LEARNING TO LEARN

Karl R. Wirth
Macalester College

Dexter Perkins
University of North Dakota

"Here we use the Socratic method: I call on you; I ask you a question; you answer it. Why don't I just give you a lecture? Because through my questions you learn to teach yourselves. By this method of questioning-answering, questioning-answering, we seek to develop in you the ability to analyze that vast complex of facts that constitutes the relationships of members within a given society."

Professor Kingsfield (in the Paper Chase)

INTRODUCTION

Many students would likely cite a desire to learn as the primary reason for committing four years to a college education. But what do we really mean when we use the word "learn"? It is something we all do from the moment of birth, so most of us likely take this very complex process for granted. How many of you have spent time trying to understand the meaning of learning, or how it occurs? Although many of us have a general sense of what it means to learn, there are often many assumptions involved. Teachers often assume that, because they are "teaching," students must be learning. Students assume that, because they have read their text and memorized facts, they have learned something. What should we expect to learn from a college education? What are the roles of students and teachers in the learning process? Are certain kinds of learning and thinking more valuable than others? What does sophisticated thinking look like and what are the developmental stages for getting there? What kinds of skills and knowledge do employers desire in their perspective employees? How do grades reflect a student's thinking and learning? What role does higher education play in modern society? These are but a few questions to consider while reflecting on the purpose of a college education.

The past few decades have seen considerable advances in understanding the brain and learning. These new findings have significant implications for what instructors teach and how students learn, and I have changed the way I approach teaching. As I began to revise my courses to include new instructional methods, I realized the need to add some readings and classroom discussions to help students understand their vital role in the learning process. I initially sought to find an existing document that would provide a concise summary about learning. After not finding a suitable overview, I decided to write one myself. So, the purpose of this document is to provide a brief overview of learning, how people learn, and the importance of learning as a lifelong objective. This summary is distilled from a number of books, papers, and web pages related to learning, thinking, and educational practices. Although intended for students, the document might also be useful to instructors as they consider what they teach and how to teach

Bud Blake

it. Feedback, both positive and negative, is welcomed to help guide future revisions of this "work in progress." A review by J. Serie greatly improved this document. However, any errors are the sole responsibility of the authors.

THE CURRENT SITUATION

The American education system is considered among the best in the world. More than 50% of our nation's high school graduates continue on to college and each year our universities and colleges enroll thousands of students from other countries. Despite these statistics, several recent studies have shown that many college seniors have neither good general knowledge nor the necessary skills for reasoning in today's society (Fink 2003). As an example, Saunders (1980) compared U.S. students who had completed a yearlong economics course with those who had never taken a course in economics. At the end of the course, the test scores of those students who had completed the economics course were only 20% better than those who had not taken the course, and this difference dropped to less than 10% seven years after completion of the course. Equally shocking are the results of a study of critical thinking and college faculty in California. Although most of the faculty (75%) claimed to value critical thinking and to promote it in the classroom, less than 19% were able to provide a clear explanation of critical thinking, and less than 10% were able to identify criteria for evaluating the quality of students' thinking (Paul et al. 1997). The results of these studies, and many others, strongly suggest that our current instructional practices are not working and that many students are not learning, or retaining what they do learn (Fink 2003).

NEED FOR NEW KINDS OF LEARNING

There have been calls for new kinds of learning from many different parts of society (Fink 2003). College teachers have expressed frustration about attendance in class, uncompleted reading assignments, and student focus on grades rather than learning. Student surveys indicate that courses are not interesting, that students fail to recognize the value of what they are learning,

> *Unless you try to do something beyond what you have already mastered, you will never grow.*
>
> Ralph Waldo Emerson

and that many faculty rely too heavily on lectures for transmitting information. Recognizing the need for greater accountability by our public schools systems, a significant number of state legislatures have begun to link appropriations to performance. A number of national organizations have also called for change. An Association of American Colleges report in 1985 recommended that the central theme of any curriculum should be to teach students "how to learn." Surveys of professional organizations indicate that besides specific competencies and skills, today's employers seek workers with people skills (e.g., teamwork, communication, leadership) along with a desire and ability for lifelong learning. The 1996 National Science Foundation report on *Shaping the Future* (of science, mathematics, engineering, and technology education) urges faculty to promote new kinds of learning that include developing skills in communication, teamwork, and lifelong learning. Gardiner (1994) compiled a list of "critical competencies" for citizens and workers from leaders in business, industry and government:

- personal responsibility,
- ability to act in principled, ethical fashion,
- skill in oral and written communication,
- interpersonal and team skills,
- skills in critical thinking and problem-solving,
- respect for people different from oneself,
- ability to change,
- ability and desire for lifelong learning.

Fink (2003) summarized Dolence and Norris' 1995 report on Transforming Higher Education in the information age as follows: "Society and individual learners now have different needs, both in terms of what people need to learn and how they can and should learn."

For all the reasons given above, and for many others, the focus of education is shifting from "teaching" to "learning" today. Faculty roles are changing from lecturing to being primarily "designers of learning methods and environments" (Barr and Tagg 1995, cited in Fink 2003). Brookfield (1985) argues that the role of teachers is to "facilitate" the acquisition of knowledge, not "transmit" it, and the NRC (2000) recommends that the goal of education shift from an emphasis on comprehensive coverage of subject matter to helping students develop their own intellectual tools and learning strategies.

If you ask most college teachers what is the greatest gift that they could give their students, you will rarely hear an answer that includes mention of specific discipline-related content. Most will answer "the desire and skills for lifelong learning." It's not that it isn't important to learn some facts while in college; these will likely be necessary for future employment. More important though is having the skill to learn on one's own after leaving college. This single,

> *The man who feels smug in an orderly world has never looked down a volcano*
>
> Anonymous

most-important skill will empower you for a lifetime and should be one of your highest priorities for attending college.

The 2002 panel report by the Association of American Colleges and Universities (*Greater Expectations: A New Vision for Learning as a Nation Goes to College*) defines student-learning needs for the 21st century. To prepare students for "emerging challenges in the workplace, in a diverse democracy, and in an interconnected world" colleges and universities should place new emphasis on educating students to be "intentional learners" who are purposeful and self-directed, empowered through intellectual and practical skills, informed by knowledge and ways of knowing, and responsible for personal actions and civic values (AACU, 2002). Becoming an intentional learner means "developing self-awareness about the reason for study, the learning process itself, and how education is used." Intentional learners are integrative thinkers who "see connections in seemingly disparate information" to inform their decisions. Self-directed learners are highly motivated, independent, and strive toward self-direction and autonomy. They "take the initiative to diagnose their learning needs, formulate learning goals, identify resources for learning, select an implement learning strategies, and evaluate learning outcomes" (Savin-Baden and Major 2004). Specifically, the AACU report recommends that students should learn to:

- effectively communicate orally, visually, in writing, and in a second language
- understand and employ quantitative and qualitative analysis to solve problems
- interpret and evaluate information from a variety of sources
- understand and work within complex systems and with diverse groups
- demonstrate intellectual agility and the ability to manage change
- transform information into knowledge and knowledge into judgment and action

In addition to intellectual skills, the report also emphasizes learning that includes "ways of investigating human society and the natural world", including:

- the human imagination, expression, and the products of many cultures
- the interrelations within and among global and cross-cultural communities
- means of modeling the natural, social, and technical worlds
- the values and histories underlying U.S. democracy

Furthermore, to ensure citizenry with social responsibility, education should foster:

- intellectual honesty
- responsibility for society's moral health and for social justice
- active participation as a citizen of a diverse democracy
- discernment of the ethical consequences of decisions and actions
- deep understanding of one's self and respect for the complex identities of others, their histories, and their cultures.

Finally, the report suggests that for the intentional learner "intellectual study connects to personal life, formal education to work, and knowledge to social responsibility." These sorts of connections don't develop on their own when one "becomes an adult." They take deliberate effort and continual reflection. When are you going to begin developing these kinds of connections? How will you develop them? Why not start now?

The most recent call for education reform comes from the Commission on the Future of Higher Education. This 19 member panel, with representatives from large research universities, liberal arts colleges, community colleges, trade schools and corporate executives, was appointed by the Secretary of Education to examine concerns about access and accountability in higher education. The panel recently released a blistering report (SECFHE, 2006) on the state of higher education in the U.S. Among other things, the panel stated: "we are disturbed by evidence that the quality of student learning at U.S. colleges and universities is inadequate and, in some cases, declining" and "employers report repeatedly that many new graduates they hire are not prepared to work, lacking the critical thinking, writing and problem-solving skills needed in today's workplaces." In addition, they note "business and government leaders have repeatedly and urgently called for workers at all stages of life to continually upgrade their academic and practical skills." The message is clear; learning is not something you just do for a few years in college. Learning is a lifelong commitment!

