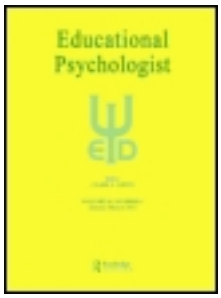

Educational Psychologist
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/hedp20

Evolution of a Learning Theory: A Case Study

Patricia A. Alexander

Version of record first published: 08 Jun 2010.

To cite this article: Patricia A. Alexander (2006): Evolution of a Learning Theory: A Case Study, Educational Psychologist, 41:4, 257-264

To link to this article: http://dx.doi.org/10.1207/s15326985ep4104_6

EDUCATIONAL PSYCHOLOGIST, *41*(4), 257–264

Evolution of a Learning Theory: A Case Study

Patricia A. Alexander
Department of Human Development
University of Maryland

In Memoriam

On Saturday July 15th, my mentor and beloved friend Ruth Garner died in her sleep after battling cancer. I would not be receiving this recognition from this august group if it were not for this remarkable scholar. Her creativity and breadth of knowledge and her unwavering passion for learning were unparalleled. As a testament to her talents as a teacher and researcher, Ruth was able to take a naïve and untested graduate student and turn her into a fairly competent educational researcher. Ruth Garner opened the universe of educational research to me, and I will be forever in her debt. I dedicate this presentation and my award to her memory and her unquestioned contributions to the field of educational psychology.

What follows is the presentation given after receiving the E. L. Thorndike Career Achievement in Educational Psychology from Division 15 of the American Psychological Association. This presentation calls for greater respect for and attention to scientific speculation in educational psychology as a critical component in theory development and model building. This presentation cites the writings of cosmologist, Joao Magueijo, as a compelling case to support the argument for such scientific speculation.

From the title of this presentation, it might logically be assumed that the case study I intend to highlight is my own program of research in academic development, the Model of Domain Learning (MDL; Alexander, 1997, 2003b). Although there is no question that I discuss my efforts to understand the nature of learning within academic domains, the case that I use to frame the ensuing discussion comes from a captivating volume by a provocative Portuguese cosmologist, Joao Magueijo (2003). That volume, *Faster than the Speed of Light,* chronicles his struggles to formulate and then gain acceptance for his controversial theory, VSL, the varying speed of light—a theory that is nothing short of a refutation of Einstein's long-established ideas about the nature of the universe. I do not intend to argue the scientific merits of Magueijo's theory. I have neither the knowledge nor the interest required for such an exercise. Rather, it is the process of formulation and justification he underwent that fascinated me and afforded me a window onto my own theorizing.

Let me reassure this audience that I do not claim to have formulated any theory or model that seeks to explain the nature of the universe. Nonetheless, my career as a researcher has been focused on understanding the universe of the classroom and the processes by which young minds are systematically transformed as a result of the experiences that unfold within this complex, dynamic, and seemingly chaotic context. Moreover, as with this brilliant and headstrong physicist, I believe that there are lessons to be learned by sharing my journey these past 30 years—a journey that took me from a middle school in rural Virginia to a professorship at the University of Maryland. Finally, I humbly submit that the conception of learning as academic development and the tenets of the MDL do more than describe *what is.* Instead, they suggest what *should be* ... what *should be* occurring if learners are participating in educational experiences that foster their academic growth and development. Thus, although the MDL will not alter our understanding of the universe, it does have the potential to shake some long-held and deeply rooted

Correspondence should be addressed to Patricia A. Alexander, Department of Human Development, University of Maryland, Benjamin Bldg., Rm 3304F, College of Education, College Park, MD 20742–1131. E-mail: palexand@umd.edu

beliefs about schools and schooling and to put educational institutions on notice that the current state of affairs may at best slow academic progress or at worst condemn learners to the black holes of educational lethargy and instructional mediocrity (Alexander, 2000).

SPECULATION AND EDUCATIONAL PSYCHOLOGY

Throughout this presentation, I use Magueijo's own words as the entry point into discussion of my own theoretical endeavors and as the means of highlighting specific concerns for this community that is as dedicated to optimizing the learning experience for all individuals as I am. For instance, there is good reason why Magueijo (2003) subtitled his book, "The Story of Scientific Speculation." As he notes

> From the way the term *speculation* is so frequently used to dismiss ideas with which one disagrees, one might be led to believe that speculation has no role in science. In fact, the opposite is true. (p. 1)

It is my contention that educational research in general and educational psychology in particular cannot survive or thrive without the promotion of scientific speculation, which is the soul of theorizing and a precondition to effective experimentation. Speculation allows us to fill in the empirical spaces, to conjecture about phenomena that cannot be directly weighed or measured, and to bridge rationalism and empiricism. However, it is also my contention that speculation is an underappreciated and undernourished dimension of our professional development perhaps for fear that the result is the promotion of "feel-good" testimonials, untested hypotheses, or nongeneralizable outcomes.

