



Against teaching: A clinician's view

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Abstract

Quality thinking and quality teaching are desirable but difficult to achieve. Although lectures are necessary to teach information, one cannot rely on them to promote critical and constructive thinking skills. Nevertheless, didacticism remains the dominant teaching strategy in secondary education and in university, perhaps because it is viewed as the most efficient way of imparting large quantities of information. In this comment, research and theory in psychology are used to argue the case that the development of critical and constructive thinking skills necessarily involves the cultivation of dialectic, flexible attitudes toward thinking and teaching in context.

Keywords: Critical Thinking; Constructive Thinking; Quality Thinking; Dialogue; Imitation; Learning

Acquaintance with the details of fact is always reckoned, along with their reduction to a system, as an indispensable mark of mental greatness.

William James – Pragmatism

Introduction

In a previous issue of Educational Research and Reviews, Geraint Johnes reviewed evidence and reported findings pointing to beneficial effects of student-centred, problem-oriented teaching strategies (Johnes, 2006). More specifically, students who reported being invited by teachers to express ideas during their secondary education performed better in school exams. These same students were also more likely to continue participation in post-compulsory education.

These findings lend credence to recent research on student preferences. For example, Zhang and her colleagues (Zhang, 2004; Zhang, Huang, & Zhang, 2005) investigated the preferred teaching styles among university students in Hong Kong and the United States. Students generally preferred that their teachers use creativity-generating teaching styles. They expressed the least interest in teaching styles that are conservative. The creativity-generating style includes a varied package of actions designed to foster higher levels of cognitive complexity. In the scheme developed by Sternberg and colleagues (Sternberg, 1997), the creativity-generating style includes the hierarchical (prioritizing one's tasks),

judicial (evaluative of other people or products), legislative (being creative), global (focusing on the wholistic picture), and liberal (taking new approaches to tasks) styles.

Nevertheless, didacticism remains the dominant teaching strategy in secondary education and in university, perhaps because it is viewed as the most efficient way of imparting large quantities of information. And although lectures are necessary to teach information, one cannot rely on them to promote thought, change attitudes, or develop behavioral skills. A strategy that engages students directly is needed -- a critical and constructive attitude is needed. In this comment some lessons from basic and applied psychology are presented to bolster this pedagogic attitude.

Cultivating a zest for science – learning constructivism

For Sir Charles Sherrington, Natural Science is a branch of knowledge by general consent not primarily based on

the *a priori*. Rather it endeavours by observation to follow and trace the 'how' of what happens in Nature and proceeds further to generalize about this 'how'. The vigorous expenditure of energy devoted to this pursuit is just part of the human 'zest to live'. Its object is to learn the 'how' of Nature for the sake of that 'how' itself as being one aspect of 'truth' (Sherrington, 1955).

Human beings strive to understand. Understanding helps us to survive, adapt, and flourish. A central theme in the history of philosophical and religious thought has been the call to 'know thyself' and to 'understand thy nature'. Since the dawn of recorded culture, each new generation has heard echoes of this call. Long before the birth of western philosophy, religion, and science, the *I Ching* opened with the warning: *The creative is successful; this is beneficial if correct.*

With the potential to be beneficial if correct, science tells us that we can learn to know ourselves by studying ourselves as a part of Nature. Although our evolved survival instincts and our adaptive coping and problem solving strategies often provide us with ample energy and intelligence to deal with many life situations, a common problem is that students don't always successfully imitate or emulate the critical thinking abilities of their teachers/lecturers. This idealized 'zest to live' that Sherrington talks about will only transfer to focused, specialized actions like *hypothetico-deductive reasoning* when the actions are intelligently selected and when energy is specifically directed into their development (Baltes, 1997).

Textbooks can help us to better understand the structure, process, and function of thinking, explain why human system factors act as constraints and affordances during the development of thinking, and provide us with sound arguments for why a dedicated thinking module should be included as part of school and university training (Boostrom, 2005; Brookfield, 1987; Gilovich, Griffin, & Kahneman, 2002; Jensen, 2005; Kuhn, 2005), but none of these textbooks provide a specific strategy for optimizing delivery of their content (or any content) in context.