DIFFERENT KINDS OF THINKING AND LEARNING: THE COGNITIVE DOMAIN

Since the 1950's, researchers in cognitive theory and education have used Bloom's (1956) taxonomies of learning. In a number of landmark papers, Bloom and colleagues identified three learning domains:

- the cognitive domain
- the affective domain
- the psychomotor domain

> *It is a great nuisance that knowledge can be acquired only by hard work*
>
> Somerset Maugham

The *cognitive domain* involves thinking of all sorts; it is discussed in some detail below. The *affective domain* includes feelings, emotions, attitudes, values, and motivations. Levels within the affective domain range from initial awareness to a commitment to values that guide behavior and decisions. The *psychomotor domain* of learning includes physical movement, coordination, motor-, and sensory-skills. The psychomotor domain is not considered further in this document. The other two domains, however, are involved in just about everything that follows. (Read on!). Although widely used by instructors for course design and student assessment, Bloom's taxonomy does not include some of the new kinds of learning deemed important today (e.g., learning how to learn, communication and leadership skills, adaptability).

Without question, the most widely used of Bloom's taxonomies is for the cognitive domain. Bloom divided this domain into six levels of understanding in a hierarchical sequence (Table 1). According to Bloom, the acquisition of facts (*knowledge*) marks only the beginning of understanding. The facts must be understood (*comprehension*) before they can be applied to new situations (*application*). Knowledge must be organized and patterns recognized (*analysis*) before it can be used to create new ideas (*synthesis*). Finally, to discriminate among competing models or evidence, the learner needs to be able to assess (*evaluation*) the relative merits and validity of information or ideas. Clearly, to attain the level of understanding that makes "*evaluation*" possible requires significant time and effort by the learner. Such a sophisticated level of understanding is not easily attained by simply reading a book or hearing a lecture. It requires active thought and reflection. Think about something in your own life in which you have attained a high level of understanding. Perhaps it is a hobby, a sport, or a skill. Try to write

Table 1. Bloom's levels of thinking, from lowest (1) to highest (6), in the cognitive domain. This taxonomy, recently revised by Anderson et al. (2001), remains essentially unchanged, except that synthesis (creating) is considered the highest level of thinking.

Level of Thinking		Example Question That Targets Understanding
1	***Knowledge*** (facts)	Define the term "mineral"
2	***Comprehension*** (understand meanings)	Explain why some crystal faces grow faster than others
3	***Application*** (apply to new situations)	For the 1994 flood in Minnesota, calculate the frequency of flooding of this magnitude.
4	***Analysis*** (see organization and patterns)	Compare the distribution of earthquakes along mid-ocean ridges with those of subduction zones
5	***Synthesis*** (generalize, create new ideas)	Use the sequence of rocks exposed along the Mississippi River to construct a model of the changes in sea level during the early Paleozoic.
6	***Evaluation*** (assess value of evidence)	Evaluate the arguments for and against the evidence of fossil life in meteorites from Mars

down examples of the different levels of understanding related to this proficiency that you have. How many hours did you spend dedicated to that task before you attained your current level of proficiency? Are you prepared to dedicate that much effort to leaning in college?

Bloom and colleagues identified six levels within the cognitive domain. Subsequently, Anderson et al. (2001) pointed out that there are four categories of knowledge within the cognitive domain, each requiring different kinds of learning. They identified four principal kinds of knowledge: factual, conceptual, procedural, and metacognitive. *Factual knowledge* consists of isolated and discrete content elements. *Conceptual knowledge* is more complex and organized, including such things as knowledge of classifications, categories, principles, theories, models, and structures. Knowledge of "how to do something" such as techniques, methods and skills is termed *procedural knowledge*. *Metacognitive knowledge* is "knowledge about cognition and awareness of and knowledge about one's own cognition." Anderson et al. (2001) revised

Bloom's taxonomy and showed that each of their four kinds of knowledge can be mapped across all six of Bloom's levels of understanding. So, there are 24 distinct combinations of knowledge type and level of understanding. In *Learning to Think: Disciplinary Perspectives*, Donald points out that different disciplines involve different and specific kinds of thinking and information. This, according to Donald explains why students gravitate toward one field or another. It is also the single most important predictor for success in a given field. Wow, our concepts of learning and understanding have already gotten a lot more complicated, and we're not finished yet!

DIFFERENT KINDS OF THINKING AND LEARNING: THE AFFECTIVE DOMAIN

Krathwohl et al. (1964) wrote the seminal book describing what Bloom and others called the affective domain. The affective domain includes all things that limit or enhance learning in addition to basic thinking. The affective domain describes learning objectives that emphasize a feeling, an emotion, or a degree of acceptance or rejection. Affective characteristics vary from simply paying attention, to complex qualities of character and conscience.

The affective domain involves many things that at first seem unconnected, but Krathwohl et al. (1964) arranged them in a hierarchical order (Figure 1) related to an individual's level of commitment to learning. The Science Education Resource Center website has a good summary of the affective domain (http://serc.carleton.edu/NAGTWorkshops/affective/intro.html). The key idea is this: receiving information is the first and easiest part of learning. More important is

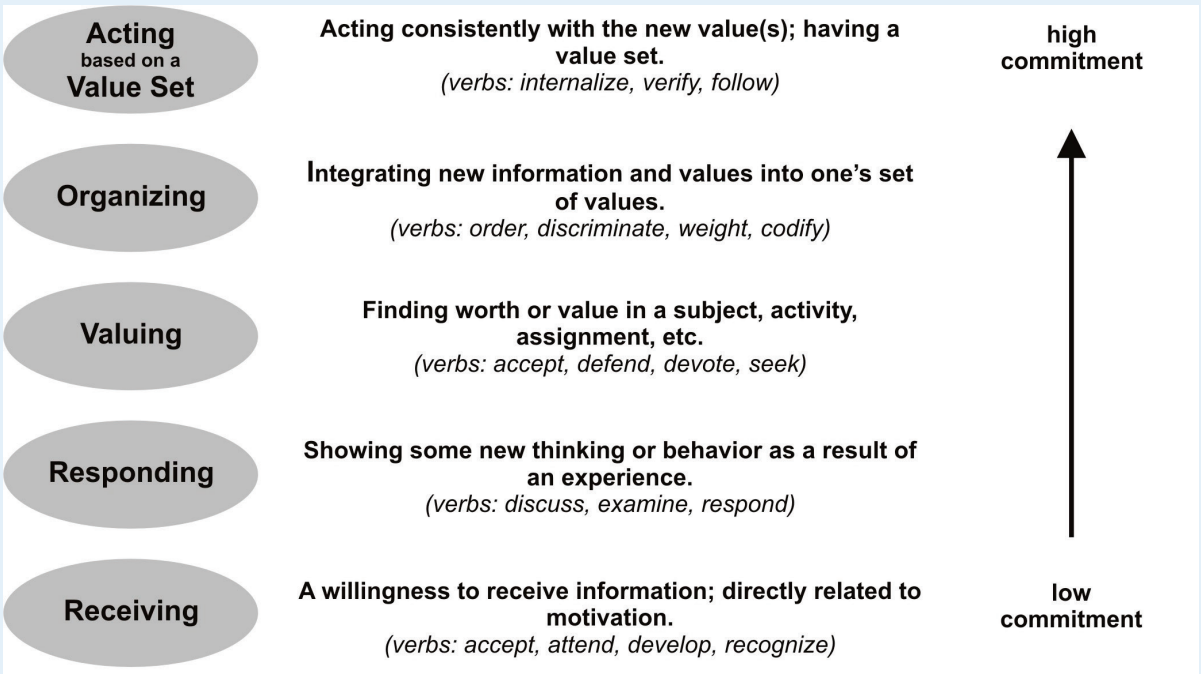

Figure 1. The affective domain as described by Krathwohl et al. (1964). Krathwohl et al. organized the domain into a hierarchy based upon an individuals commitment to living and valuing.

that you respond to what you learn, you value it and organize it and eventually use it to guide your lives. A key part of this process is developing good attitudes toward learning and what you learn. Motivation and values are important. In fact, a recent study by Dweck and others demonstrates that student views of learning often have significant effects on student grades.

The affective domain, according to current educational literature, is essential for learning. Yet, it receives little attention from most teachers. Instead, most teachers focus on the cognitive aspects of the teaching and learning and most of the classroom time is designed for cognitive outcomes. Additionally, many affective characteristics are nebulous or hard to quantify making it difficult for both teachers and students to specify goals and to evaluate whether those goals are met. Perhaps the most important consideration of the affective domain occurs when you assess your own learning. You can consider and evaluate motives, attitudes, and other things in a way that your teacher cannot. You can identify and deal with affective roadblocks to learning that can neither be recognized nor solved when using a purely cognitive approach.