It is not only in the realm of physics that speculation has had a somewhat sorted past. In the early years of psychology, there was a respected branch of study called speculative psychology. As with cosmology in physics, or theoretical mathematics, speculative psychologists straddled domain borders. In this case, it was the boundary between philosophy and psychology. The goal was to harness the best of both domains: the ideational exploration and insightfulness of philosophy and the scientific rigors of the emerging domain of psychology.

Regrettably, this effort at integration was doomed as the push to purge psychology of its philosophical cerebration, conjectures, and suppositions gained momentum; thanks, in part, to the writings of Thorndike (1910, 1924; Thorndike & Woodworth, 1901) for whom this great honor is named. Soon the field of speculative psychology was regarded as mental psychology or mind reading as Thorndike (1910) referred to it and was progressively replaced with the "new" psychology or experimental psychology as it came to be known. Thorndike, in effect, held that science was to be located in the physical world that held concrete data, which could be weighed and measured with precision. Rationalism in any form was an interloper in this new psychology. Experimentation in more controlled settings (laboratories) with more controllable subjects (animals) became its hallmark, leaving little room for mental ruminations, even if those ruminations were founded on credible evidence.

The Confessional

Why revisit psychology's past here? Why raise the specter of speculation yet again? That is because I have a confession to make, a reality I have come to accept. That reality came to me suddenly this past November during a visit to Steve Graham and Karen Harris at Vanderbilt. Between the visit to the Country Music Hall of Fame and the renowned BlueBird Café, I gave an invited talk. In the discussion that ensued, Steve posed what seemed to be a rather innocuous question: "So what are you working on now?" What followed was a bit of a *luftpausen* (i.e., a pregnant pause). I could not rattle off the experiments I was conducting as I might have in years past. It was not that I was idle—far from it. However, I had become increasingly engaged in theorizing and model building, working toward a reformulation of views of learning that challenged many long-held conceptions of schooling and expertise (Alexander, 2000). As I began to share my latest endeavors, Steve chimed in: "So, you are a theorist!" As if a veil had suddenly been lifted, I happy admitted to those assembled that "Yes! Yes! I *am* a theorist." Steve and I came to agree that my primary interest is in the explanatory system—the big picture—that takes shape through a careful blending of rationalism and empiricism.

More to the point, I am a contemporary version of a speculative psychologist. I relish reasoned conjecture, the positing of ideas that are open to verification or refutation. I have a passion for playing with messy problems situated within dynamic educational contexts. I do not want to study animals because they are easier to control or work within the confines of a sterile laboratory so the noises of everyday learning can be muffled or silenced. I want to experience learning in all its messiness and yet to discern whatever forces operate there and whatever credible, predictable, and replicable patterns can be identified through the carefully choreographed dance of deductive and inductive reasoning; the dance that Jonna Kulikowich (personal communication, August 2006) poetically described as "walking the möbius strip." Although nature and the patterns in nature are basic to this manner of theorizing, it remains essential for there to be points of abstraction, inference, or speculation—"leaps of faith"—because nature in the classroom (as in subatomic particles) does not and cannot reveal all its secrets to those plying the scientific tools of observation and measurement.

One might question my surprise or hesitancy to admit publicly that I perceive myself principally as a theorist. It is not that I shy away from experimentation. In addition, nothing excites me more than the well-conceived, well-executed study. I still

feel a rush when I see the data unfold. However, experimentation for me has become a means and not an end. The empirical study is a necessary step toward theory building or model testing. Further, the training we receive is designed to sharpen our skills at experimentation not scientific speculation.

THE NEED FOR THEORY

Also, as a community, it appears that experimentation is privileged within our journals and in the vetting procedures favored by our academic institutions and funding agencies. As my colleague Phil Winne (2004) has argued, we must remain open to new ideas, speculations that may run counter to established traditions and practices, and speculations that might give rise to experimentation but are not intended simply as background to empirical studies. Occasionally we encounter such speculations as insightful reviews in *Review of Educational Research, Educational Psychology Review,* or the like or as brief commentaries followed by counterpoints in outlets such as *Educational Psychologist* or *Learning and Instruction.* Of course, educational psychologists love their theories and models and the theoretical framework remains a critical part of the reporting of experiments. Yet, where are the outlets in our domain that welcome theoretical speculation without experimental addenda? My struggles to find a suitable outlet for the MDL as well as the difficulties others have experienced finding platforms for their theoretical works are testament to these publication dilemmas. Fundamentally, theory and scientific speculation deserve greater respect within educational psychology.