And so how do you construct and optimize a teaching strategy? Does one size fit all or does one need to flexibly adjust strategies in response to real-time contingencies in context? Imparting an intrinsically motivated, actively engaged thinking process is very difficult. It is much more difficult than simply imparting information. It means transforming a one-way information transfer system into a two-way dialectic transfer system. It means devising a strategy that asks students to think about the information presented, not simply imitate it. Importantly, imitation of existing memes – ideas, values, and beliefs – is insufficient to drive cultural evolution (Richerson & Boyd, 2005), and each new generation needs to combine successful imitation with successful learning.

For teachers who rigidly hold to the *a priori* effectiveness of one educational system over another, the idea that the *a priori* needs to be corrected by experience might seem unacceptable. The hope is that deduction will provide the *perfect* working model, a model that is successful across time and contexts. However, human systems are dynamic systems. Human systems adapt and change (Thelen & Smith, 1994; Vickers, 1983). Theory-driven models cannot ignore the contingencies of the real world. The marriage of deduction and induction is beneficial if correct (Baltes & Freund, 2003).

What applies to teachers also applies to students – everyone needs the opportunity to learn from experience. Kant argued that education is best designed to *empower enlightened application of reasoned action*, such that the process of application becomes automatic and second nature. Whatever way you look at it, the hard graft of learning is necessary to enhance the average fitness of a population¹. In other words, learning always supplements imitation and becomes paramount for enlightened application of reasoned action. With didacticism, self-generated, self-regulated action on the part of students is not a priority. Educators may well be learning about how best to 'get results' by tweaking their didactic system one way or the other, but they do so at the expense of treating students like 'subjects' in a psychological experiment rather than as active 'participants' in a learning process.

Ultimately, learning at school and at university requires *action in context*. The action of the teacher is the crucial context for the student as learner, and the action of the students is the primary context for the teacher as educator. The *learning objective* is shared by both teachers and students. In this dialectic process of engagement both teachers and students learn.

Drawing upon systems biology, Piaget argued that mental representations are built up through a process of adaptation and organization. We modify our mental representations to the facts of this world as *they are presented to us through our own action*. However, even assuming that learning involves the construction of increasingly organized and complex mental representations, a constructivist can never assume that by simply empowering self-generated, self-regulated action students will acquire a zest for scientific modes of thought. A major criticism of Jean Piaget's constructivist

¹ Mathematical models suggest that imitation increases the average fitness of learners by allowing organisms to learn more selectively, learning when learning is cheap and accurate, and imitating when learning is likely to be costly or inaccurate, or when environments are unpredictable; for those who can flexibly shift from the strategy 'imitate' to the strategy 'learn', imitation raises average fitness by allowing learned improvements to accumulate from one generation to the next (Boyd & Richerson, 1988; 1989; 1995).

theory of cognitive development came from the observation that not all adults reach his final period, the period of *formal operations*, where hypothetico-deductive reasoning acts as the pinnacle process driving adult cognitive development². It was a surprise for many to find that fewer thinkers than expected actually achieved the quality of thinking, problem solving, and decision-making that Piaget associated with formal operations (Kuhn, 1991; Niemark, 1981). It was later observed that the attainment of formal operations is strongly influenced by culture, and particularly the formal education systems of culture (Dasen, 1977; Shweder, 1991; Shweder et al., 1984).

Poor skill in the use of formal operations is sometimes observed after a protracted period of attendance at University. For example, although some improvement in critical thinking can result from students' having attended college, this improvement is not always substantial (Keeley, Browne, & Kreutzer, 1982). A common cry amongst academics is that the thinking undergirding essay writing in exams is poorly structured, lacking essential coherence and organization, even when many of the facts are present. Clearly, there is more to critical thinking than having a set of facts stored in mid-term or long-term memory. For William James, it is an *acquaintance with the details of fact, along with their reduction to a system* that are an indispensable mark of mental greatness.

