Teaching Thinking and Problem Solving in the University Curriculum: A Rationale

Eric Pappas
James Madison University


Introduction

This paper and presentation present a rationale for teaching higher order thinking and problem solving skills in a dedicated university curriculum. Instruction in linear, non-linear, and abstract thinking skills leading to sophisticated meta-cognitive skills offers students the ability to work productively in complex professional environments. An overview of issues related to course development and the integration of these skills into established curricula is included.

Background

The Greeks were the first to develop methods of inquiry into science and philosophy. The convergence of thinking in these two disciplines emerged during the sixth century B.C. on the Greek coast of Asia Minor and in the Greek cities of southern Italy. The Pre-Socratic philosophers integrated their logical investigations of thought and observation in science and philosophy in an attempt to answer such questions as “What are things made of?” and “What is the nature of life and death?” which led to the investigation of the laws of nature, of man’s (sic) duty on Earth, and of the nature of the divine.¹
Similar investigations by Anaximander, Anaximenes, and Pythagoras in the mid-sixth century B.C. led to Xenophanes work on social ideas and art (which many believe included scientific inquiry and politics). Only a few years later, Zeno (according to Aristotle) invented dialectics and thus laid the groundwork for Socrates’ fifth century philosophy of “inquiry.” Although Socrates and his contemporaries made important discoveries in science, medicine, and mechanics, their approach remained largely philosophical and theoretical.

Plato’s philosophical work perhaps eclipsed that of Socrates, especially in terms of defining intellectual approaches to inquiry. These philosophical processes continued to combine a wide variety of disciplines and were based mostly on observations in everyday life, assumptions based on contemplation, and structured argumentation.

Aristotle carried on the theory of argumentation as a means of discovering truth, and early in the *Nicomachean Ethics*, he notes that in order to be a good “critic” of a particular subject, one needs to be well informed on that subject, as well as educated in a wide variety of others. In addition to his interdisciplinary approach to argumentation, he refutes Plato’s philosophy of linear investigatory procedure (a starting premise that proceeds in a direct line to a finish—or the reverse). Instead, Aristotle suggests that the ultimate human goal of “pursuing good” (discovering scientific and moral principles) relies on continuous contemplation which is meant to include learning by different approaches to thinking including induction, intuition, and habitation (living successfully with others).

Aristotle was perhaps the first to combine “thinking processes” as an addition to Socrates’ and Plato’s interdisciplinary approach to inquiry. Aristotle’s philosophy was
centered on achieving “happiness” (a combination of goodness and virtue), but this fact is
less important than his comprehensive approach to living. Ultimately, he brings together
all known disciplines of the day (political science, philosophy, science, art, ethics, and
medicine) and suggests contemplation as a method for discovering the interconnectedness
of these topics. In short, Aristotle stresses that contemplation is an end in itself\(^3\) …the
continuous activity of human existence and the primary means of challenging accepted
values and thought, and complacency.

Aristotle (as well as Plato and Socrates) influenced virtually all Western
philosophers, and few have reputed Aristotle’s basic premise of engaging in a variety of
rational and abstract methods of thinking to solve problems, or his contemplative and
interdisciplinary approach to discovering truths.

The practical matter of applying Aristotle’s wisdom to contemporary pedagogical
approaches in higher education is a challenging task. Even though Western philosophers
have carried on the debate over Aristotelian theories of knowledge and thinking
(Decartes, Hegel, Locke, Berkeley, and Hume, for instance), higher education in the U.S.
has turned away from this sort of inquiry, adopting a more linear and deductive approach
to thinking that largely discounts the integration of a variety of thinking processes,
especially abstract thought. Hence, our approach to discovery in engineering, science,
and technology in the university has become reliant on what can be proven rationally and
empirically according to the laws of science and mathematics only. Thinking as a
process (and aesthetic education) has fallen from favor as a means of innovation or
problem solving in lieu of well established linear approaches (which have, admittedly,
yielded great scientific advances). During the Renaissance and the Industrial Revolution,
we find evidence of a resurgence of Aristotle’s philosophy. It is a mystery why we retreat to more narrow and linear approaches to thinking at other times, but these upheavals in thought and discovery were preceded by periods of societal stagnation, and relative intellectual and artistic unrest. The needs of society for growth and survival were not being met by each society’s established approaches to thinking. Perhaps the solution to this mystery is based upon the need, at various times in history, for us to eclipse accepted thought as a means for advancing civilization, solving problems, and insuring survival. Whether rapidly advancing technology has now brought us to a similar junction in history is speculation. It may be that the technological problems we now face do not seem to be yielding to the thinking processes and problems solving approaches considered adequate for decades…some technological problems have non-technical solutions.