We need to remember that we cannot function without a guiding model or good theory, as Magueijo (2003) reminds us

> Trying to expand our knowledge by waiting for new observations to be found by accident is like shooting in the dark. … Better to have a guiding theory telling you what to look for. Undoubtedly, it *is* observation that establishes facts, but without a theory one risks wasting a lot of time looking in vain. (p. 55)

THE EVOLUTIONARY PATH

So specifically how did the course of my professional development lead me to don this mantle of theorist? As I stated, I did not set out to become a theorist—I am not sure who in educational psychology does. In fact, I did not even set out to become a university professor. It would seem at times as if our developmental trajectories are set in motion by any number of factors—some of which are directly in our control and others that are not.

The Catalysts

I have claimed that we all research ourselves in some way, shape, or form. Perhaps it is the variables we target, the contexts to which we are drawn, or the methodologies that we select. Within our programs of research there is some element of our experiences, our character, or our interests. This is certainly the case for me. Without question, the years devoted to teaching middle-school students set me on my present course and reverberate throughout my theoretical and empirical work. In actuality, when I began my doctoral studies, my goal was to improve my knowledge and skills so that I could better serve those middle-school students. For that reason, I chose to focus in the area of reading—a threshold domain considered a key to academic success in a range of fields. That decision and the opportunity to apprentice under the master, Ruth Garner, were transformational events. In addition, there were several facets of that doctoral experience and my early years as a professor that are particularly relevant to this discussion.

For instance, the late 1970s and early 1980s were the heyday of strategy research. The intent was to explicitly train students in an array of general processing and study strategies that would generalize to written materials. Among those strategies were main idea location or construction, summarization, text search, and questioning strategies.

Further, scholars such as John Flavell (1971), Ellen Markman (1977), Ruth Garner (1987), and Ann Brown (1975) introduced the concepts of metacognition and executive functioning (i.e., thinking about thinking) and other "meta"-constructs (e.g., metamemory) into the research vernacular. This was also the heyday of the Center for the Study of Reading, which led the way in the empirical study of reading and writing during that period. Under the leadership of Dick Anderson, the Center and the interdisciplinary scholars it attracted, including Diane Schallert, Ralph Reynolds, Rand Spiro, and Bonnie Armbruster, altered the very face of literacy research.

THE THEORETICAL LEGACIES

Those years and the decade that followed were fundamental to the evolution of the MDL and my own development as a theorist and contributed to perceptions that endure—theoretical legacies if you will.

Affirmation That Strategies Are Essential in Meaningful and Complex Learning

For one, it affirmed what I had observed as a classroom teacher: that effective learning and continued academic growth cannot occur without strategic engagement. There was also the confirmation of my earlier perceptions that the processing of challenging texts was requisite to students' academic success. So much essential information remains inaccessible to those who cannot break the linguistic code.

In essence, what began as the "hunches" of an experienced teacher became the building blocks for what would eventually become the MDL. As Magueijo (2003) acknowledges, such is the nature of scientific speculation:

> We start off with a hunch, a feeling, even a desire that the world be one way, and then proceed from that presentiment. (p. 14)

Where I broke with the prevailing wisdom was in projected strategy use over time. That prevailing wisdom, as clearly voiced by Claire Ellen Weinstein (1995) at the first public airing of the MDL (Alexander, 1995), considered the relation between learning and strategy use to be positive and linear. In effect, the better the student, the more general strategies he or she should display.

There was something troubling to me about that assumption. To my way of thinking, the more knowledgeable and skilled one became within a given domain, the more tasks became familiar and routinized, diminishing the need for general strategic intervention. This particular hunch was strengthened by a review of the literature conducted with Judith Judy (Alexander & Judy, 1988). Consequently, I hypothesized a decrease in reported strategy use as one moved toward expertise, at least to a point. When individuals reached a certain level in their development, their focus was expected to shift away from knowledge acquisition to knowledge generation. It was at this point that the need for strategic effort was hypothesized to rise. The result overall was a predicted curvilinear relation between strategy use and expertise development. Regrettably this prediction was not upheld in empirical testing.