Working to become acquainted with the details of fact and working to reduce the facts to a system necessitates gaining increased levels of control over action. The demand for cognitive control increases as the complexity of the cognitive systems you develop increases. Good executive control is a skill that all good educational training should impart. Executive control involves the ability to manage one's thoughts, memories and actions in accordance with task-relevant goals (Anderson & Craik, 2000). Component processes of executive control include working memory (Baddeley, 1986), attention switching (Kramer, Larish, Weber, & Bardell, 1998), sustained attention (Posner & Peterson, 1990), inhibition (Hasher, Zacks, & May, 1999; Shimamura, 1995), and goal maintenance (Duncan, 1995). Each of these skills develops with the exercise of the skill (Hogan, 2005).

And so, if cultural evolution is driven by a process where imitation and learning are flexibly combined, and if we hope that students will acquire not only an acquaintance with the facts but also the skills to reduce facts to a system and manage their thoughts, memories and actions in accordance with task-relevant goals, what attitudes of thought – or memes – should our thinking

²Note, a post-formal period has since been proposed. Central to this stage is cognitive-emotional integration in a field of doubt, uncertainty, and limitation.

contexts make available, and how do we facilitate acquisition of these attitudes of thought?

The critical and constructive attitudes

Consider two attitudes of thought, the critical attitude and the constructive attitude. Let us assume that the critical attitude maps onto discreet cognitive skills identified by the Delphi Committee (Facione, 1990): *interpretation, analysis, evaluation, inference, explanation and self-regulation*. Operating (in coherence or in conflict) with the critical attitude is the constructive attitude: it maps onto acts of *synthesis* that seek to bring the products of critical thinking into a system of relations suitable for *reasoned problem-solving and decision-making*. The merger of critical and constructive attitudes is one of the more difficult challenges the thinker has to face. As noted in the Delphi report:

“Not every useful cognitive process should be thought of as critical thinking (CT). Not every valuable thinking skill is CT skill. CT is one among a family of closely related forms of higher-order thinking, along with, for example, problem-solving, decision-making, and creative thinking. The complex relationships among the forms of higher-order thinking have yet to be examined satisfactorily”. (p. 5)

Twentieth-century experimenters have documented how dysfunctional human performance when acting alone, in groups, and in organizations can mar a successful merger of the critical and constructive attitudes (Allison, 1971; Argyris, 1982; Boulding, 1966; Janis, 1982; Simon, 1974; Warfield, 1974, 1995). Some psychologists have emphasised the need for training both critical and constructive attitudes, labelling the merger ‘productive thinking’ (Wertheimer, 1959). I like to label the merger as one dimension of ‘quality thinking’.

Strategies designed to foster an *integrated* collection of quality thinking skills are still somewhat rare in third-level education, and yet, strategies that set out to develop select skills can be successful (Huang, 2005; Jin, Bierma, & Broadbear, 2004; Rimiene, 2005). Because there are too few well-argued models of good practice in this regard, and because an integrated collection of quality thinking skills has to be packaged and delivered in a *unique* context, it is understandable why cultural evolution has been slow and difficult³.

³Note: The cultural tool box itself evolves so quickly that the craftsman can be left sitting with too many tools and no strategy to focus a functional application. It takes time to master the use of any given tool. In science, as the facts accumulate and more and more schools of thought enter the arena, quality thinking itself becomes more difficult. New systems of thought and action are necessary, but they must be designed to ‘manage’ complexity and not just ‘stir’ complexity.

In order to solve many problems in science and in society we have to work to develop a support system that facilitates optimal coherence of the critical and constructive attitudes such that they facilitate the modelling of 'problematic situations' (Warfield, 2003). Naturally, the building of such a prop -- what Vygotsky called scaffolding -- involves some understanding of the psychophysical constraints latent in the developing action system, i.e., those operating at an individual and group level. An understanding of developmental psychology, social psychology, cognitive psychology, and neuroscience can be beneficial if correctly applied.