FINK'S TAXONOMY OF SIGNIFICANT LEARNING

In response to a need for a broader consideration of learning, Fink (2003) proposed a taxonomy of "significant learning" (Table 2) that involves aspects of both the cognitive and affective domains. This taxonomy was developed to emphasize that learning involves changes in the learner. Significant learning is characterized by "some kind of lasting change that is important in terms of the learner's life" (Fink 2003). Each of Fink's rather broad categories includes several related specific kinds of learning. However, unlike in Bloom's taxonomy, the categories in the Fink (2003) taxonomy are interactive rather than hierarchical.

According to the Fink scheme, *foundational knowledge* includes knowledge and understanding of basic facts, ideas, and perspectives. Foundational knowledge also includes understanding the conceptual structure of factual knowledge within a subject, essential when applying factual knowledge in other areas. Foundational knowledge is also essential for other kinds of learning to be useful, hence the term foundational.

In addition to being able to recall information and ideas, one also needs to be able to apply one's knowledge or skills to new situations; this is *application*. This category includes learning to engage in new kinds of thinking (critical, creative, practical) as well as certain skills (e.g., communication, playing an instrument). Critical thinking, discussed in more detail below, refers to the process of analyzing and evaluating, whereas creative thinking is the process of creating new ideas, designs, products, or forms of expression (Sternberg 1989; cited in Fink 2003). Practical learning occurs when foundational knowledge is applied to answering questions, solving problems, or making decisions. In the Fink taxonomy, the real intellectual power comes from *integration*, which involves being able to make connections between specific ideas, people, or different realms of life. This includes interdisciplinary learning, learning communities, and connecting academic work with other areas of life. The *human dimension* of learning describes the type of learning that occurs when a student learns something important about himself or

Table 2. Fink's (2003) Categories of Significant Learning.

Learning Categories	Specific Kinds of Learning	Examples from Geology
Foundational Knowledge	Understanding and Remembering Information & Ideas	Understand important geologic features, processes, and concepts sufficiently well to explain and predict other observations
Application	Skills; Critical, Creative, and Practical Thinking; Managing Projects	Be able to find and analyze information to solve problems from a geologic perspective; learn to manage complex tasks; develop new skills such as language, communication, music, dance, sports
Integration	Connecting Ideas, People, and Realms of Life	Identify the interactions between geology and other realms of knowledge such as biology, politics, or economics
Human Dimension	Learning about Oneself and Others	Be able to identify ways in which one's own life affects and is affected by interactions with the Earth; learning how to be a leader or a team member; developing character and ethics; becoming culturally sensitive and serving others; taking responsibility for one's own life
Caring	Developing New Feelings, Interests, and Values	Be interested in the Earth and continue learning about it; wanting to be a good students; being excited about a subject or activity
Learning How to Learn	Becoming a Better Student; Inquiring About a Subject; Self-Directing Learners	Be able to interpret the significance of new geologic information; learning how to inquire and construct knowledge; developing a learning agenda and plan

herself, or what they might desire to become. This new self-knowledge enables them to recognize the personal and social implications of their knowledge and to function and interact more effectively with others. (Others are broadly defined by Fink to include interacting with technology). These kinds of learning (human dimension) are broadly similar to "emotional intelligence," which Goleman (1998; cited in Fink 2003), describes as including self-awareness, self-regulation, motivation, empathy, and social skills. Both authors note the importance of understanding self and others, and of the reciprocity of learning about oneself and others.

When a learning experience has a profound effect on a student, it can result in a greater sense of *caring* for the subject, for themselves, others, or learning in general. Greater caring can lead to new interests, energy for learning, or a change in values. Finally, it is also important to *learn how to learn*. This includes learning how to diagnose one's own need for learning and how to be a self-learner. This type of learning enables students to continue learning with greater effectiveness and is a particularly important skill with the recent explosion of knowledge and technology.

At best, most traditional college courses and curricula are designed to provide students with foundational knowledge and the skills for self-directed learning after graduation. How does one develop the other aspects of significant learning? That's a question for both the learner and the instructor. For an overview of the skill and value objectives considered by teachers when designing courses, view the Teaching Goals Inventory (http://www.uiowa.edu/~centeach/tgi/).

The bottom line is this: there is a lot more to learning than memorizing, recalling, or even understanding, facts. Stated another way: there is much more to learning than content. The successful student must also know how to apply knowledge to new areas; integrate knowledge with other aspects of life; understand the implications of knowledge for self and others; care about learning; and learn how to learn. None of these learning categories can be neglected because learning in one area enhances learning in other areas (Fink 2003).

WHAT REALLY IS LEARNING?

> *The lecturer pumps laboriously into sieves. The water may be wholesome, but it runs through. A mind must work to grow.*
>
> C.W. Eliot

If we are to know if "significant learning" is taking place in the classroom, we must be capable of recognizing it when it occurs. If you look up the definition of "learn" in a dictionary, you will likely find the following: 1) to acquire knowledge of a subject or skill through education or experience, 2) to gain information about somebody or something, or 3) to memorize something, for example, facts, a poem, a piece of music, or a dance. This definition is not particularly insightful, although it reminds us that the word can be used to describe the acquisition of both knowledge and skill, and that acquisition can be by a variety of means, including education, experience, or memorization. Still, we are left without a clear understanding of what it means to "acquire knowledge or skill." Other things that "we acquire" are obtained by physical means. How does this relate to learning? Are there different degrees of "acquisition" and, if so, do they represent equal types of learning? For example, is memorizing a fact the same as learning to interpret a complex text? How about learning to play a musical instrument? The Oxford English Dictionary also provides a definition that acknowledges the importance of teaching as a vehicle for learning, a welcome reminder for teachers. Taking a different view, Atkinson et al. (1993) describe learning as "a relatively permanent change in behavior that results from practice." Others (e.g., Simon 1996) have pointed out that the purpose of learning has recently shifted from being able to recall information (surface learning) to being able to find and use it (deep learning).

Until several decades ago, most college teachers thought that teaching simply involved filling a student's head with information. Knowledge was 'transmitted' from an authority (the teacher) to a learner (the student), generally by lecture. This thinking and practice are firmly entrenched in most classrooms despite the fact that the ineffectiveness of lecture-based teaching has been known for quite some time.

Modern cognitive psychology tells us that learning is a constructive, not receptive, process (Glaser 1991). This theory of learning (constructivism) holds that understanding comes through experiences and interaction with the environment, and that the learner uses a foundation of previous knowledge to construct new understanding. Consequently, the learner has primary responsibility for constructing knowledge and understanding, not the teacher. In a constructivist classroom, the teacher is no longer the "authority" but instead is a guide or facilitator who assists students in learning.

> *A lecture is a process by which the notes of the professor become the notes of the students without passing through the minds of either*
>
> R.K. Rathbun

According to Kolb (1984), the learning cycle begins when the learner interacts with the environment (*concrete experience*). Sensory information from this experience is integrated and compared with existing knowledge (*reflective observation*). New models, ideas, and plans for action are created from this information (*abstract* hypotheses), and finally new action is taken (*active testing*). The Kolb cycle is consistent with the earlier work of Piaget and others who pointed out that learning has both a concrete (active) and an abstract (intellectual) dimension (Figure 2).

Within the brain, knowledge is organized and structured in networks of related concepts. Accordingly, new knowledge must connect to, or build upon a framework of existing knowledge (Zull 2002). Put simply, learning involves building mental models (schema) consisting of new and existing information. The richer the links between new and existing information, the deeper

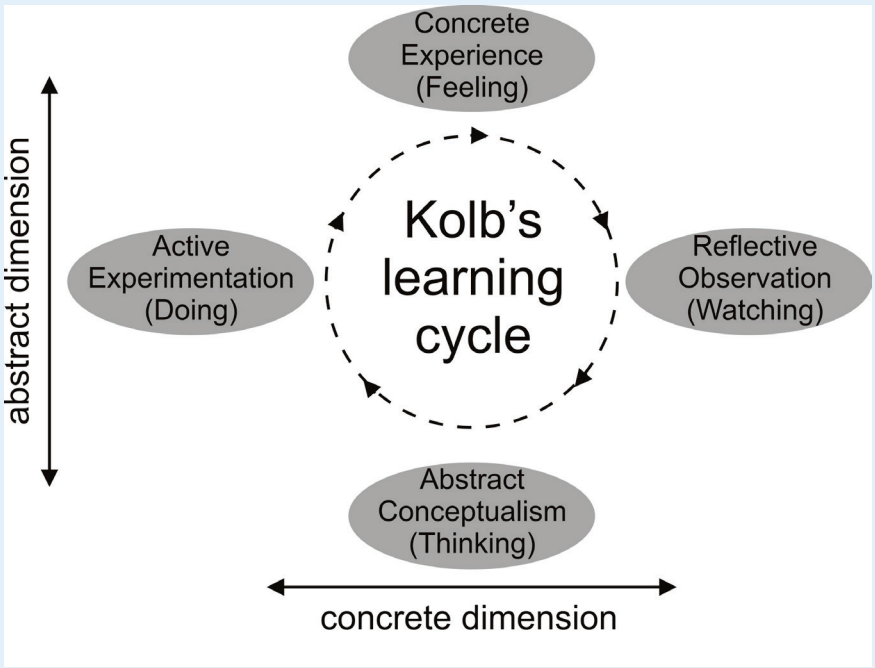

Figure 2. Kolb's learning cycle.

the knowledge and the more readily it can be retrieved and applied in new situations. Building rich links involves an iterative process of building, testing, and refining schema that organizes knowledge into conceptual frameworks. If existing knowledge serves as a foundation for new learning, then it is also essential that existing misconceptions, preconceptions, and naive conceptions are acknowledged and corrected during the learning process.