Basically, I perceived this setback as one of the necessary failures that are part and parcel of scientific speculation. Even the legendary Richard Feynman "warned us that we should be ready to fail, and that we would indeed mostly fail if we imposed our individuality on our science. But he still felt the risk was worth it" (cited in Magueijo, 2003, p. 168). As do I.

Recognition of the Power of Experimentation to Justify or to Modify Scientific Speculations

That dilemma did not cause me to abandon my views on the relation between strategies and expertise development entirely or convince me to adopt the prevailing beliefs. However, this situation did reinforce the power of experimentation to justify or modify scientific speculation and led me to explore the data with greater precision.

Specifically what was required was more systematic empirical examination of the problem. After all

> What ultimately saves us is that at the end of the day, experiment acts as the ultimate referee, settling all disputes. No matter how strong our hunch is, and how well it is articulated, at some point we will have to prove it with hard, cold facts. Or our hunches, no matter how strongly held, will remain just that. (Magueijo, 2003, p. 14)

What that experimentation—those hard, cold facts—revealed were differential relations between strategy use and expertise depending on strategy type. Specifically, there is a strong reliance on surface-level strategies for learners who are new to a domain or in acclimation. Such strategy use does, in fact, wane with increased expertise. Conversely, there is a noticeable increase in the use of deep-processing strategies for those who have acquired more principled knowledge in a target domain, that is, those who are more competent or proficient.

Value of Well-Crafted Texts and Measures

Working closely with Ruth Garner, and tracking the research at the Center for the Study of Reading, I also came to appreciate how essential well-crafted texts and measures meant in experimentation. Say "the wrestler/prisoner" text, "homebuyer/burglar" passage, "card players/musicians" text, or "balloon" passage to any cognitive or literacy researchers of that period and they immediately know to what you are referring (Anderson, 1977; Anderson, Reynolds, Schallert, & Goetz, 1977; Bransford & Johnson, 1973; Reynolds & Shirey, 1988). These texts were critical tools in helping to substantiate the legitimacy of information processing theory and schema theory.

Ruth Garner was truly gifted at devising the deceptively simple text or task that was the gateway to extremely novel and complex theoretical notions. Thus, with such brief paragraphs as the "Click Beetle" text (Garner, Gillingham, & White, 1989), she sparked a decade of research into seductive details, those highly interesting but low importance tidbits in text that distract from comprehension rather than reinforce it.

My colleagues and I carried on that tradition with our texts on Stephen Hawking and Grand Unification Theory (Alexander, Kulikowich, & Schulze, 1994). We used those texts to not only investigate the seductive detail effect but also to study how one's prior domain knowledge and interests served to mitigate that effect. This legacy for the well-crafted text continues into contemporary research, as evidenced by the use of refutational texts in studies of persuasion and conceptual change and the work on the relation between graphic illustrations and text. For instance, who in educational psychology is not familiar with the infamous, "Lightning Passage!!" (e.g., Mayer, Hegarty, Mayer, & Campbell, 2005).

In addition to the texts that were so critical to experimentation, there were a variety of measurements tools that we either created or adapted for the purpose of unearthing students' comprehension or strategic capabilities. Among those were prior knowledge measures, free recalls, a title generation task, completion tests, interest and importance ratings, summarization tasks, and the Test of Analogical Reasoning for Children (White & Alexander, 1986), a gamelike test for gauging analogical reasoning abilities in children between the ages of 3 and 6.

One concern that plagued me during this phase of my development was the tendency in research and in classrooms to treat responses on whatever measures as "right" or "wrong," when individuals' understanding typically lies somewhere between these poles. There are simply shades of rightness

and wrongness that often go unrecognized in our assessment practices, especially in the case of high-stakes achievement measures. My counter to that was to construct multiple-choice measures of domain knowledge that were built according to response models devised for particular age/ability groups. The distracters were then differentially scored on the basis of their distance from the correct option. The items displayed in Figure 1 were from a human biology measure for sixth graders. As a new doctoral student, Jonna Kulikowich cut her teeth on those graduated-response multiple-choice tests (Alexander, Pate, Kulikowich, Farrell, & Wright, 1989) an assessment procedure we continue to employ with a great deal of success (Alexander, Sperl, Buehl, Fives, & Chiu, 2004; Maggioni, Riconscente, & Alexander, in press).

We also devised domain-specific analogy tests in which content was presented both in the form of classic analogy problems and analogical and nonanalogical versions of extended text passages. Here again, the goal was to move beyond dichotomous scoring. What I was able to devise was a hierarchical scoring procedure for the classical problems that resulted in reliable and valid data and a much richer understanding of the interaction of knowledge and strategic processing (Alexander, 1990). Karen Murphy and Jonna Kulikowich were instrumental in helping me establish the legitimacy of this analogical reasoning hierarchy (Alexander, Murphy, & Kulikowich, 1998).