On Dialogue

As Vygotsky noted, providing scaffolding for a student implies acting as a *guide*, leading students slowly, gradually into their zone of proximal development, knowing first where they *are at* and then taking them forward.

Knowing where students are at involves application of the first principle of any module designed uniquely to develop quality thinking: *quality dialogue*. The utility of quality dialogue can be gleaned from reading literatures tangential to psychology and philosophy (Bohm & Nichol, 1996; Bruner, 1990; Labouvie-Vief, 1994) but to my mind understanding the true value of dialogue comes only through using it as part of problem-based learning in a group context.

Further, understanding quality dialogue is central to understanding collaborative cognition⁴, which is of central importance to the systems science school of thought (Bertalanffy, 1968; Miller, 1978; Vickers, 1983; Warfield, 2003, 2004).

The 'quality dialogue principle' cannot be implemented when simply lecturing students. Lectures are good examples of one-way communication -- the percentage of time that students spend talking is limited. More generally, the quality of student talk is usually restricted to *asking questions*, which is but one amongst a set of useful skills that educational training should promote.

At the same time, knowing how to take a group of students forward involves knowing what you want to teach them -- knowing what the desired end-state is -- and devising an *orderly, cumulative, and directional* path to that endstate. Unique to any dedicated quality thinking module is that dialogue must be operative at all points, during all exercises, on this orderly, cumulative, and

directional path. This is the best way to optimize movement into the zone of proximal development (Cannell, 2004; Derry, 2004; Kozulin, 2004; Popkewitz, 1998; Vygotsky, 1967, 1979).

Approaching the task at hand

A few other points on strategy before closing: One strategy when teaching 'thinking' is to make some attempt to identify and then remove all the systemic biases in human action, including all relevant population-wide bad attitudes⁵ that may have a negative effect on quality action. For example, an educator may decide to develop a system that works with students to better *inhibit* errors during application of the critical attitude of thought, i.e., while training interpretation, analysis, evaluation, inference, explanation, and self-regulation. Naturally, this would involve developing an orderly, cumulative, and directional training programme that achieves this desired goal. Students would emerge with a much better understanding of the critical attitude; they would be better able to use each of the critical attitude sub-processes, and they would likely do so with great care.

At the same time, using this strategy we might also hope to *activate* the constructive attitude -- acts of *synthesis* that seek to bring the products of critical thinking into a system of relations suitable for *reasoned problem-solving and decision-making* -- or, further, we might hope to enhance coherence between the critical and constructive attitudes. However, achieving the first goal does not imply transfer of benefit to the other two. And enlightened sceptics might reason that the module itself is hardly likely to be very beneficial if all it does is work to create careful critics.

More generally, activation and inhibition have distinct neural substrates (LeDoux, 1996), and systems theories on the development of emotion regulation consider these inter-dependent dynamics to be important (Lewis, 2001, 2002, 2005; Lewis & Stieben, 2004). Also, successful development is marked by an ability to optimize strategic and contextualized *engagement and disengagement* of selected actions (Brandtstadter, 1998).

Simply stated, the action that is the focus of educational training needs to be selected for development; if you want to develop functional coherence between the critical attitude and the constructive attitude in an interpersonal field where collaborative cognition marks *progress* at the level of the group, then consider developing a strategy that activates the necessary skills.

⁴ Collaborative cognition refers to the distributed nature of cognition in social and cultural systems. The study of collaborative cognition embeds the critical and constructive attitudes described in the previous section within an interpersonal field.

⁵ *Attitudes* are composed of cognition, emotion, and behaviour. *Bad*, in this context, implies 'unreasonable'. The Delpi report tells us to be 'trustful of reason'. The exercise of reason shapes attitudes.

You cannot ask an organism to activate an action by asking them to inhibit another. Approach motivation is distinct from avoidance motivation. Flexible dynamic balance between activation and inhibition is part of any adaptive action process, and practice is necessary before some elements of action flexibly cohere. Notably, groups where the ratio of positive to negative emotion is high demonstrate greater flexibility in this regard (Fredrickson & Losada, 2005).