There are both 'surface' and 'deep' approaches to learning (Savin-Baden and Major 2004). Surface approaches to learning concentrate on memorization (Bloom's lowest level: knowledge). In surface learning, the learner's goal is often to complete required learning tasks by memorizing information needed for assessments. Surface learners mostly focus on facts without integration, they are generally unreflective, and they see learning tasks as external impositions. In contrast, students with deep approaches to learning have an intention to understand. They generally engage in vigorous interaction with content, relate new ideas to old ones, relate concepts to everyday experience, relate evidence to conclusions, and examine the logic of arguments. While doing this, they "construct" their own knowledge. Think for a minute about your own approaches to learning. Where do they fall between the surface and deep approaches described above?

> *When Pablo Casals reached ninety-five, a young reporter asked him a question: "Mr. Casals, you are ninety-five and the greatest cellist who ever lived. Why do you still practice six hours a day?" Casals answered, "Because I think I'm making progress."*

To what extent is learning enhanced or limited by genetics? Although natural talent is often considered to play a significant role in becoming an "expert," even "talented" individuals must engage in significant practice to reach the master level (Ericsson et al. 1994). The single best measure of mastery in a subject is time spent intellectually engaged with that particular subject. For example, chess masters spend roughly 50,000 to 100,000 hours studying chess to reach the "expert" level of playing chess (Simon and Chase 1973). Stop. Re-read that sentence again. Think about it. Those are some big numbers. How big are they (you should be trying to reach a deeper level of understanding here)? Let's do a quick calculation. An average of 75,000 hours means spending 8 hours per day, 365 days per year, for more than 25 years to become an accomplished chess player! That's how long it takes to develop the necessary skills for recognizing patterns of chess pieces, understanding their implications for future outcomes, and making the best moves. No wonder spending just a few hours on a homework problem, or even a semester reading a textbook often fails to provide the level of understanding that we often desire. Clearly, significant learning requires major investments of time. Unfortunately, time on task alone does not guarantee that significant learning will occur.

LEARNING AND THE BRAIN: NEW EVIDENCE FROM RESEARCH

Many people, both young and old, enjoy solving problems. It's something we do for relaxation. As children, many of us assembled jigsaw puzzles or solved word games. Even the name "word games" implies that it is something fun to do. Many adults enjoy working on

> *I used to think that the human brain was the most fascinating part of the body and then I realized, 'what is telling me that?'*
>
> Erne Philips

crossword puzzles or other intellectual challenges (the current popularity of Sudoku attests to this). These observations suggest that the human brain has a fundamental need to solve problems and understand its surroundings. Essentially, we are born with a desire to learn, but the need for learning is not limited to children or young adults in the classroom. It is a lifelong occupation. Although we are by nature lifelong learners, what do we really know about the process of learning in the human brain? Quite a bit, it turns out. In the past few decades there have been significant advances in our understanding of the brain and science of learning. A recent book published by the National Research Council (NRC 2000) provides a fascinating overview of new research on the brain, mind, and processes of learning.

Studies of developmental psychology, cognitive psychology, learning science, and neuroscience have converged on a new understanding of the workings of the brain (NRC 2000). Key findings include: 1) learning changes the physical structure of the brain, 2) learning organizes and reorganizes the brain, and 3) different parts of the brain may be ready to learn at different stages of development. During development, the "wiring of the brain" is created through the formation of synapses, which are the junctions between neurons through which information passes. At birth, the human brain contains all the neurons it will ever have, but has a relatively small portion of the large number of synapses that it will eventually develop. New synaptic connections are added to the brain after birth in two ways: 1) by overproduction and loss, and 2) by synapse addition. Overproduction of synapses occurs in different parts of the brain at different rates during childhood and early adolescence. Those synapses that are unused through experience are "pruned" during later stages. In other words, brains initially have an extensive neural network, but only those parts that are used are retained. The second method of synapse addition occurs throughout life and is "driven" by experience. In other words, activity in the nervous system associated with learning experiences somehow results in the formation of new synapses and "re-wiring" of the brain. The increasing complexity of neural networks that results from sensory experiences is the physical explanation for the theory of constructivism (described above).

Experiments on laboratory animals have demonstrated that experience increases the overall quality of functioning of the brain. "Experience" equates to learning. Additionally, research suggests that the gross structure of the brain is altered both by exposure to opportunities for learning, and perhaps more importantly for this discussion, by learning in a social context. Think about it, that's pretty cool stuff! The brain is a dynamic organ. Learning in individual and social contexts actually results in new patterns of organization (the physical structure) and improved functioning of the brain. It's also worth noting that we test our learning through action. That is, our brain gets feedback about our thinking when we put ideas into action (e.g., speak, write, draw, play an instrument or sport), hence the importance of not neglecting the psychomotor

domain (described briefly above). This is also a good reason for learning in groups; learning in social environments results in richer neural networks.

Studies of memory and brain processes indicate that people's memories of images are far superior compared with people's memories of words (NRC 2000). This has implications for how we teach and learn. Research also indicates that the brain does not simply record information as it arrives. Instead, the brain reorganizes information for more efficient recall and later use. In fact, the structure of information in the brain is one of the primary features that distinguishes "novices" from "experts."

Our new knowledge of brain development and learning comes, unfortunately, with new responsibilities to continually "exercise" and nurture the brain. Educational institutions and instructors are faced with the awesome responsibility of designing curricula and learning experiences that will stimulate and guide re-wiring in student brains. Students bear responsibility for nurturing and engaging their brains during this important developmental process. Ed Nuhfer at Idaho State University has recently compiled online overviews of "brain foods" (Nuhfer 2005; 2006) that promote brain functioning and synapse development. We're not talking gimmicks here; this is about sound nutrition and the importance of water, protein, amino acids, glucose, vitamins (especially B-6), and minerals for learning. It turns out that breakfast really is one of the most important meals, especially for developing brains.

Caring for our brains also involves making other lifestyle choices. Recent research (e.g., see review by Butler 2006) sheds light on the neurobiological effects of alcohol, and the evidence is sobering (no pun intended). A number of studies have shown that even moderate amounts of alcohol cause significant cellular damage (even after the effects of alcohol have worn off) to the forebrain and hippocampus regions of the brain. These structures are crucial for learning that involves integrative processing (e.g., decision-making, questioning, discrimination, and goal-setting) and memory. Studies of laboratory animals at Duke University have observed drastically suppressed activity of chemical receptors in the hippocampus due to alcohol. These effects are not just short term; there are also significant long-term cognitive consequences from excessive drinking of alcohol during adolescence. A 1998 study at the University of California, San Diego examined test results of verbal and nonverbal memory in teenagers. They observed significant cognitive deficits in teens that reported even occasional excess drinking. Another study found that alcohol-abusing teens exhibit different brain activity compared with non-drinking peers when accomplishing spatial tasks. The forebrains of the alcohol-abusing teens were too damaged to complete these tasks, so some "forebrain" tasks had to be conducted in less damaged regions of the back cortex. These examples illustrate the delicate nature of the brain. Apparently, much of what we do has a physical affect on the development of our brains.

Education is what survives when what has been learned has been forgotten

B.F. Skinner

INTELLECTUAL DEVELOPMENT

One goal of college education should be to develop more sophisticated approaches to

thinking. To a new college student, the previous sentence may not have much meaning. Without knowing what "sophisticated thinking" is, it is hard to know how to learn to do it! When you travel to a foreign land, it often helps to have a map and, yes, it also helps to ask others for directions along the way. A number of researchers have studied the intellectual development of college students, and their work provides insight into the various dispositions to thinking that a student might experience and develop. It is also worth noting that other aspects of student development have also been investigated, including moral, attitudinal, emotional, and identity (e.g., Chickering and Reisser 1993). These are also very important, but here we focus on intellectual development.