Benefits of Collaborative Inquiry

In *Faster Than the Speed of Light,* Magueijo (2003) discusses the pain of sharing his still fragile ideas about VSL with colleagues. However, as he makes apparent, theories cannot survive if they are not thrust into the light of public scrutiny:

Omnivore is:
- a. a breakfast dish made with eggs (NSI)
- b. an animal that has a trunk (SI)
- c. the lining of the stomach (BI)
- d. an organism that eats plants and animals (BC)

Inhale means:
- a. to take oxygen into the lungs (BC)
- b. large pieces of ice that fall from the sky (SI)
- c. the flow of blood into the heart (BI)
- d. to salute or recognize a superior (NSI)

Sperm means:
- a. the rejection of a hypothesis (SI)
- b. a curly hairstyle (NSI)
- c. the male reproductive cell (BC)
- d. a bacteria that destroys white blood cells (BI)

Epidermis is:
- a. the outer covering of the kidney (BI)
- b. an electric blanket (NSI)
- c. a disease of plants (SI)
- d. the top layer of skin (BC)

FIGURE 1 Sample items from human biology domain knowledge test, sixth grade. *Note.* BC = biology correct; BI = biology incorrect; SI = science incorrect; NSI = nonscience incorrect.

> If you shut yourself in your own little world, this will be the death of your theory. (p. 197)

More than merely asking others to listen to my ranting about MDL, what was required was collaborative inquiry. As with Magueijo (2003)

> I needed a collaborator; some things are just not made for lonely creation. I needed someone to bounce them off, to complement my failings, and to get me out of the mental jams. (p. 135)

Over the past 3 decades, I have been blessed with remarkable collaborators who challenged my thinking, complemented my failings, and got me out of mental jams. Among those collaborators are my former and current graduate students who continually infuse their thoughts and energies into my research endeavors.

Need For Conceptual Clarity

In discussing his obvious frustrations with the peer-review process—a process he has had to endure to gain acceptance of VSL—Magueijo (2003) spoke about the problems of linguistic precision to be overcome:

> Hopefully the definitions you introduce make the real content of the theory clearer. (p. 201)

Magueijo is not alone in this frustration. During those initial years of theory building there was a growing concern about conceptual clarity. Speculators must have conceptual road markers that keep them on the right path toward justified true beliefs. It was not long before I realized that conceptual clarity was not a salient attribute of educational research. Perhaps this is the nature of our field. Unlike some domains, in which terminology has specific and even mathematically precise meanings, the lexicon of educational research is often vague or ill-defined. There are many instances when constructs are perceived as so basic that they require no definition at all. However, theorizing requires conceptual specificity.

This became quite apparent when Diane Schallert, Victoria Hare, and I tried to make sense of the litany of knowledge terms within the field of literacy. The end result of that trying but extremely informative analysis was the "coming to terms" piece that remains highly cited (Alexander, Schallert, & Hare, 1991). Subsequently, I have engaged in similar conceptual analyses in relation to strategies with Steve Graham and Karen Harris. In that review (Alexander, Graham, & Harris, 1998), we explored critical conceptual questions including: What exactly is a strategy? How do strategies differ from skills? What is the distinction between general and domain-specific strategies? I was also privileged to work with Karen Murphy in her attempt to understand key motivational

constructs from the vantage point of someone acclimating to that expansive literature (Murphy & Alexander, 2000).

This need for conceptual clarity remains strong within educational psychology, as more recently evidenced by efforts to specify the boundaries between knowledge and beliefs or to come to grips with the nature of epistemological and epistemic beliefs.

Awareness of the Power of External Funding

There is another indelible mark that the Center for the Study of Reading left on me as an impressionable young scholar: the effect that a significant infusion of federal funding can have on the face of educational research. To this day, I have mixed feelings about the external funding process (Alexander & Buehl, 1999). I understand that academic institutions can no longer survive without it and that large grants can support graduate students who are in dire need of such support. Much of the work that entices me is never likely to match the interests of those funding agencies. Although I consider theoretical work to be the most basic of research, it does not fit the definition of basic espoused by funding agencies. I have yet to encounter the "dollars for theories" program into which my studies of academic development or the MDL fit nicely. Oh, that does not mean I would not give my eye teeth to be well funded in my efforts. As with others, I have worked hard to bend, fold, and almost mutilate my ideas, so that they seem fundable. However, I have long resolved myself that my square-pegs theorizing will never fit the round-hole priorities of federal funding. Maybe that is as it should be. Maybe that frees me from the constraints that funding places on my speculative pursuits.