Importantly, some aspects of what students commonly define as 'critical' for a critical thinking process needs to be reconsidered from within a broader perspective on human psychology. This includes understanding how certain philosophical assumptions can bias action. For example, scepticism -- the disbelief in any claims of ultimate knowledge -- is only adaptive if it does not suppress the potential for enlightenment, which according to Kant means having the 'courage to use your own reason'. This implies not being afraid to face opposition, which is inevitable in life as no one has access to the ultimate 'truth'⁶. And yet, in my experience, students are often afraid to speak out, particularly during the first few weeks of any dialogue; they report not wishing to use their own reason for risk of being *criticized*. In other words, they clearly confuse critical thinking with *being critical of thinking*. It takes time to build first their resilience and second their joy in thinking.

Further, if the critical attitude activates unnecessary negative emotions it can dampen synchrony with the constructive attitude (i.e., both may fail to operate in coherence). More specifically, it is often beneficial and correct to have positive emotions readily activated while thinking, as positive emotions tend to facilitate the act of synthesis (Fredrickson, 1998, 2001; Fredrickson & Branigan, 2005). If negative emotion is a more powerful attractor than is positive emotion in the group, and if the critical attitude comes to suppress the constructive attitude, then we limit our action potential as a group (Fredrickson & Losada, 2005). Without working to optimize affect while developing quality thinking, we

⁶ Bertrand Russell argues that developing the resilience to face opposition, and, more specifically, the ability to engage in reductive dialogue with those with a different system view, is a central skill for the critical thinker. In his notes on 'enlightenment' Kant says "Laziness and cowardice are the reasons why so great a portion of mankind, after nature has long since discharged them from external direction, nevertheless remains under lifelong tutelage, and why it is so easy for others to set themselves up as their guardians. It is so easy not to be of age. If I have a book which understands for me, a pastor who has a conscience for me, a physician who decides my diet, and so forth, I need not trouble myself. I need not think, if I can only pay - others will easily undertake the irksome work for me".

constrain the potential for a more differentiated cognitive-emotional representation to develop (Labouvie-Vief & Márquez González, 2004). The optimal systems solution is one where both positive and negative emotions are well-integrated (Zautra, 2003).

Thinking can be an intrinsically rewarding and enjoyable experience, but the creation of a well-integrated culture of thinking in a group of students -- who will invariably compete as well as co-operate with one another -- is a challenge. Without working *with* students, guiding them, as *they* transform the culture of the group over an extended period of time (with quality dialogue and quality action as the tools they come to master) we don't help them along the path to enlightenment.

Also, by grounding progress in dialogue, and by injecting positive emotion into the dialectic we may help to remove some blocks to flourishing and activate a cycle of thinking and action that produces valued outcomes -- removing positive emotions and play from their daily routine people suffer headaches, fatigue, and tension (Csikszentmihalyi, 1975, 1990, 1996, 1997; Csikszentmihalyi & Csikszentmihalyi, 1988; Csikszentmihalyi & Larson, 1984; Csikszentmihalyi & Schneider, 2000); encouraging people to take an active role in caring for themselves increases vigour, engagement, health and longevity (Rodin, 1986; Rodin, Schooler, & Schaie, 1990).

Again, from a systems perspective, quality dialogue and quality action are necessary for the development of quality systems. A strategy led by dialogue means that everyone is an *active* agent, and being an active agent, having a centre of control within one's own system, is important, a central feature of lifespan theories of successful development (Heckhausen, 1987, 1997, 2000; Heckhausen & Schulz, 1995, 1999).