Intellectual growth has been characterized as the progression from ignorant certainty to intelligent confusion (Kroll 1992). However pithy that characterization might sound, it comes close to summing up the beginning and ending stages of intellectual growth. Let's look at some of the details of the developmental process. A classic study of intellectual development was conducted by William Perry (1970). He concluded that intellectual growth occurs in a series of stages, starting with blind acceptance of authority (which Perry termed *dualism*), and moving on to gradual acceptance of uncertainty (*multiplicity*) and the idea that all opinions have merit. The next stage recognizes that perspectives are important and that competing ideas may be evaluated in that light (*relativism*). Relativists learn how to think and act in specific contexts. The final stage involves making choices and decisions (*commitments*) (Figure 3). It also involves transference – being able to apply something you learn in one context to a different situation. Most students enter and leave college at Perry's second stage, multiplicity.

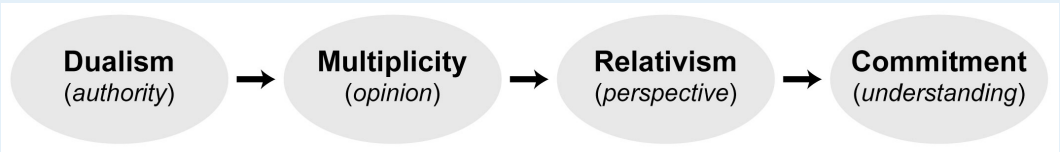

Figure 3. The four stages of intellectual growth described by Perry (1970).

Many subsequent studies supported Perry's work, but there were some concerns about the universal applicability of his model because his sample population consisted largely of Harvard males. Notably, Belenky et al. (1986) extended Perry's study to include the intellectual development of women and they identified five different perspectives of knowing. Although many aspects of the Belenky et al. model have counterparts in Perry's scheme, there are distinct variations that the authors attribute to gender differences in intellectual development. These are largely incorporated in the work of Baxter Magolda and are described below.

Based on the work of John Dewey and William Perry, King and Kitchener (1994) developed a model for the development of reflective judgment among college students that describes how students approach "ill-defined" problems, evaluate evidence, and justify claims about questionable issues. In this model, students initially are not aware that knowledge is uncertain (*pre-reflective thinking*) and gradually come to realize that some knowledge is uncertain (*quasi-*

reflective thinking), but commonly do not reason or argue from evidence. In the final stages (*reflective thinking*), students recognize that knowledge is constructed and that knowledge is inextricably linked to the context in which it is developed.

Baxter Magolda's (1992) model of intellectual development (Table 3) is based on studies of equal numbers of male and female students and builds on the models of Perry, Belenky et al., and King and Kitchener. She identified four ways in which college students "make meaning," noting that there are some gender differences, but that patterns of development are not exclusive

Table 3. Baxter Magolda's (1992) levels of intellectual development. Patterns that are characterized by males and females at each level are also shown. As an example, views of science that characterize students at each developmental level are from Palmer and Marra (2004). Modified from Felder and Brent (2004).

<table>
<tr><th>Level</th><th>Pattern Characterized by More Men</th><th>Pattern Characterized by More Women</th><th>View of Science</th></tr>
<tr><td>Absolute Knowing
All knowledge that matters is certain, and positions are either "right" or "wrong". Authorities have the truth.</td><td>Mastery
Students raise questions to make sure their information is correct and challenge deviations from their view of the truth.</td><td>Receiving
Students record information passively, without questioning or challenging.</td><td>Science is a collection of known facts. Students at this stage exhibit difficulty understanding the use of evidence for basis of judgments or decisions.</td></tr>
<tr><td>Transitional Knowing
Some knowledge is certain and some is not. Authorities communicate certainties, but students bear responsibility for making own judgments where uncertain.</td><td>Impersonal
Make judgments using prescribed logical procedures. Perceptions that full credit is deserved for following the right procedure, regardless of clarity or quality of the supporting evidence.</td><td>Interpersonal
Base judgments on intuition and personal "sense"; distrust logic, analysis, and abstract theories.</td><td rowspan="2">Science is a set of theories and facts with exceptions.</td></tr>
<tr><td>Independent Knowing
Most knowledge is uncertain. Students are responsible for own learning and use; conclusions viewed as equally good with emphasis on use of objective procedures.</td><td>Individual
Rely on objective logic, critical thinking, and adversarial challenging of their own and others' positions to establish truth and make moral judgments.</td><td>Interindividual
Rely more on caring and empathy as base for efforts to understand and judge. Listening to others as important as expressing ones own ideas.</td></tr>
<tr><td colspan="3">Contextual Knowing
All knowledge is uncertain, contextual, and individually constructed. Students take responsibility for making judgments, acknowledge the need to do so in the face of uncertainty and ambiguity. Use all possible sources of evidence and remain open to change in when faced with new evidence. No apparent gender differences at this level.</td><td>Science is collection of approximate models of reality; models are only as good as available data. Willingness to challenge what is known, question underlying assumptions, and tolerate ambiguity.</td></tr>
</table>

to either gender. In the first stage (*absolute knowing*), students consider knowledge absolute, that authorities have all the answers, and that the student's role is to "receive" knowledge. When authorities express uncertainty, it is interpreted to reflect that the individual does not know the right answer. At this stage, women tend to manifest a more private approach to learning (receiving pattern) whereas males tend to seek verbal interaction to acquire knowledge (mastery pattern). Students in the stage of *transitional knowing* accept that some knowledge is uncertain, but still hold that most knowledge is certain. They also tend to rely less on authority and begin to accept that the role of the learner is to construct knowledge, not just receive it. During this stage, women tend to view learning as gathering ideas from others (interpersonal pattern) whereas men tend to view interactions with others more as a vehicle for clarifying individual understanding (impersonal pattern).

The view that knowledge is uncertain becomes a basic assumption during the stage of *independent knowing*. Independent knowers recognize their own views as legitimate. Authorities are seen as only one source of knowledge and differences among authorities are seen as reflecting different views of the world. During this stage, interindividual-pattern knowers (mainly women) develop closer connections with peers and authorities to clarify their own ideas, whereas individual-pattern knowers (mainly men) move toward separation from peers and authorities while acknowledging the legitimacy of others' views. In the fourth stage of development (*contextual knowing*), gender differences appear to converge and both women and men value the importance of thinking for oneself. Individuals at this stage hold that knowledge comes from integrating the ideas of others with one's own. Contextual knowers judge evidence and recognize that some claims are better supported by evidence than others are. Baxter Magolda (1992) observed only a few college students that exhibited patterns of contextual knowers. Other studies of the intellectual development of college students (see e.g., Pavelich and Moore, 1996; Wise et al. 2004) confirm these observations. Our understanding of intellectual development not only has implications for how things are taught, but should also help learners understand why many teachers encourage their students to embrace new views of knowledge and learning.

CRITICAL THINKING: A TOOL FOR EVERYONE

> *Wisdom is not a product of schooling but of the life-long attempt to acquire it*
>
> Albert Einstein

Critical thinking is so central to sound reasoning that it deserves special attention. No doubt, you have encountered this term previously, but what does it mean? The tradition of critical thinking goes back at least 2,500 years to the time of Socrates who established the importance of evidence, questioning, and analysis utilizing "Socratic questioning." Since then, many others (including Plato, Aristotle, Thomas Aquinas, Francis Bacon, Descartes, and Kant, just to name a few) have contributed to the development of tools for critical thought. Many scientists (e.g., Newton, Boyle, and Darwin

are a few notable examples) have applied the tools of critical thinking to develop new models of our natural world. The methods of critical thought are by no means limited to thinking in science, but have also been applied in virtually all other disciplines. They involve both cognitive and affective components.

As with other terms introduced in this document, let us start with a definition. Scriven and Paul suggested the following definition to the National Council for Excellence in Critical Thinking (http://www.criticalthinking.org/aboutCT/define_critical_thinking.cfm):

> *Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness.*

Note that the beginning of this definition emphasizes that critical thinking must be "actively and skillfully" applied. The essential elements of reasoning that should be employed in all thinking, regardless of discipline, are given in Table 4. Additionally, intellectual standards (e.g., clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness) and traits (e.g., intellectual integrity, intellectual humility, confidence in reason, intellectual perseverance, fairmindedness, intellectual courage, intellectual empathy, and intellectual autonomy) should also be applied to thinking to ensure quality (http://www.criticalthinking.org/articles/critical-mind.cfm).

