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REVIEW ARTICLE

# Evolution of a Learning Theory: In Praise of Scientific Speculation

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## Abstract

In 2006, after receiving the Division 15 Career Award, Alexander delivered a keynote address entitled "Evolution of a Learning Theory: A Case Study." This presentation was a clarion call for greater respect for and attention to scientific speculation in educational psychology as a critical component in theory building. To build her case, Alexander drew on the writings of a provocative cosmologist, Joao Magueijo (2003), as an analogy to the processes and experiences that led to the Model of Domain Learning (1997, 2003)—her theory of academic development. Within the published text of her presentation, Alexander outlined the confluence of factors that instigate or inhibit scientific speculation and the conditions that transform such speculation into empirically supported theories. For this topical collection, the premises, factors, and conditions touched on in that keynote delivered 16 years ago will be revisited and re-examined in light of contemporary practices and prevailing orientations in educational psychology.

**Keywords** Scientific Speculation · Academic Development · Theory · Theoretical Models · Theoretical Frameworks

## Evolution of a Learning Theory: Redux

> *Experience without theory is blind, but theory without experience is mere intellectual play.*

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Immanuel Kant, *Critique of Pure Reason*, 1899

In 2006, when Alexander was awarded the American Psychological Association Division 15's Career Award for her work on the Model of Domain Learning (MDL), she used the occasion of her invited address to call attention to a situation within the educational psychology community she found troubling. That situation was the lack of regard for and attention to scientific speculation, which she argued was an essential component in the formation of the MDL, and more generally, in theory building. Fundamentally, the MDL is a theoretical model of academic development that describes the journey from acclimation (novicehood) in any field of study to competence and, potentially, to proficiency or expertise. That journey is captured by the shifting dynamics of individuals' topic knowledge (depth) and domain knowledge (breadth) of the field; their use of surface-level and deep-processing strategies; and their reliance on situational interest (temporary and environmentally triggered) and individual interest (deep-seated and personally evoked). Each stage of the MDL is represented by a specific configuration of these six forces, which has been empirically tested in a range of domains from special education to mechanical engineering. As we will discuss in this treatise, the MDL took shape over many years, marked by a confluence of theory-building approaches undergirded by robust methodological techniques. Across all those years and varied approaches, however, scientific speculation remained front and center.

The nature of *scientific speculation* to which we refer is far from the pedestrian notion of speculation regarded as pure conjecture or unfounded opinions (Achinstein, 2018, 2022). Speculation that is scientific "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" (Alexander, 2006, p. 258). As Joao Magueijo (2003), the cosmologist, explicated in his volume, *Faster than the Speed of Light*, the ability to weigh evidence against perceptions and experiences, to embrace reasonable doubt, to seek alternative explanations for accepted "truths"—to "philosophize"—is at the heart of rigorous disciplines such as theoretical physics, cosmology, and theoretical mathematics. As this relates to the development of the MDL, the insights afforded by years of classroom teaching and observations of student learning combined with studies of knowledge, strategic processing, and interest still required certain leaps of faith that filled in the empirical spaces. This is the essence of scientific speculation that is core to theory building in general and the formation of the MDL in particular.

## Speculation and Psychology: A Tumultuous Relationship

In fact, the significance of scientific speculation to all manner of theoretical pursuits is not acknowledged only in such prized fields as theoretical physics or theoretical mathematics (Shan, 2022). It was once central to our own field of educational psychology. As Fodor (1975) detailed in the preface to his classic book, *The Language of Thought*, there was an established and well-regarded branch of psychology called *speculative psychology* within the academy.

> It wasn't quite philosophy because it was concerned with empirical theory construction. It wasn't quite psychology because it wasn't an experimental science. But it used the methods of both philosophy and psychology because it was dedicated to the notion that scientific theories should be both conceptually disciplined and empirically constrained. What speculative psychologists did was this: *They thought about such data as were available about mental processes, and they thought about such first-order psychological theories as had been proposed to account for the data. They then tried to elucidate the general conception of the mind that was implicit in the data and the theories* [our emphasis]. Speculative psychology was, by and large, quite a good thing: William James and John Dewey were speculative psychologists, and so, in certain of his moods, was Clark Hull. *But it's commonly said that there aren't any speculative psychologists any more* (p. vii) [our emphasis].