In conclusion, the design of a strategy to develop thinking skills needs to be shaped by some constructive perspective (i.e., by a theory of sorts), and if the discovery of 'how' in education, much like the discovery of 'how' in science, involves mapping the energy of the system onto a correspondent mapping and manipulation of energy by the mind, then the only way such a theory can be developed is by using the principles of deduction and induction (i.e., learning both from prior theory and from experience). The existing bulk of psychological science provides us with much fodder for quality deduction, but mapping the energy of the system onto a correspondent mapping and manipulation of energy by the mind also involves exploring the system as *it is* and grounding one's educational theory and educational practice in experience.

References

Allison GT (1971). *Essence of decision*. Boston: Little, Brown.

- Anderson ND, Craik FIM (2000). Memory in the aging brain. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford Handbook of Memory*. Oxford: Oxford University Press. pp. 421-452.
- Argyris C (1982). *Reasoning, Learning, and Action*: Jossey-Bass: San Francisco, CA.
- Baddeley A (1986). *Working Memory*. Oxford: Oxford University Press.
- Baltes PB (1997). On the incomplete architecture of human ontogeny: Selection, optimization, and compensation as foundation of developmental theory. *American Psychologist*, 52(4), 366-380.
- Baltes PB, Freund AM (2003). Human strengths as the orchestration of wisdom and selective optimization with compensation. In: LG Aspinwall UM Staudinger (Eds.), *A psychology of human strengths: Fundamental questions and future directions for a positive psychology*. pp. 23-35.
- Bertalanffy LV (1968). *General system theory: Foundations, development, applications*. New York: Braziller.
- Bohm D, Nichol L (1996). *On dialogue*. New York: Routledge.
- Boostrom RE (2005). *Thinking: The foundation of critical and creative learning in the classroom*. New York: Teachers College Press.
- Boulding K (1966). *The Impact of the Social Sciences*. New Brunswick: Rutgers University Press.
- Brandstadter J (1998). Action perspectives on human development. In: W Damon, RM Lerner (Eds.), *Handbook of child psychology: Vol1. Theoretical models of human development*. New York: Wiley. pp. 807 – 863.
- Brookfield S (1987). *Developing critical thinkers: challenging adults to explore alternative ways of thinking and acting* (1st ed.). San Francisco: Jossey-Bass.
- Bruner JS (1990). *Acts of Meaning*: Harvard University Press.
- Cannell P (2004). Vygotsky's educational theory in cultural context. *Bri. J. Edu. Technol.* 35(3), 385-385.
- Csikszentmihalyi M (1975). *Beyond boredom and anxiety* (1st ed.). San Francisco: Jossey-Bass Publishers.
- Csikszentmihalyi M (1990). *Flow: The psychology of optimal experience* (1st ed.). New York: Harper & Row.
- Csikszentmihalyi M (1996). *Creativity: Flow and the psychology of discovery and invention* (1st ed.). New York: HarperCollinsPublishers.
- Csikszentmihalyi M (1997). *Finding flow The psychology of engagement with everyday life* (1st ed.). New York: BasicBooks.
- Csikszentmihalyi M, Csikszentmihalyi IS (1988). *Optimal experience: psychological studies of flow in consciousness*. Cambridge; New York: Cambridge University Press.
- Csikszentmihalyi M, Larson R (1984). *Being adolescent : conflict and growth in the teenage years*. New York: Basic Books.
- Csikszentmihalyi M, Schneider BL (2000). *Becoming adult : how teenagers prepare for the world of work* (1st ed.). New York: Basic Books.
- Dasen PR (1977). *Piagetian psychology: Cross cultural contributions*. New York: Gardner Press: distributed by Halsted Press.
- Derry J (2004). The unity of intellect and will: Vygotsky and Spinoza. *Edu. Rev.* 56(2), 113-120.
- Duncan J (1995). Attention, intelligence and the frontal lobes. In: MS Gazzaniga (Ed.) *The Cognitive Neurosciences*. Cambridge, MA: MIT Press.
- Facione J (1990). *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction: The California Academic Press*.
- Fredrickson BL (1998). What good are positive emotions? *General Review of Psychology*, 2(3), 300 - 319.