Stated another way, critical thinking is thinking that assesses itself. It examines the elements of thought and is based on intellectual values that transcend the frame of reference of the thinker and the subject matter, purpose, implications, and consequences of the thinking. Scriven and Paul also note that critical thinking has two components: 1) a set of skills to process and generate information, and 2) the habit of using those skills to guide behavior. In other words, its not sufficient to have the skills for critical thinking, you also need to employ them. In another document from the National Council for Excellence in Critical Thinking, Paul and Elder (2004) argue that there are two essential dimensions of thinking that students need to master: 1) be able to identify the "parts" of their thinking, and 2) be able to assess their use of those parts in thinking. Paul and Elder (2004) suggest the following elements of critical thinking:

- All reasoning has a purpose
- All reasoning is an attempt to figure something out, to settle some question, to solve some problem
- All reasoning is based on assumptions
- All reasoning is done from some point of view
- All reasoning is based on data, information, and evidence

- All reasoning is expressed through, and shaped by, concepts and ideas
- All reasoning contains inferences by which we draw conclusions and give meaning
- All reasoning leads somewhere, has implications and consequences

The elements of one's reasoning can be assessed using standards such as clarity, precision, accuracy, relevance, depth, breadth, logic, and significance. It is important to regularly monitor your thinking for flawed intellectual standards such as "it must be true because:" "I believe it;" "we believe it;" "I want to believe it;" "I have always believed it;" "it is easier to believe it than to understand it;" "or because it is in my vested interest to believe it" (see http://www.criticalthinking.org/articles/critical-mind.cfm). It should be clear from the above discussion, and the guidelines in Table 4, that questioning is the key to sound reasoning. Questions define the path of our thinking, they determine the evidence that we seek, and they lead us to new levels of understanding. Never stop asking questions!

Table 4. Guidelines for developing elements of reasoning (modified from Paul & Elder, 2004).

Elements of Reasoning	Guidelines
Purpose or Motivation	Choose significant and realistic purposes; state you purpose clearly; distinguish your purpose from related purposes; periodically check that your purpose is still valid
Question or Problem	Clearly and precisely state the question; reformulate the question several different ways to clarify its meaning and scope; identify if the question has one right answer, is a matter of opinion, or requires reasoning from more than one point of view
Assumptions	Clearly identify your assumptions and determine if they are justifiable; consider how the assumptions are shaping your point of view
Point of View	Clearly identify your point of view; seek other points of view and identify their strengths and weaknesses; seek an open-minded evaluation of all points of view
Data, Information, Evidence	Restrict your claims to those supported by the data that you have; search for evidence that opposes you position as well as supports it; make sure that all information is clear, accurate, and relevant to the question; make sure that you have gathered sufficient information to address the question at hand
Concepts and Ideas	Identify key concepts and explain them clearly; consider alternative concepts; make sure you are using concepts with care and precision
Inferences and Conclusions	Infer only what the evidence implies; check inferences for internal consistency; identify assumption with lead you to your inferences
Implications and Consequences	Trace the implications and consequences that follow from you reasoning; search for negative as well as positive implications; consider all possible consequences

METACOGNITION: THINKING ABOUT ONE'S OWN THINKING AND LEARNING

Intentional thought about one's own thinking (metacognition) is generally regarded as an essential component of successful thinkers and learners. Studies show "experts" constantly

> *I went to a bookstore and asked the sales-woman, "Where's the self-help section?" She said if she told me, it would defeat the purpose*
>
> George Carlin

monitor their understanding and progress during problem solving. Critically, their metacognitive skills allow them to decide when their current level of understanding is not adequate. This type of planning, self-monitoring, self-regulation, and self assessment not only includes general knowledge about cognitive processes and strategies, but also appropriate conditions for use of those strategies, and general self-knowledge. Research suggests that metacognitive skills cannot be taught out of context. In other words, one can't just take a course on metacognition. You need to learn it and apply it within the context of disciplinary content. As you are learn, you should engage in constant questioning (e.g., What am I trying to accomplish? What is the best strategy for learning? How is my progress? Did I succeed?). This sort of self-monitoring and reflection not only leads to deeper and more effective learning, but also lays the groundwork for being a self-directing learner.

EFFECTIVE LEARNING AND LEARNING STYLES

From what you have read so far in this document, it should be clear that the best learning occurs when students are engaged in active learning – when they are doing things instead of sitting passively and listening. A classic study by the National Training Board found that students retained only 5% of the information they received in lecture, twenty-four hours later. Retention rates increased to 75-90% when active learning involving peer teaching was used instead of lectures. Other active learning methods (e.g., demonstration and discussion) also resulted in higher retention rates (30% and 50%, respectively). In another study of the effectiveness of lectures (McLeish 1968; cited in Fink 2003), students were tested on their understanding of facts, theory, and application after hearing a lecture that was specially designed to be effective. Despite being able to use their own lecture notes and a printed summary of the lecture, average student recall after the lecture was only 42%. A week later recall had dropped to only 20%.

In a recent review of the effectiveness of active learning, Prince (2004) found extensive, widespread support for active learning approaches, especially when activities were designed around important learning outcomes and promoted thoughtful engagement. Many instructors recognize that active learning results in significant improvements in student knowledge retention, conceptual understanding, engagement, and attitudes about learning.

> *A rock pile ceases to be a rock pile the moment a single man contemplates it, bearing within him the image of a cathedral*
>
> Antoine de Saint Exupèry

A commonly used approach in active learning is cooperative learning. An enormous body of research confirms the effectiveness of cooperative learning. Compared with more traditional individualized and competitive models of learning, students who learn in

cooperative groups exhibit markedly improved individual achievement, metacognitive thought, willingness to assume difficult tasks, persistence, motivation, and transfer of learning to new situations, (e.g., Johnson et al. 1991; Prince 2004). Cooperative learning also improves relationships between students and between students and faculty, and it generally improves self-esteem and attitudes toward learning.

A large body of research indicates that people have different learning styles (see Felder 1993; and references therein). A learning style is a student's way of "responding to and using stimuli in the context of learning" (Clark 2004). That is, people tend to focus on different types of information, they tend to operate on that information differently, and they achieve understanding at different rates. Importantly, no single learning style is better or worse than the others. They are simply different. Although the effects of learning styles on learning have been difficult to quantify, new evidence suggests that the various "styles" of learning can be mapped both to the learning cycle and to the different functional regions of the brain. Many instructors teach (inadvertently?) in ways that are most akin to their own styles of learning.

Once aware of your learning style, you can improve learning by translating material from other modes into a mode that best fits you. The many "dimensions" of learning style are complex and are not entirely understood at present. As a result, there are several different models in common use. One learning style indicator currently enjoying considerable popularity is the VARK (Visual, Aural, Reading, Kinesthetic) guide to learning style, developed by N. Fleming in 1987 (http://www.vark-learn.com). The VARK questionnaire profiles user preferences for absorbing and communicating information in a learning context. In this sense it is not a learning style indicator because it focuses on only one dimension of learning. This questionnaire not only provides insight into one's learning preferences, but also provides strategies for using those preferences to enhance learning. Interestingly, research suggests that one's preferred learning style can change with age and experiences. Complete the VARK questionnaire (http://www.vark-learn.com) to determine your own learning preferences and find strategies for enhancing your learning.

In yet another model, H. Gardner (1993) proposed that there are multiple intelligences (verbal/linguistic, logical/mathematical musical/rhythmic, visual/spatial, body/kinesthetic, interpersonal, intrapersonal, and naturalist), but that we use only one or two of these for most

Table 5. Learning style dimensions (modified from Felder, 1993).

Elements of Learning	Learning Style Dimensions
Type of Information	**Sensory** (sights, sounds, physical sensations) or **intuitive** (memories, ideas, insights)
Modality of Sensory Information	**Visual** (pictures, diagrams, graphs, demonstrations) or **verbal** (sounds, written and spoken word, formulas)
Organization of Information	**Inductive** (underlying principles are inferred from facts) or **deductive** (consequences are deduced from principles)
Preferred Method for Processing Information	**Active** (through engagement in physical activity or discussion) or **reflective** (through introspection)
Method of Progressing Toward Understanding	**Sequential** (logical, incremental steps) or **global** (holistic, large jumps)

effective learning. To find your preferences, take the multiple intelligences inventory at: http://ps.uvm.edu/pss162.learning_styles.html. Finally, Felder and Silverman (1988) and Felder (1993) have synthesized the findings of several of the previous studies into a learning style model that is particularly relevant to science education (Table 5).

In summary, there are many different ways of modeling the ways of learning. No one model provides a complete description of learning, and no single learning style is superior to another. However, it is important to be aware of your own learning style preferences so that you can make the necessary adjustments to maximize your learning. If you have good, caring, instructors you will encounter unfamiliar pedagogies (e.g., active learning, cooperative learning, just-in-time learning, student-centered learning, case studies, writing to learn, group learning, assessment as learning, problem-based learning, service learning, online learning) in your courses. These have largely been designed to teach to a wide variety of learning styles and to facilitate learning the content and skills encompassed within "significant learning." Some of these new instructional approaches may seem foreign at first, but keep an open mind and try to understand the objectives of each pedagogical approach. If you have questions about classroom methods, ask your instructor. Most teachers are happy to discuss instructional practices with their students.