**Curriculum and Integration**

Integrating instruction in thinking skills and problem solving into a science and technology or engineering curriculum must take into account a wide variety of factors related to students’ ability and desire to examine and change their intellectual habits, and perhaps, their lifestyle. The remainder of this paper briefly addresses a variety of philosophical and practical issues related to developing a curriculum which includes significant instruction in thinking skills relevant to a department’s academic mission as well to workplace applications and students’ quality of life.

It is clear to most all, especially academicians, that the problems faced by contemporary society are not yielding easily to the sometimes random and unorganized set of thinking practices and problem solving skills in use for some time. Confronting
complicated political, social, cultural, and economic issues requires skills beyond what most universities have promoted as instructional components of any engineering, science, or technology curriculum. In short, universities do not teach thinking skills to the degree required by emerging technologies and increasingly complex global human relations.

It seems natural to look to institutions of higher learning to set the pace and path towards resolving this dilemma. Certainly, it is important to improve students’ intellectual abilities, not simply in the necessary technical understanding needed to address complex problems, but also in managing this understanding to achieve broad scientific and technical outcomes. Few would disagree that the information revolution has put myriad facts at our disposal, but often with no means of completely understanding the methods with which to successfully apply this information in real world or human contexts. In short, understanding technical information is largely useless unless one can access, contextualize, apply, and evaluate that information in increasingly non-technical terms.

If we accept the suggestion that higher education has some responsibility to address these issues, three problems emerge: 1) how to convince academicians and students that teaching thinking skills is the legitimate and natural responsibility of higher education, 2) how to define the skills to be taught and integrate them into already tight curricula, and 3) how to determine who will teach these skills. The remainder of this article addresses general issues related to these three topics.

As with any additions to an academic curriculum, convincing students (and some faculty members) of the value of learning new skills is a first order of business. Teaching new non-technical skills in specifically relevant technical contexts usually meets little
resistance although established instructional practices are often resistant to change. Attempts to integrate writing and communication skills, or apply social, economic, and political contexts to university engineering, science, and technology curricula have met with documented success. Teaching thinking and problem solving skills in the university curriculum may be a natural extension of these trends.\(^4\)

Integrating new material into a curriculum ought to be a relatively slow process for two reasons: 1) so that faculty can learn new skills and integrate them into their courses and 2) so that students are not pushed too hard to accept new ideas without some evidence of their relevancy to the curriculum and workplace. Examining the process of thinking is often thought of as a purely esoteric endeavor of people who lock themselves in small dark rooms to struggle with the demons of human existence (and whose place is in the arts, philosophy, and, increasingly, psychology). Consequently, the results of such activity may appear to be purely philosophical in nature, especially for those who study engineering, the sciences, or technology. For this reason, faculty members need to be the first to embrace this change.

Convincing students to commit to learning apparently abstract skills may meet with some resistance: fear of the information being irrelevant to their studies (and careers), or just fear of new and unfamiliar material or abstract topics of study. Simply sparking students’ enthusiasm will not produce results here—a careful and measured plan of curriculum additions and revisions is the most reasonable approach. Usually, teaching students often-used linear problem solving strategies and computer-based skills such as concept mapping, pattern matching, and data mining is successful (while informing students that computers offer only organized information which becomes the raw
material of thinking). Instruction in brainstorming and linear approaches to risk assessment, problem solving, and decision making have also been popular additions to some progressive academic programs. Less linear approaches to problem solving such as writing as thinking, drawing as thinking, non-argumentative approaches to conversation, and even visualization are strategies used in progressive corporate venues, but they are usually facilitated by outside consultants. While this trend is positive, if less than earth-shaking, what is missing is not the willingness of students or employees to participate in such thinking exercises, but the ability of individuals to master these thinking strategies for themselves and know how to match problem solving approaches to appropriate problems or situations requiring new ideas. I will not try to argue (yet) that what we may wish is to graduate a group of “elite thinkers,” but it is not an undesirable goal. Because it is reasonable to think of everything we do as “a problem to solve” (even if it is simply to generate good ideas), educated and practiced thinkers have the potential to understand and synthesize information in both technical and human contexts, and apply them effectively in the workplace.

Thinking is an art, and as with any art (like piano playing, writing, painting, or dancing), practice is central to learning, as is at least moderate instruction. This fact becomes more apparent as individuals move away from learning and applying only popular “thinking tools” (like brainstorming) and, instead, to discovering their own thinking processes and understanding how and when to apply them. These internalized skills are generally abstract in nature and do not apply to such unfortunate clichés as “thinkers’ toolbox” or “thinking outside the box” which mostly relate vaguely to some linear and non-linear approaches to problem solving and thinking skills.
It may not be too great a task to convince students of the value of possessing good thinking skills and the many rewards such skills yield, but it is a more time consuming task to teach individual thinking processes and experimental approaches to thinking. Teaching students to examine “how” they think is educationally challenging; it is significantly more difficult to teach, and it requires from students a greater trust in a learning process that may seem foreign to them. Studying such abstract thinking processes has an impact on students’ daily intellectual and personal routines which, in turn, influence lifestyle. Such changes require students to understand the relationship between time and thinking, the biological and philosophical nature of change, and methods of intentional personal change. Being busy all the time (“I don’t have a life” or “I don’t have time to think”) is not convincing evidence of good thinking or increased productivity. “Doing” seems to be a more popular endeavor these days than thinking. If “task completion” (which is greatly facilitated by advancing technology) becomes the mantra of the current generation of students, higher education will have failed in its mission.