My consternations regarding the granting process are not unique to me or even a problem solely of educational research. Magueijo (2003) labeled grant proposal forms as "old-fart certificates of existence" (p. 142). He further wrote:

> In reality, our financial survival depends on extremely bureaucratic institutions that manage scientific funding … . As a result, instead of spending our time discovering new things, we have to waste long periods yawning at never-ending meetings, writing stupid reports and proposals, and filling in endless forms that do no more than justify the existence of these institutions. (p. 142)

THE CRITICAL FORCES

What physicists like Magueijo recognize is that forces within nature do not operate independently. Changes in one central force manifest as predictable shifts in related forces. The same holds for the nature of learning, and after decades of walking the möbius strip that is theorizing, I was able to articulate certain interactions between critical forces in academic development. For example, with regard to the interface between subject matter knowledge and strategies, deduction and induction gave rise to testable hypotheses.

Specifically, it is projected that the need for strategic effort should diminish as the simplicity or familiarity of a task increases. Greater strategic effort should be required of less knowledgeable individuals, who paradoxically seem less equipped to execute appropriate strategies efficiently or effectively. Elegant strategic processing should come with increased knowledge and skill in a domain. Different domains should place varied strategic demands on learners as a consequence of the structure, perceived complexity, or familiarity of those domains, and different modes of strategic processing should be characteristic of learners at varying points in their domain learning (Alexander & Judy, 1988).

With each added variable, it became essential not only to accurately project the path of that variable over time but also to be able to anticipate its predictable effects on every other component in the model. Consequently, when interest is added to this mix, other critical interactions emerge. Thus, predictions surfaced about the degree to which quantitative and qualitative shifts in learners' subject-matter knowledge over time should be associated with a decreased reliance on situational interest and an increasing role for individual interest. Moreover, it was predicted that an increase in subject-matter knowledge should result, in part, because of learners' deepening involvement in the domain and their identification with that community of practice.

Similarly, predictions must explain the shifting relations between strategic processing and the two forms of interest. For example, it was hypothesized that the predicted increase in deep-processing strategies evidenced in later competence and proficiency/expertise should arise because of learners' increased interest in the domain, which, in turn, sparks and sustains efforts even when individuals confront highly complex problems and the frustrations that come with problem formulation.

The incorporation of each dimension into the theoretical model was never gratuitous. It was compelled by the data. It made empirical sense to incorporate knowledge, strategies, *and* interest into the MDL. Each addition brought domain learning into clearer focus. In other words, the more I came to know about the nature of individual interest and its development over time, the better I could interpret the quantitative and qualitative changes in domain-specific knowledge observed and the better I could understand the pattern in strategy use discerned.

I have not yet broached the issue of the tripartite interactions among knowledge, strategies, and interest that are the hallmark of the MDL and characteristics of those at particular points in their academic development. An extended discussion of these complex relations must be reserved for another time and place. The MDL does, in fact, predict specific interactions between and transformations in the knowledge, strategy, and interest triumvirate over the course of one's de-

velopment in an academic domain (Alexander, 1997, 2003b; Alexander et al., 2004).

This interplay is presumed to be in continuous flux, in response to the situation and the internal and external factors operating within that situation; what I have labeled the "phases" of the MDL. However, there is also the more stable configuration of knowledge, strategic processing, and interest that marks the individual as acclimated, competent, or proficient with regard to the target domain. This more stable configuration is what is called the stages of the model.

THE ENSUING CONFLICT

Where has this systematic program of research into the interplay of knowledge, strategies, and interest brought me? What is the current state of my thinking about the MDL that informs this conversation about theories and theorizing? If I were to put a title to this episode, it would be called "The Wrath of Complexity." I am afraid one lesson I failed to learn from Ruth Garner was how to keep it simple. Ruth was the paragon of minimalism. I, on the other hand, am drawn to chaos.