- Fredrickson BL (2001). The role of positive emotions in positive psychology - The broaden-and-build theory of positive emotions. *American Psychologist* 56(3), 218-226.
- Fredrickson BL, Branigan C (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion*, 19(3), 313-332.
- Fredrickson BL, Losada MF (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist*, 60(7), 678-686.
- Gilovich T, Griffin DW, Kahneman D (2002). *Heuristics and biases: The psychology of intuitive judgement*. Cambridge, UK; New York: Cambridge University Press.
- Hasher L, Zacks RT, May CP (1999). Inhibitory control, circadian arousal and age. In: A Koriat D Gopher (Eds.), *Attention and performance*. Vol. XVIII, pp. 653-675. Cambridge, MA: MIT Press.
- Heckhausen J (1987). Balancing for Weaknesses and Challenging Developmental Potential - a Longitudinal-Study of Mother Infant Dyads in Apprenticeship Interactions. *Developmental Psychology*, 23(6), 762-770.
- Heckhausen J (1997). Developmental regulation across adulthood: Primary and secondary control of age-related challenges. *Developmental Psychology*, 33(1), 176-187.
- Heckhausen J (2000). Evolutionary perspectives on human motivation. *American Behavioral Scientist*, 43(6), 1015-1029.
- Heckhausen J, Schulz R (1995). *A Life-Span: Theory of Control*. *Psychological Review* 102 (2), 284-304.
- Heckhausen J, Schulz R (1999). The primacy of primary control is a human universal: A reply to Gould's (1999) critique of the life-span theory of control. *Psychological Review*, 106(3), 605-609.
- Hogan MJ (2005). Physical and cognitive activity and exercise for older adults: a review. *Int J Aging Hum Dev*, 60(2), 95-126.
- Huang C (2005). Designing high-quality interactive multimedia learning modules. *Computerized Medical Imaging & Graphics*, 29(2-3), 223-233.
- Janis IL (1982). *Groupthink: Psychological Studies of Policy Decisions and Fiascos*. Boston, MA: Mufflin.
- Jensen E (2005). *Teaching with the brain in mind* (2nd, Rev. and updated.). Alexandria, Va.: Association for Supervision and Curriculum Development.
- Jin G, Bierma TJ, Broadbear JT (2004). Critical thinking among environmental health undergraduates and implications for the profession. *J. Environ. Health*, 67(3), 15-20.
- Johnes G (2006). Didacticism and educational outcomes. *Edu. Res. Rev.* 1(2), 23-28.
- Keeley SM, Browne MN, Kreutzer JS (1982). A Comparison of Freshmen and Seniors on General and Specific Essay Tests of Critical Thinking. *Res. Higher Edu.* 17(2), 139-154.
- Kozulin A (2004). Vygotsky's theory in the classroom: Introduction. *Eur. J. Psychol. Edu.* 19(1), 3-7.
- Kramer AF, Larish JF, Weber TA, Bardell L (1998). Training for executive control: Task coordination strategies and aging. In: S Monsell & Driver (Eds.), *Control of Cognitive Processes: Attention and Performance XVIII*. Cambridge, MA: MIT Press.
- Kuhn D (1991). Reasoning, higher order in adolescence. In: RM Lerner, AC Petersen, J Brooks-Gunn (Eds.), *Encyclopedia of adolescence* (Vol. 2). New York: Garland.
- Kuhn D (2005). *Education for thinking*. Cambridge, Mass.: Harvard University Press.
- Labouvie-Vief G (1994). *Psyche and Eros: Mind and Gender in the Life Course*: Cambridge University Press.
- Labouvie-Vief G, Márquez González M (2004). Dynamic Integration: Affect Optimization and Differentiation in Development. In: DY Dai RJ Sternberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development*. Mahwah NJ: Lawrence Erlbaum. pp. 1 – 36.
- LeDoux JE (1996). *The Emotional Brain*. New York: Simon & Schuster.
- Lewis MD (2001). Self-organizing brains don't develop gradually. *Behavioral and Brain Sciences*, 24(1), 47.
- Lewis MD (2002). The dialogical brain - Contributions of emotional neurobiology to understanding the dialogical self. *Theory & Psychology*, 12(2), 175-190.
- Lewis MD (2005). Bridging emotion theory and neurobiology through dynamic systems modeling. *Behavioral and Brain Sciences*, 28, 169-194.
- Lewis MD, Stieben J (2004). Emotion regulation in the brain: Conceptual issues and directions for developmental research. *Child Development*, 75(2), 371-376.
- Miller JG (1978). *Living systems*. New York: McGraw-Hill.
- Niemark ED (1981). Confounding with cognitive style factors: An artifact explanation for the apparent nonuniversal incidence of formal opera-

