to be a powerful tool for evaluation and this, together with other new evaluation methods that are beginning to emerge, shows promise for both educational research and practice. It is impossible to improve practice based on research when the evaluation tools used in the research have limited validity at best, and in some cases are *negatively* correlated with valuable human performance such as creativity.

Education is an enormously complex set of events. Comparing my research experiences in botany as a graduate student with my experience over the past four decades as a researcher in education, I would say educational research is an order of magnitude more complex and difficult than most research done in botany. Moreover, botany and other sciences have relatively well-defined theoretical foundations, and also well-defined theory-based methodologies for gathering data, to say nothing about comparatively sophisticated instrumentation. In spite of the morass that educational research has represented (see, for example, Kaestle, 1993), I now feel highly optimistic about future improvement in educational research and subsequent improvement in educational practice. My optimism is based in part on an increasingly powerful theoretical foundation for education and a slow but steady movement toward its application, driven by new global economic pressures.

There is a great need for strengthening the linkages between researchers and practitioners. We already know much that could be extremely useful for the improvement of teaching and learning. There are many skilled and creative teachers in schools, universities and corporations. Slowly but surely, managers in private and public organizations are learning to be teachers of the kind I seek to encourage with this book. An important challenge is to find better ways to increase the flow of information between researchers and practitioners, and the flow must be in both directions. Federal, state, and local budgeting to encourage this exchange and broaden the context of educational research are needed. New initiatives along the lines of the highly successful Federal Hatch

2 For a critique of typical educational testing, see Hoffman (1962); Keddie (1973); Gould (1981); and Ziliak & McClosky, 2008).

Act (passed in 1865) and the Extension system that has been so successful for our advances in agriculture could yield enormous advances in education. What has been needed is a vision or, more specifically, a comprehensive *theory of education* to guide the changes needed. The foundations for theory/research-based improvement of education are being laid. We need to seek better institutional structures to advance and build upon these foundations. There are no easy solutions to the political problems that will need to be solved to effect this advance. With the growing importance of education in every phase of our lives, including our economic well-being, I am confident that solutions will be found.

With the accelerating “globalization” of business and the growing importance of creating and using knowledge to remain competitive, we have seen in the past decade significant growth in corporate interest in educating—that is educating that empowers people to be more creative as well as more content. I see a future where new partnerships will be formed between businesses and educational institutions, where a new kind of sharing and seeking solutions will take place. The first few decades of the twenty-first century are likely to be revolutionary in many respects, and most importantly in how we learn better to educate people for whatever the needs may be.

Meaningful Learning for Empowerment

Meaningful learning results when the *learner chooses* to relate new information to ideas the learner already knows. Its quality is also dependent upon the conceptual richness of the new material to be learned and the quantity and quality of the organization of the relevant knowledge held by the learner. Rote learning occurs when the *learner memorizes* new information without relating it to prior knowledge or when learning material that has no relationship to prior knowledge. As will be discussed in the next chapter, creativity is seen as resulting from very high levels of meaningful learning. There is a continuum in learning from “pure” rote to highly meaningful, and Figure 3.1 represents this continuum. Meaningful learning has three requirements:

1. **Relevant prior knowledge:** That is, the learner must know some information that relates to the new information to be learned in some non-trivial way;
2. **Meaningful material:** That is, the knowledge to be learned must be relevant to other knowledge and must contain significant concepts and propositions;
3. **The learner must choose to learn meaningfully:** That is, the learner must consciously and deliberately choose to relate new knowledge to relevant knowledge the learner already knows in some non-trivial way.

This raises the question: What are non-trivial relationships? For example, if a learner knows that Ohio, California, and New York are states, it is comparatively trivial to learn that Michigan is also a state, unless one goes further and recognizes that states are relatively large geographic units and there are only 50 in the United States, including Alaska and Hawaii. The learner needs to seek to build an *organized* knowledge structure that moves toward recognition of the differences between towns, cities, states, and countries.

When knowledge structures are well organized, “higher order” concepts that are more inclusive and more general *subsume* “lower order” concepts that are more specific and less general. Figure 3.2 illustrates these relationships for the study of history, where the superordinate concept is HISTORY, and two