The italicized sentences in the prior quote reinforce the conception of scientific speculation we offered previously. In addition to declaring the death of speculative psychology, Fodor also described the confluence of forces that led to speculative psychology's demise as a respected discipline and its subsequent treatment within the academy as little more than a "methodological anomaly and administrative nuisance" (p. viii). Perhaps the most notable of those forces leading the charge against speculative psychology were E. L. Thorndike (1910, 1924) and his followers who sought to purge anything philosophical from the field of psychology; to replace pragmatism and progressive notions with a "new" experimental psychology; and, to cast scientific speculation as no more than mentalism.

There is ample evidence that Thorndike's influence has loomed large over educational psychology for many decades and, in many ways, served to silence the speculation of educational psychologists, writ large. For one, behaviorism, which was the theoretical manifestation of Thorndike's experimental psychology, pushed its way into every nook and cranny of human learning and performance well into the 1970s. There was a privileging of "true" experimentation, where elements of everyday situations like those commonly found in classrooms or contexts were purged in favor of more sterile and controllable laboratory conditions. There was the heralding of measurable data as the source of "truth" over the rich chronicling of human experiences (Murphy et al., 2023). Even with the onset of the cognitive revolution in the 1970s that dampened the community's enthusiasm for behaviorism, the desire for measurable, quantifiable outcomes continued to hold sway. Concurrently, philosophy treatises in journals and course offerings within colleges of education or psychology departments began to dwindle (Murphy et al., 2024). In fact, many of those forces that contributed to speculative psychology's fall in the early twentieth century still stand as impediments to theory divining today.

We wanted to call attention to Fodor's claim that there are no speculative psychologists anymore, because, in many ways, that is precisely how we would self-identify as educational psychologists. In fact, in defiance of such prevailing sympathies, Alexander (2006) proclaimed:

> 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. (p. 258)

Whether it is the MDL or the other theoretical frameworks, models, or principles we have contributed to the literature, all were born from a marriage of philosophy and psychology and a wedding of scientific speculation and empirical validation (e.g., Alexander, 1997, 2003, 2017; Alexander et al., 1996; Murphy, 2003, 2007; Murphy et al., 2011).

## The Model of Domain Learning in Brief

Alexander (2006) used Joao Magueijo's (2003) struggles to gain support for his controversial Varying Speed of Light theory—a disputation against Einstein's well-established theory—as a metaphor for her efforts to formulate, refine, and validate the MDL (1997, 2003, 2017). The apt subtitle for Magueijo's book documenting his struggles was *The Story of Scientific Speculation*. However, the role of scientific speculation in theory building is, by no means, a contemporary realization. Rather, we want to emphasize the deep philosophical roots of scientific speculation with the opening quote attributed to Immanuel Kant, likely a loose translation of a passage from the *Critique of Pure Reason* (1781). In this tome, Kant explored the role and limits of reason as it relates to theory, self, and practical matters. Of note, in Kant's first and third critiques pertaining to theoretical and practical reason, respectively, he sheds light on the explanatory role of reason in empirical judgments (Williams, 2023). In essence, theoretical divining at *any level* requires empirical judgments by the reasoner to fill in the spaces that invariably exist between sensory experience and conceptual understanding. Further, those levels encompass "grand" theories, to borrow Dickmeyer's (1989) term for the highly influential theories, as well as theoretical frameworks, models, and principles (Achinstein, 1963).