UNDERSTANDING GRADES

In many respects, grades are an unfortunate part of the learning process. Many students, especially those new to college, do not have a clear understanding of what it takes to be successful in the college environment. For other students, the focus is too easily shifted from learning to grades. For the college teacher, assigning grades at the end of the semester can be simultaneously rewarding and frustrating. When a student has worked hard, challenged himself or herself, and shown evidence of deep learning, it is very gratifying to assign a high mark. In contrast, it is very trying to assign a low mark to a student who has great potential, but who has demonstrated surface learning or has made little effort to improve. Although a single letter grade does not adequately represent the sum total of a person's potential or abilities, it is a widely accepted method for summarizing a student's performance in a particular course. Overall performance in a course is undoubtedly a function of many things, but can be distilled down to a student's native ability and motivation (as indicated by attendance, preparation, attitude, curiosity, effort, and retention). Although greater effort (working hard) in a course can result in improved results (learning), this is not necessarily always the case. It is important not to confuse these two very important, but different, dimensions of performance. Effort alone does not guarantee success. Conversely, the most outstanding student in a classroom is not necessarily the individual with the greatest native ability. Look over the following table (Table 6), modified from well-known papers in *The Teaching Professor* by J.H. Williams (1993) and Solomon and Nellen (1996) to evaluate your own behavior in the classroom. In which aspects do you excel? Which ones need improvement? Remember, time-on-task is the single variable most highly correlated with learning. If learning is not your highest priority, then you should not expect to

receive an "A" and you should work toward a more attainable grade. Lastly, remember that not every professor has the same standards for grading and that it is your responsibility to know which standards are in effect.

Finally, it may not be obvious to you why there is so much emphasis on writing in college. Writing provides an opportunity to explore old ideas and find new ones. Simply stated, what you write, and how you write it, is evidence of your ability to think critically (Paul 2004). When you write vague sentences, or fail to provide detailed examples to make a point, it indicates that your understanding of a topic lacks clarity or detail. When you fail to provide a detailed logical analysis in your writing, it suggests that your conceptual understanding may be weak. "A" level work requires a clear demonstration of the elements of critical thinking, including evidence of a mind that has "taken charge of its own ideas, assumptions, inferences, and intellectual processes" (Paul 2004). To the extent that a student needs assessment by another individual, they are not thinking critically or engaging their metacognitive skills. As a student you should strive to be an independent, self-directing learner.

Remember, the choices that you make in college may result in habits that affect the rest of your life. Skip Downing, author of *On Course: Strategies for Creating Success in College and in Life* (2005) has provided a list of characteristics of successful and struggling students (Table 7). Look over this list. How do you measure up? Are you where you want to be, or would you like to make some changes? The choice is yours and we're here to help!

Table 6. Behavioral dimensions of grades and characteristics of outstanding and average students (modified from Williams, 1993).

Behavioral Dimension	"A" or Outstanding Student	"C" or Average Student
1. Attendance (commitment)	Nearly perfect attendance; rare excused absences except for other scheduled conflicts; make prior arrangements for missed content	Sometimes comes to class late; occasional absences from class are rarely excused; frequently puts other priorities ahead of course
2. Preparation	Well-prepared; readings and assignments completed before class with great attention to detail; rarely misses deadlines; retains information from the course and makes connections with past learning	Readings and assignments completed in a timely, but perfunctory manner with little attention to detail or further contemplation; work often appears to be "draft" quality
3. Curiosity	Has a motivating purpose; inquisitive; asks thoughtful questions and is an active participant in classroom discussions; makes the extra effort to learn more and connect with other aspects of education or life	Uninterested in subject material and class; participates in class and projects without enthusiasm; exhibits only modest interest in subject matter
4. Attitude (dedication)	Has a winning attitude and shows responsibility, motivation and determination to succeed; enjoys and values learning; listens to feedback and acts on it	Rarely does more than required; Seldom shows initiative; defensive about feedback and unwilling to accept responsibility; perceive themselves as victims
5. Talent (ability)	Possesses special talents such as exceptional intelligence, unusual creativity, or outstanding commitment that are evident to the instructor	Can have greatly varying natural talent; some students are quite talented, but lack organization or motivation; others are motivated, but lack special aptitude
6. Retention	Learns concepts rather than memorizes details so better able to connect past learning with present material	Tries to memorize facts at the last minute rather than learn concepts; makes few conscious efforts to connect new learning with past knowledge
7. Effort (time commitment)	Reads, studies, and thinks about course subject on a regular basis; begins assignments and projects well before deadlines; often willing to devote extra time and effort when needed; attention to detail; seeks out instructor outside of class	Does not develop a regular system for studying and doing assignments; frequently begins readings and assignments at the last minute; rarely willing to devote time necessary to develop deeper understanding
8. Communication Skills	Speaks confidently and writes well; presentations and documents are well-conceived, well-prepared, and informative	Presentations and written work lack organization and clarity; papers are generally draft quality requiring extensive re-writing to be effective; quality of content limited by poor communication skills
9. Results (performance)	Exams and papers are always of the highest quality (among the highest in a class); contributions in the classroom are significant and insightful; work demonstrates critical thinking	Products are mediocre or inconsistent in quality; writing and speaking indicates only a cursory understanding rather than a mastery of material

Table 7. Characteristics of successful and struggling students (from Cuesta College, 2003)

Successful Students	***Struggling Students***
Accept personal responsibility for creating the outcomes and quality of their lives	See themselves as victims, believing for the most part that what happens to them is beyond their control
Discover a motivating purpose, characterized by personally meaningful goals and dreams	Have difficulty choosing a purpose and often experience depression and/or resentment about the meaninglessness of their lives
Consistently plan and take effective actions in pursuing their goals and dreams	Seldom identify the specific actions needed to accomplish a task, and when they do, they tend to procrastinate
Build mutually supportive relationships that assist them in pursuing their goals and dreams	Are solitary, seldom requesting, even rejecting offers of assistance from legitimate resources
Gain heightened self-awareness, developing empowering beliefs, attitudes, and behaviors that will keep them on course	Are slaves of disempowering life scripts that carry them far off course
Become life-long learners, finding valuable lessons in nearly every experience they have	Tend to resist learning new ideas and skills, often viewing learning as drudgery rather than mental play
Develop emotional maturity, characterized by optimism, happiness, and peace of mind	Live at the mercy of their emotions, having success hijacked by anger, depression, anxiety, and a need for instant gratification
Believe in themselves, feeling capable, lovable, and unconditionally worthy as human beings	Doubt their personal value, feeling inadequate to accomplish meaningful tasks and unworthy to be loved by others or themselves

BIBLIOGRAPHY OF LEARNING

AACU, 2002, Greater Expectations: A New Vision for Learning as a Nation Goes to College: National Panel Report, American Association of Colleges and Universities, Washington, DC 62 p.

Atkinson, R.L., Atkinson, R.C., Smith, E.E., and Bem D J., 1993, Introduction to Psychology. Harcourt Brace Jovanovich, Fort Worth, TX, 11th edition.

Anderson, L.W., Krathwohl, D.R., Airasia, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., Wittrock, M.C., (eds), 2001, A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman, New York.

Anonymous, 2004, The Critical Mind is A Questioning Mind: Critical Thinking Consortium. Available at: http://www.criticalthinking.org/University/questioningmind.htm

Angelo, R.A., 1991, Ten Easy Pieces: Assessing Higher Learning in Four Dimensions. In Classroom Research: Early Lessons From Success, New Directions for Teaching and Learning. Jossey-Bass Publishers, San Francisco, CA, no. 41, p. 17-31.

Angelo, T.A., and Cross, K.P., 1993, Classroom Assessment Techniques: A Handbook For College Teachers (2nd edition). Jossey-Bass Publishers, San Francisco, CA, 427 p.

Arter, J., and McTighe, J, 2001, Scoring Rubrics In The Classroom: Using Performance Criteria For Assessing And Improving Student Performance. Corwin Press, Thousand Oaks, CA, 189 p.

Bain, K., What the Best College Teachers Do. Harvard University Press, Cambridge, MA, 207 p.

Barr, R.B., and Tagg, J., 1995, From Teaching to Learning: A New Paradigm for Undergraduate Education. Change, v. 27, p. 13-25.

Baxter Magolda, M.B., 1992, Knowing and Reasoning in College. Jossey-Bass Publishers, San Francisco.

Belenky, M.F., Clinchy, B.M., Goldberger, N.R., and Tarule, J.M., 1986, Women's Ways of Knowing: The Development of Self, Voice, and Mind. Basic Books, New York (reprinted in 1997).

Bloom, B.S., editor, 1956, Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain. McKay, New York.

Bok, D, 2006, Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why They Should be Learning More: Princeton University Press, Princeton, NJ 413 p.

Brookfield, S.D., editor, 1985, Self-Directed Learning: From Theory to Practice. New Directions for Adult and Continuing Education, no. 25. Jossey-Bass Publishers, San Francisco, CA.

Butler, K., 2006, The grim neurology of teenage drinking. Article in New York Times, 04 July, 2006.

Chickering A. and Reiser, L., 1993, Education and Identity. Higher and Adult Education Series, Jossey Bass Publishers, San Francisco, CA.