As I stated at the outset, scientific speculation cannot remain in the realm of simple conjecture. It must eventually withstand empirical test. That is as it should be. We are educational researchers who seek quantitative rigor, as do the physicists that Magueijo (2003) described:

> The truth of the matter is that we hate being qualitative … No matter how poetic we claim to be, we love and cannot live without quantitative rigor. (p. 21)

However, achieving quantitative rigor in the face of such complexity is daunting, to say the least. I truly understand Magueijo's (2003) frustration at attempting to convert "beautiful insight" into "concrete mathematical theory" with disaster threatening to strike at every turn (p. 21). The impending disaster for me traces to the inability of statistical procedures to keep pace with theoretical predictions. For instance, it is tough enough to find or create measures that produce reliable and valid data that permit the testing of specific model tenets. Even after 30 years, seeing into the "black box" of learners' thinking, accurately chronicling their strategic efforts, or uncovering their deeply held beliefs and interests is a risky venture.

There is also the nagging problem of variability. When you want to examine performance that runs the gamut from acclimation to expertise you face the real possibility of depressed scores on measures of subject-matter knowledge or individual interest among those in acclimation and a potential ceiling effect for those within expertise. The challenge of looking longitudinally at the shifting partnership of knowledge, strategies, and interest only compounds this measurement problem. Further, one of the key aspects of the MDL that has yet to be tested is the concept of phases. It is not only finding a viable means for tracking the moment-by-moment interplay among knowledge, interest, and strategies but also the way in which those continuous fluctuations eventually give rise to more stable profiles indicative of the stages in domain expertise.

Therefore, it is not simply that I require collaborators; I require collaborators with expertise in measurement and statistics who are willing and able to tackle the challenging tenets of the MDL. Such collaborators represent the "right people" that Magueijo (2003) believed "must come together" in science before any given project could "take off" (p. 7). One of those collaborators for me has been Jonna Kulikowich on whose creativity in measurement and statistics I have come to rely. However, the truth of the matter is that a model or theory must win the approval of those outside your academic family if it is to take hold. That battle is perhaps the hardest of all for speculative psychologists. Until the theorizing catches the eyes and ears of others, worms its way into their psyche, or becomes a frame for their empirical studies, its viability is at risk.

CONCLUDING THOUGHTS

I have written elsewhere about educational psychology's growing appreciation for its philosophical roots—a renaissance I applaud (Alexander, 2003a, 2004). Perhaps in this climate of openness, we, as a community, can more fully embrace the significance of scientific speculation and the need to nurture and encourage such speculation in our young scholars. Such encouragement would require us to rethink the mentoring that our graduate students and young professors receive as they move toward greater expertise in educational psychology.

Magueijo (2003) put my fears and my excitement about theorizing and scientific speculation well when he stated that

> I want people to understand the scientific process for what it really is—rigorous, competitive, emotional, and argumentative … . I also want the non-scientist to understand that the history of science is littered with speculations that sounded great but ultimately did not demonstrate explanatory power and ended up in the garbage bin of scientific inquiry. The process of trying out new ideas, and then accepting or rejecting them, is what science is all about. (p. 9)

It is my sincere hope that the theoretical model of domain learning and the foundational concept of academic development to which it relates have the explanatory power required to survive that garbage bin of scientific inquiry. I am committed to the continued testing and refinement of the MDL as long as I retain belief that such a model affords a broader and deeper view of the learning and the development that should be evidenced as a consequence of such learning. Further, it will be through the intricate blending of rationalism and empiricism that this testing and refinement will unfold—such is the life of a speculative psychologist, after all.

REFERENCES

Alexander, P. A. (1990, April). *Categorizing learner responses on domain-specific analogy tests: A case for error analysis.* Paper presented at the annual meeting of the American Educational Research Association, Boston.

Alexander, P. A. (1995, April). Stages and phases of domain learning: The dynamics of subject-matter knowledge, strategy knowledge, and motivation. In R. Garner (Chair), *Toward a multidimensional model of domain learning.* Symposium presented at the annual meeting of the American Educational Research Association, San Francisco.

Alexander, P. A. (1997). Mapping the multidimensional nature of domain learning: The interplay of cognitive, motivational, and strategic forces. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 213–250). Greenwich, CT: JAI.

Alexander, P. A. (2000). Toward a model of academic development: Schooling and the acquisition of knowledge: The sequel. *Educational Researcher, 29*(2), 28–33, 44.

Alexander, P. A. (2003a). Coming home: Educational psychology's philosophical pilgrimage [Special issue on "Rediscovering the Philosophical Roots of Educational Psychology"]. *Educational Psychologist, 38,* 129–132.

Alexander, P. A. (2003b). The development of expertise: The journey from acclimation to proficiency. *Educational Researcher, 32*(8), 10–14.