Moreover, when we refer to theories or theoretical development in this treatise, we unapologetically espouse a rather liberal orientation. That orientation, as Kant's quote emphasizes, is dynamic and bidirectional in nature. It fluxes between experience and theory and between empirical data and reason, as those engaged in theoretical divining seek to describe or explain phenomena that exist. To be sure, we endorse the idea that a myopic focus on facts hobbles the process of speculation and that as a field such a focus has likely stunted our theoretical growth. As Greene (2022, p. 3014) noted, theories can "productively organize empirical literature, differentiating promising from not-so-promising" paths. We acknowledge that approach to theorizing, while advocating a robustness in speculation that has no

strong need for premeditated or immediate validation. As it pertains to human learning and development, speculation is a wellspring for theorizing about, around, and with phenomena as they exist in situ. That is certainly how the seeds of the MDL took root.

Long before the MDL was captured in crafted text and empirical data, it began to grow in the dynamic interplay of teacher and student in formal school settings. When Alexander entered the doctoral program at the University of Maryland to study reading under the mentorship of Ruth Garner, she had spent nearly a decade teaching middle school students. There is no way to be an effective teacher of this or any age unless educators pay careful attention to the patterns and the rhythm of students' actions and responses, and unless teachers reflect on what particular lessons or tasks worked for some students on certain days but not all students or all days. It was the need to understand the patterns that Alexander witnessed in her students, combined with an ardent desire for them all to grow and thrive academically, that ultimately drove her to pursue a doctorate in reading. Further, it was those years of systematic observation of learning as it unfolded in *real* classrooms with *real* students that were the taproot of Alexander's investment in academic development and the catalyst for the body of empirical studies that inspired the MDL.

Of course, the understanding of learning acquired as a practicing teacher was a necessary but certainly not sufficient condition for building the MDL. The seeds planted via observation and reflection needed to be nurtured by other means. All emergent descriptions or explanations resulting from initial or repeated speculations had to be set against the knowledge that existed within the scholarly literature and had to withstand empirical validation if they were to be judged as viable. Scientific speculation remains a core feature of the ongoing process of theorizing. Through scientific speculation, the underlying threads within the literature, the contrasts and similarities within existing theories, and the intricate patterns among elements in nature were analyzed, assembled, and represented.

Although some of the theories highlighted in this topical collection may have developed in a holistic manner, such was not the case for the MDL. Rather, the MDL is a prime example of a theoretical assemblage resulting in the initial theory and its initial form. The initial stage of the model took the shape of a hypothesized relation between individuals' strategic processing and their domain knowledge base. The first step was a systematic review of the literature examining "The Interaction of Domain-Specific and Strategic Knowledge in Academic Performance" (Alexander & Judy, 1988). This was then followed by a series of studies carried out with middle-school, high-school, and college students in the domains of human biology and immunology (Alexander et al., 1989) and social studies (Pate et al., 1989), funded by a Spencer Postdoctoral Fellowship.

That review of the literature and the empirical studies served to counter the prevailing wisdom that higher-performing students should engage in more strategic processing than students who were not as high performing, regardless of what they knew about the subject. In fact, the key finding of this stage was that the breadth and depth of individuals' subject matter knowledge are factors in whether strategies are implemented more or less often and what forms of strategic processes are more frequently evidenced. Thus, individuals with limited domain or topic knowledge and

little individual interest in the content will frequently call upon surface-level strategies to make sense of the problem at hand. Conversely, individuals with a relevant body of subject-matter knowledge who are personally invested in the domain or task will employ more deep-processing strategies that let them reframe, transform, or think creatively about the problem.

What came next in the building of the MDL was the realization that subject-matter knowledge and strategic processing were insufficient to explain the patterns in student learning and performance that we observed. Students' interest in the task or the domain began to emerge as a significant force in their learning; not just in that moment (situational interest) but over time and over an array of domain-specific pursuits (individual interest). Further, in a series of empirical studies, we identified significant associations between students' knowledge, their strategic processing, and their level of situational and individual interest (Alexander et al., 1994, 1996, 1997, 1998). With this interrelation among domain knowledge, strategic processing, and interest articulated, the general structure of the MDL was in place, although further scientific speculation was required in subsequent years as various refinements were made in the model.