- tions. In: I Siegel, D Brodzinsky, R Golinkoff (Eds.), *New directions in Piagetian research and theory*. Hillsdale, NJ: Erlbaum.
- Popkewitz TS (1998). Dewey Vygotsky and the social administration of the individual: Constructivist pedagogy as systems of ideas in historical spaces. *Amer. Edu. Res. J.* 35(4), 535-570.
- Posner MI, Peterson SE (1990). The attention system of the human brain. *Annual Review of Neuroscience*, 13, 25-42.
- Richerson PJ, Boyd R (2005). *Not by genes alone: How culture transformed human evolution*. Chicago: University of Chicago Press.
- Rimienne V (2005). Assessing and developing students' critical thinking. *Psychology Learning & Teaching*, 2(1), 17-22.
- Rodin J (1986). Aging and health: Effects of the sense of control. *Science*, 233(4770), 1271-1276.
- Rodin J, Schooler C, Schaie KW (1990). Self-directedness : cause and effects throughout the life course. Hillsdale NJL Erlbaum Associates.
- Sherrington CS (1955). *Man on his nature*. Harmondsworth: Penguin.
- Shimamura AP (1995). Memory and frontal lobe function. In M. Gazzaniga (Ed.), *The Cognitive Neurosciences*. Cambridge, MA: MIT Press. pp. 803-813.
- Shweder RA (1991). *Thinking through cultures: expeditions in cultural psychology*. Cambridge, Mass: Harvard University Press.
- Shweder RA, LeVine RA: Social Science Research Council (U.S.). Committee on Social and Affective Development During Childhood. (1984). *Culture theory: essays on mind, self, and emotion*. Cambridge; New York: Cambridge University Press.
- Simon HA (1974). How big is a chunk? *Science*, 183, 482-488.
- Sternberg RJ (1997). *Thinking styles*. Cambridge; New York: Cambridge University Press.
- Thelen E, Smith LB (1994). *A Dynamic Systems Approach to the Development of Cognition and Action*. Cambridge, MA, USA: Mit Press.
- Vickers G (1983). *Human systems are different*. London; New York: Harper & Row.
- Vygotsky LS (1979). Development of Higher Forms of Attention in Childhood. *Soviet Psychology*, 18(1), 67-115.
- Warfield JN (1974). *Structuring complex systems*. [Columbus, Ohio: Battelle Memorial Institute.
- Warfield JN (1995). SPREADTHINK: Explaining ineffective groups. *Systems Research*, 12(1), 5-14.
- Warfield JN (2003). A Proposal for Systems Science. *Systems Research and Behavioral Science*, 20, 507 - 520.
- Warfield JN (2004). Linguistic Adjustments: Precursors to Understanding Complexity. *Systems Research and Behavioral Science*, 21, 123 - 145.
- Wertheimer, M. (1959). *Productive thinking* (Enl. ed.). New York: Harper.
- Zautra A (2003). *Emotions, stress, and health*. Oxford: Oxford University Press.
- Zhang LF (2004). Thinking styles: University students' preferred teaching styles and their conceptions of effective teachers. *J. Psychol.* 138(3), 233-252.
- Zhang LF, Huang JF, Zhang LL (2005). Preferences in teaching styles among Hong Kong and US university students. *Personality and Individual Differences*, 39(7), 1319-1331.