If we only manage to teach our students to follow instructions for using “thinking tools” effectively, instead of understanding thinking processes, our efforts will not be sufficient, even if we have provided appropriate contexts in which to apply these technological and linear approaches. My thoughts concerning the value of teaching students abstract and individualized thinking skills (as a logical progression from teaching them linear and non-linear thinking skills) is not wishful thinking, nor is it my idea. Besides Aristotle, notable Eastern and Western philosophers, writers, scientists, artists, and even political theorists have promoted the value, and personal and
professional rewards of learning how to “think about thinking” (referred to mostly as meta-cognition or “meta-thinking”). While the task of integrating problem solving and thinking skills into a curriculum is not to be solved by a few class lectures and appropriate assignments, academicians can teach processes and approaches to thinking that students can apply and continue to apply throughout their lives. Teaching “thinking as a process” may be a hard sell to students, especially if faculty do not consider themselves practitioners of this sort of thinking, but I would argue that most of us do think in this way although we may not attach the word “process” to it. As we might teach our students something about writing through our own writing experiences, even though we are not all writing teachers, we can identify the processes we use to think and solve problems and, subsequently, share these approaches with our students.

Teaching abstract thinking skills is a lifestyle issue: Good thinking takes time and may rob students of the “task completion” they often associate with productivity and that may have become an entrenched and satisfying habit. The overwhelmingly popular trend of being perpetually busy does not allow suitable time for focused thinking. Some abstract thinking skills that may require a lifestyle change, especially in terms of how one spends one’s time, include, but are certainly not limited to, the following: 1) learning focused reflection skills, 2) practicing listening skills, 3) changing one’s approach to conversation (learning discussion skills rather than argumentation skills), 4) accepting diversity in all its forms, 5) understanding social and cultural processes and norms, 6) becoming more self-aware, and 7) practicing intentional change.

Teaching thinking skills in an engineering, or science and technology program will require some curriculum changes. Course additions to the curriculum are the most
obvious and effective method, and require the development of new courses and programs; however, integrating some instruction in thinking skills and problem solving into an established curriculum is also an effective approach. Augmenting students’ established technical thinking and problem solving practices with some of the methods outlined in this paper requires some intervention into course-level preparation and teaching…but less so into established department-level curricula.

Determining which faculty members will teach these skills depends on several factors. For course or program development considerations, the most obvious candidates are those who have experience teaching interdisciplinary courses that combine the sciences and humanities. For the purposes of integrating some thinking and problem solving instruction into established courses, faculty members whose personal interests and academic practices (including research) combine a wide variety of thinking strategies may be natural candidates. This group would most certainly include those of us who have some interest and personal experience in the arts and humanities. Finally, most any faculty member interested in expanding his or her instructional skills through research and practice will also be quite valuable to the effort.

Conclusion

The need for instruction in thinking skills has never been more relevant to higher education, especially in engineering, the sciences, and technology. An integrated approach to instruction in these skills preserves teaching time for technical topics. Faculty acceptance of these concepts and subsequent faculty development will determine how successful we will educate our students to meet the technical and human challenges in the coming decades. It has been too long that university programs have touted
instruction in problem solving skills without committing to more than anecdotal
instruction in random skills, mostly on the course level.

Integrating thinking and problem solving skills into the curriculum may simply be
promoting universal common sense—teaching students the kind of intellectual
empowerment most of us want in our own lives and work, and the kind we want for our
students and our children. Well-developed and practiced problem solving skills and
thinking processes give us a measure of control over the factors that influence our lives
—and offer us the ability to solve problems and generate ideas in our day-to-day
professional and personal lives.
References

ERIC PAPPAS

Dr. Eric Pappas is associate professor of integrated science and technology at James Madison University. He developed, and was director of, the Advanced Engineering Writing and Communications Program in the College of Engineering at Virginia Polytechnic Institute and State University (Virginia Tech) from 1993-2003.

Dr. Pappas was on the faculty of Virginia Tech from 1987-2003 and taught classes in technical writing, creative writing, American literature, interpersonal communications and public speaking, creative thinking, leadership, engineering design, management skills, gender issues, and professional ethics.

Since 1975, Dr. Pappas has consulted on a wide variety of topics including management skills, technical and scientific writing, public speaking, interpersonal communications, sexual harassment prevention, employee relations, creative thinking, diversity, and conflict negotiation.