One of the earliest refinements came when the hypothesized curvilinear relation between knowledge and the unidimensional construct of strategic processing in Alexander (1997) was replaced by the two forms of strategies (surface and deep) that behave very differently across the stages (Alexander, 2003). The other came in converting the stage of competence into three substages—early, middle, and late competence—each with varying patterns in the interplay of knowledge, strategies, and interest. Both these modifications resulted in a significantly better fit to the data gathered in the ensuing years of empirical study. However, over the years, the work of refining and elaborating the components of the MDL has been taken up by others as well (see Fives & Dinsmore, 2017 for a compilation of relevant research). For example, the work of Dinsmore and colleagues (Dinsmore & Alexander, 2012; Dinsmore et al., 2020) has been especially significant in the refinement and elaboration of the distinctions between surface-level and deep-processing strategies.

Our purpose in dredging up these *past events* related to the demise of speculative psychology as well as the emergence, development, and refinement of the MDL is to lay the groundwork for three critical questions related to the *present* and *future* of theory development in educational psychology. Neither we nor the field has remained dormant in the 30 years since the first theoretical work was published on the MDL (Alexander, 1997), iterative investigations took hold (e.g., Alexander et al., 1994, 1996, 1997, 1998). As educational psychologists, we have continued to devise, revise, and empirically test theoretical frameworks, models, and principles (e.g., Alexander, 2017; Murphy, 2018). Over the past decades, we have also witnessed subtle and dramatic shifts in the theoretical landscape in which this discipline is situated (Murphy et al., 2023; 2024). Yet, where have those personal and disciplinary changes brought the educational psychology community in terms of scientific speculation and theory development? That is the critical question we ponder for the remainder of this treatise.

As we consider the present state of affairs, we first focus on lingering concerns and deeply entrenched beliefs that, in our estimation, undermine scientific

speculation and, thus, remain obstacles to theoretical pursuits. Then, on a more optimistic note, we highlight several emerging trends that offer a glimmer of hope that scientific speculation and theory development may be experiencing a reawakening. As for the future of theory development, we have chosen to engage in scientific speculation. To be more precise, we will draw on the past and present in educational research to identify forces and conditions that seem essential to instigate a revaluing of scientific speculation and a renaissance in theory development.

## Contemporary Forces and Theory Development

So, where is the field of educational psychology now with its relationship with scientific speculation and theory building? Are there barriers to theoretical pursuits that have continued unabated since Fodor wrote *The Language of Thought* in 1975? Have new impediments emerged since Alexander delivered her address in 2006? Or, have there been transformative events that have prepared current community members to embrace the uncertainty that comes with generating theoretical frameworks, models, or principles? We first examine the less facilitative forces that stand in the way of the MDL's construction and theory development in general before exploring conditions that bolster the ability to engage effectively in scientific speculation.

### Barriers to Theoretical Insights

Perhaps there are readers of this article under the impression that the concerns heralded by Fodor (1975) or Alexander (2006) are but relics of a distant past. On the contrary, there is ample evidence that such beliefs warrant reappraisal (Eronen & Bringmann, 2021; Greene, 2022). In fact, there are those who claim that theory development in psychology is in crisis (Eronen & Bringmann, 2021) due in large part to a limited "shelf life," that is, the tendency of theories to come and go. Whether that be the case, the question we ponder here is "Why?" What forces, factors, or conditions hamper educational psychologists from engaging in theory building or complicate their abilities to forward viable theories? Here, we propose multiple forces, factors, or conditions that were barriers to our construction of the MDL and that can undermine any theoretical pursuits related to human learning and development.

### Prevailing Values in Psychology

Within psychology, there are invariably shifts in the theoretical and empirical landscape that have a direct bearing on the theories that hold sway over the terrain (Alexander et al., 2009). Pragmatism lost ground to behaviorism, which then fell out of favor when cognitive orientations appeared on the horizon, and onward to more sociocultural and cultural-contextual perspectives of learning and development (López, 2022; Vargas & Saetermoe, 2023). We have witnessed at least five such shifts in our careers. Do those inevitable shifts that push theories of learning

and development off center stage mean that those frameworks, models, or principles simply vanish, along with any insights or perspectives they afforded?