Clark, Don, 2004, Learning Styles: Or, how we go from the unknown to the known. Available at: http://www.nwlink.com/~donclark/hrd/learning/styles.html.

Cuesta College, 2004, Characteristics of a Successful Student: Cuesta College. Available at: http://academic.cuesta.edu/acasupp/as/201.HTM.

Dolence, M.G., and Norris, D.M., 1995, Transforming Higher Education: A Vision for Learning in the Twenty-First Century. Society for College and University Planning, Ann Arbor, MI.

Donald, J.G., 2002, Learning to Think: Disciplinary Perspectives. Jossey-Bass Publishers, San Francisco, CA, 330 p.

Downing, Skip, 2005, On Course: Strategies for Creating Success in College and in Life. Houghton-Mifflin, 272 p.

Duch, B.J., Groh, S.E., and Allen, D.E., (editors), 2001, The Power Of Problem-Based Learning. Stylus Publishing, Sterling, VA, 274 p.

Edelson, D. C., 2001, Learning-For-Use: A Framework For The Design Of Technology-Supported Inquiry Activities. Journal of Research in Science Teaching, v. 38(3), 355-385.

Ericsson, K.A, Charness, N., 1994, Expert performance: Its structure and acquisition. American Psychologist, v. 49, p. 72-745.

Felder, Richard, 1993, Reaching the second tier: learning and teaching styles in college science education. Journal of College Science Teaching, v. 23, p. 286-290.

Felder, R.M., and Brent, R., 2004, The Intellectual Development of Science and Engineering Students. 1. Models and Challenges: Journal of Engineering Education, v. 93, no. 4, p. 269–277.

Felder, R.M., and Silverman, L.K., 1988, Learning and Teaching Styles in Engineering Education: Journal of Engineering Education, v. 78, no. 7, p. 674-681.

Felder, R., and Solomon, B.A., 2004, Learning Styles and Strategies. Available at: http://www.ncsu.edu/felder-public/ILSdir/styles.htm.

Fink, L.D., 2003, Creating Significant learning Experiences: An Integrated Approach to Designing College Courses. Jossey-Bass Publishers, San Francisco, CA, 295 p.

Gardner, H., 1993, Frames of Mind: The Theory of Multiple Intelligences. Basic Books, NY, NY.

Gardiner, L., 1994, Redesigning Higher Education: Producing Dramatic Gains in Student learning. ASHE-ERIC Higher Education Report 7, Washington D.C., George Washington University.

Goleman, D., 1998, Working with Emotional Intelligence. New York, Bantam Books.

Huba, M.E., and Freed, J.E., 2000, Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning. Allyn and Bacon, Needham Heights, MA, 286 p.

Johnson, D.W., Johnson, R.T., and Smith, K., 1991, Active Learning: Cooperation in the College Classroom. Interaction Book Company, Edina, MN.

King, P.M. and Kitchener, K.S., 1994, Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults. Jossey Bass Publishers, San Francisco, CA.

Kolb, D.A., 1984, Experiential learning: Experience as the source of learning and development. Prentice Hall, Upper Saddle River, NJ.

Krathwohl, D.R,. Bloom, B.S, and Masia, B.B., 1964, Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook II: Affective Domain. David McKay Company, Inc

Kroll, B.M., 1992, Teaching Hearts and Minds: College Students Reflect on the Vietnam War in Literature. Southern Illinois University Press, Carbonadale, IL.

Leamnson, R., 1999, Thinking About Teaching and Learning: Developing Habits of Learning with First Year College and University Students. Stylus Press, Sterling, VA, 169 p.

McKeachie, W., Hofer, B., Van Note Chism, N., Zhu, E., Kaplan, M., Coppola, B., Northedge, A., Weinstein, C.E., Halonen, J., Svinicki, M.D., 2002, Teaching Tips: Strategies, Research, and Theory for College and University Teachers (eleventh edition). Houghton Mifflin Co., 371 p.

McLeish, J., 1968, The Lecture Method. Cambridge Institute of Education, Cambridge, England.

National Research Council, 1999, How People Learn: Bridging Research and Practice. National Academy Press, Washington D.C., 346 p.

National Research Council, 2000, How People Learn: Brain, Mind, Experience and School. National Academy Press, Washington D.C., 374 p.

National Research Council, 2001, Knowing What Students Know: The Science and Design of Educational Assessment. National Academy Press, Washington D.C., 366 p.

National Research Council, 2003, Evaluating and Improving Undergraduate Teaching in Science, Technology, Engineering, and Mathematics. National Academy Press, Washington D.C., 215 p.

National Science Foundation, 1996, Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology, Washington D.C.

Nuhfer, E., 2005, Nutrition for Neurons – Eating for Thinking (Part I). Nutshell Notes, v. 13, no. 8, December, 2005, Idaho State University. Available from http://www.isu.edu/ctl/nutshells/nutshell13-8.html. Accessed 24 August, 2006.

Nuhfer, E., 2006, Nutrition for Neurons – Eating for Thinking (Part II). Nutshell Notes, v. 14, no. 1, February, 2006, Idaho State University. Available from http://www.isu.edu/ctl/nutshells/nutshell14-1.html. Accessed 24 August, 2006.

Palmer, P.J., 1998, Courage to Teach: Exploring the Inner Landscape of a Teacher's Life. Jossey-Bass Publishers, San Francisco, CA, 199 p.

Paul, R., 2004, Grading Policies: Critical Thinking. National Council for Excellence in Critical Thinking. Available from: http://www.criticalthinking.org/University/univclass/gradingpolicies.html

Paul, R., and Elder, L., 2004, The elements of critical thinking: Helping students assess their thinking: Defining Critical Thinking. National Council for Excellence in Critical Thinking. Available from: http://www.criticalthinking.org/University/univclass/helps.html

Paul, R., Elder, L., and Bartell, T., 1997, California teacher reparation for instruction in critical thinking: Research findings and policy recommendations. Sonoma, California, Foundation for Critical Thinking.

Pavelich, M.N., 1996, Helping students develop higher-level thinking: Use of the Perry Model. Journal of Engineering Education, v. 85, no. 4, p. 287-292.

Perry, W.G., Jr., 1970, Forms of intellectual and ethical development in the college years: A scheme. Jossey-Bass Publishers, San Francisco (updated and republished in 1999; Holt, Rinehart, and Winston, New York), 256 p.

Plucker, J. A., editor, 2003, Human intelligence: Historical influences, current controversies, teaching resources. Retrieved [insert month day, year], from http://www.indiana.edu/~intell

Prince, M., 2004, Does Active Learning Work? A Review of the Research. Journal of Engineering Education, v. 93, p. 223-231.

Saunders, P., 1980, The lasting effects of introductory economics courses: Journal of Economic Education, v. 12, p. 1-14.

Savin-Baden M., and Major C.H., 2004, Foundations of Problem-Based Learning. Society for Research into Higher Education and Open University Press, Berkshire, England, 197 p.

Schroeder, C.C., 2004, New Students – New Learning Styles. Available at: http//www.virtualschool.edu/mon/Academia/KierseyLearningStyles.html.

Scriven M., and Paul, 2004, Defining Critical Thinking. National Council for Excellence in Critical Thinking. Available from: http://www.criticalthinking.org/University/univclass/Defining.html.

SECFHE, 2006, Retrieved 11 August, 2006 from the U.S. Department of Education Boards and Commissions: A Draft Panel Report "A National Dialogue. The Secretary of Education's Commission on the Future of Higher Education" (http://www.ed.gov/about/bdscomm/list/hiedfuture/reports/0809-draft.pdf)

Simon, H.A., and Chase, W.G., 1973, Skill in chess. American Scientist, v. 61 p. 394-403.

Solomon, P., and Nellen, A., 1996, The Teaching Professor, February, p. 3-4.

Sternberg, R.J., 1989, The Triarchic Mind: A New Theory of Human Intelligence. New York, Penguin.

Teaching Goals Inventory, 2004, Available from: http://www.uiowa.edu/~centeach/tgi/.

Walvoord, B.E., Breihan, J.R., 1997, Helping Faculty Design Assignment-Centered Courses. In DeZure, D., (editor), To Improve the Academy, New Forums Press, Stillwater, OK, v. 16, p. 349-372.

Wiggins, G., and McTighe, J., 1998, Understanding by Design: Association for Supervision and Curriculum Development. Prentice Hall, Upper Saddle River, NJ, 201 p.

Williams, John, H., 1993, Clarifying grade expectations. The Teaching Professor, August/ September.

Wise, J., Lee, S.H., Litzinger, T.A., Marra, R.M., and Palmer, B., 2004, Encouraging intellectual growth: Senior college student profiles. Journal of Adult Development, v. 11, p. 111-122.

Zull, J.E., 2002, The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of Learning. Stylus Publishing, Sterling, VA, 262 p.