Alexander, P. A. (2004, April). Coming home: Educational psychology's philosophical pilgrimage. In P. K. Murphy (Chair), *Rediscovering the philosophical roots of educational psychology.* Symposium presented at the annual meeting of the American Educational Research Association, San Diego.

Alexander, P. A., & Buehl, M. M. (1999). An Escherian perspective: The recursive nature of reading research. *Issues in Education, 5,* 37–43.

Alexander, P. A., Graham, S., & Harris, K. (1998). A perspective on strategy research: Progress and prospects [Special issue]. *Educational Psychology Review, 10,* 129–154.

Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Educational Research, 58,* 375–404.

Alexander, P. A., Kulikowich, J. M., & Schulze, S. K. (1994). How subject-matter knowledge affects recall and interest. *American Educational Research Journal, 31,* 313–337.

Alexander, P. A., Murphy, P. K., & Kulikowich, J. M. (1998). What responses to domain-specific analogy problems reveal about emerging competence: A new perspective on an old acquaintance. *Journal of Educational Psychology, 90,* 397–406.

Alexander, P. A., Pate, P. E., Kulikowich, J. M., Farrell, D. M., & Wright, N. L. (1989). Domain-specific and strategic knowledge: Effects of training on students of differing ages or competence levels. *Learning and Individual Differences, 1,* 283–325.

Alexander, P. A., Schallert, D. L., & Hare, V. C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge. *Review of Educational Research, 61,* 315–343.

Alexander, P. A., Sperl, C. T., Buehl, M. M., Fives, H., & Chiu, S. (2004). Modeling domain learning: Profiles from the field of special education. *Journal of Educational Psychology, 96,* 545–557.

Anderson, R. C. (1977). The notion of schemata and the educational enterprise. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge* (pp. 415–431). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Anderson, R. C., Reynolds, R. E., Schallert, D. L., & Goetz, E. T. (1977). Frameworks for comprehending discourse. *American Educational Research Journal, 14,* 367–381.

Bransford, J. D., & Johnson, M. K. (1973). Consideration of some problems of comprehension. In W. G. Chase (Ed.), *Visual information processing* (pp. 383–438). New York: Academic.

Brown, A. L. (1975). The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10, pp. 103–152). New York: Academic.

Flavell, J. H. (1971). First discussant's comments: What is memory development the development of? *Human Development, 14,* 272–278.

Garner, R. (1987). *Metacognition and reading comprehension.* Norwood, NJ: Ablex.

Garner, R., Gillingham, M. G., & White, C. S. (1989). Effects of "seductive details" on macroprocessing and microprocessing in adults and children. *Cognition and Instruction, 6,* 41–57.

Maggioni, L., Riconscente, M., & Alexander, P. A. (in press). Perceptions of knowledge and beliefs among undergraduate students in Italy and in the United States. *Learning and Instruction.*

Magueijo, J. (2003). *Faster than the speed of light.* Cambridge, MA: Perseus Book Group.

Markman, E. M. (1977). Realizing that you don't understand: A preliminary investigation. *Child Development, 48,* 986–992.

Mayer, R. E., Hegarty, M., Mayer, S., & Campbell, J. (2005). When static media promote active learning: Annotated illustrations versus narrated animations in multimedia instruction. *Journal of Experimental Psychology: Applied, 11,* 256–265.

Murphy, P. K., & Alexander, P. A. (2000). A motivated look at motivational terminology [Special issue]. *Contemporary Educational Psychology, 25,* 3–53.

Reynolds, R. E., & Shirey, L. L. (1988). The role of attention in studying and learning. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation* (pp. 77–100). San Diego, CA: Academic.

Thorndike, E. L. (1910). The contributions of psychology to education. *Journal of Educational Psychology, 1,* 5–12.

Thorndike, E. L. (1924). Mental discipline in high school studies. *Journal of Educational Psychology, 15,* 1–22.

Thorndike, E. L., & Woodworth, R. S. (1901). The influence of improvement in one mental function upon the efficiency of other functions. *Psychological Review, 8,* 247–261.

Weinstein, C. E. (1995, April). Discussion. In R. Garner (Chair), *Toward a multidimensional model of domain learning.* Symposium presented at the annual meeting of the American Educational Research Association, San Francisco.

White, C. S., & Alexander, P. A. (1986). Effects of training on four-year-olds' ability to solve geometric analogy problems. *Cognition and Instruction, 3,* 261–268.

Winne, P. H. (2004, April). Discussion. In P. K. Murphy (Chair), *Rediscovering the philosophical roots of educational psychology.* Symposium presented at the annual meeting of the American Educational Research Association, San Diego, CA.