If the realm of human learning and development existed as a true dichotomy where only one prevailing theory could be deemed correct, then perhaps that would be the case. In reality, however, many theories over the ages afford meaningful glimpses at one sector of human learning and development or another. Moreover, none have captured the full and complex panoramic vista of the learning phenomenon—perhaps no theory can. This theoretical conundrum was the premise behind the theoretical treatise, *What Is Learning Anyway?* (Alexander et al., 2009). The authors, who represented different theoretical positions on learning, sought to position contrasting theories within a topographical framework. That resulting framework illustrated how each contrasting theory described certain dimensions of learning well, but from very different vantage points. Consequently, those diverse theories are able to co-exist within the broader landscape, dispelling the myth of one all-encompassing theory able to explain all facets of learning in all its true complexity.

Further, we would contend that these shifting values are important for the field, particularly when dominant paradigms are queried and laid bare for examination (DeCuir-Gunby & Schutz, 2014). What remains problematic is that scholars, us included, are sometimes so siloed in their thinking that they fail to explore the diverse landscape of theoretical possibilities and invoke habitual thinking and practices (Murphy et al., 2023). This issue came into play when the conception of expertise development in MDL was set in contrast to the dominant theory of the time (Ericsson, 2014; Ericsson & Smith, 1991) and had to initially fight for its own theoretical space. For one, the MDL consisted of three stages rather than the novice versus expert distinction. For another, the MDL's orientation was at the level of academic domains rather than diverse problem solving areas such as chess, medicine, and physics. Finally, one of the most noticeable differences was that the MDL stepped beyond cognitive variables such as knowledge, memory, and problem-solving strategies central to the dominant theory to embrace the motivational construct of interest.

### Insufficient Training and Mentoring Opportunities

A repeated lament within the educational psychology literature, past and present, is that the new generation of academics is ill-prepared to tackle the demands that come with theory building (Dickmeyer, 1989; Eronen & Bringmann, 2021). This is certainly a concern that we have voiced over the years (Alexander, 2006; Murphy et al., 2024). One of the root causes identified for this woeful state of affairs is the lack of adequate training that young scholars receive in theory development (Gray, 2017). We do not disagree with that observation, although our interpretation of the manner of training that is required varies from what is often described. To be more precise, much of the rhetoric surrounding theory development emphasized the need for rigorous preparation in measurement and statistics. Nowhere is the weight on quantification more apparent than in Suppes's (1974) Presidential Address to the

American Educational Research Association, where Dewey's approach to theorizing was treated with veiled disdain:

> Although in many respects John Dewey can be identified with the development of the empirical tradition, it is important to note that his work and that of his close collaborators is not notable for the sophistication of its scientific aspects; Dewey himself, it can properly be said, continually stood on shifting ground in advocating empirical and innovative attitudes toward teaching. In fact, one does not find in Dewey the emphasis on tough-minded empirical research that one would like, but rather a kind of hortatory expression of conviction in the value of methods of inquiry brought directly to the classroom, and indeed more directly to the classroom than to the scientific study of what was going on in the classroom. (p. 4)

We certainly have urged our graduate students to have a rich repertoire of empirical methodologies at their disposal: quantitative, qualitative, and mixed methods. Yet, we are also well aware that no manner of sophisticated analyses will prove adequate for theoretical divining. Data, whether scores on a measure or words in a transcript, bear no "truth." Further, knowledge of methods can also serve as a limiting factor both in terms of those methods that researchers understand and those that have yet to be developed. In essence, methods can very easily limit our speculation. As a case in point related to the MDL, Alexander has long prognosticated about phases of change that are more subtle and potentially, recursive, within and across the stages of the MDL. Until very recently, no methods existed to validate the existence or impact of these phases of change. As such, we contend that whatever insights those data may convey about human learning and performance must be revealed by theory and by experiences of the very phenomenon they represent. In this way, our position on training coincides with Gray's (2017) admonition that "the more we focus on methodological details, the less we notice the broader connections" (p. 731).

For more than 20 years, we have stood alongside others, like Krista Muis, Frank Pajares, and Paul Schutz, to proclaim the value of philosophy in enhancing students' ability to theorize (Alexander et al., 2012; Murphy et al., 2024). Through philosophical studies, young scholars are urged to reflect, question, doubt, criticize, reason, and more—all essential tools in theory building. As philosophy course offerings dwindle within educational psychology programs, this call for more opportunities for young scholars becomes even more dire. Those who mentor this young generation must, themselves, be comfortable with philosophizing about foundational issues relevant to learning, development, and performance. After all, they are the role models that significantly shape the path their academic progeny will likely follow.

## Constrained Knowledge and Bounded Perspectives

As just described, the formation of the MDL required that we not only extended the boundaries of the existing theories of expertise but also interjected concepts and constructs aligned with other disciplinary orientations, including motivation, learning, and development. As we realized from the construction of the MDL, theorizing

at any level is challenging for individuals because they must be willing and able to push beyond the known and accepted. Theorists must also be open to and even seek out concepts, principles, and methods rooted in other disciplines. However, as pointed out, the training that many receive in graduate programs most often reinforces the known and accepted and affords little opportunity for interdisciplinary exploration (Murphy et al., 2023). In effect, graduate students spend much of their time *learning about* existing theories but little, if any time *learning how* to theorize. This is understandable to a certain degree, of course, in that these emerging scholars must be familiar with the known and accepted before they are equipped to push boundaries and pose theoretical alternatives. However, training that does not invite scientific speculation into the unknown or welcome interdisciplinary ways of thinking may not foster theorizing or theory building. Anecdotally, the results of this orientation can be seen in those graduate students struggling to formulate a coherent theoretical framework or laboring to find meaningful patterns within a body of literature or a rich dataset. For many, these theoretical challenges seemingly continue beyond graduate school.

Our insights into the aforementioned barrier, come, in part, from our editorial experiences. Together, we have served as senior editors or associate editors for seven major journals in our field and editorial board members for at least 15 other venues. What these roles have shown us, time and again, is that those engaged in empirical research often demonstrate a rather superficial knowledge of their subject—one that rarely examines the topic historically or in an interdisciplinary way. The vastness of the educational literature notwithstanding, it becomes a serious impediment to theory building—even at the level of frameworks or models—if individuals do not have a wealth of knowledge that they can bring to bear.

The historical context also becomes a significant factor in analyzing and critiquing empirical writings because the prevailing conditions of the time can matter greatly to what ideas are valued and who is free to give voice to established notions about human learning, development, and performance. Although as White women of a certain age and living in the United States, we are privileged in a way that permits us to speak against established theoretical ideas, that was not always the case. Even in the 1970s and into the 2000s we had to confront the biases and small-mindedness of others who felt that we had little right to engage in theoretical pursuits. We greatly appreciate how much more other members of our educational psychology community have struggled and continue to struggle to have their ideas heard or to have their methodological approaches valued and respected (DeCuir-Gunby & Schutz, 2014; Fong et al., 2019; Matthews & López, 2020; Schutz, 2020). Yet, as is evident in the contributions to this special issue, those very voices are the catalysts for theoretical transformation that our discipline has sorely needed.

### Established Culture Within the Academy

The last barrier to theoretical pursuits we want to forward is one that we have not heard voiced in the extant literature. Nonetheless, it remains a major impediment to the nurturing of theoretical pursuits in aspiring, young, and even mid-career

scholars—the very culture of the academy. The value system of the academy puts a premium on the productivity of young faculty: the number of journal publications, the h-index, and the grant dollars. These pressures can severely limit the ability of academically young scholars to immerse themselves in schools and communities to gain requisite experiences or to develop studies that address problems identified by or in collaboration with stakeholders. Those evident or implied constraints may stifle individuals' willingness to delve into literatures beyond those frequently cited or directly related to their primary construct. Further, those voiced or unvoiced pressures can also dampen young scholars' inclination to criticize what are commonly accepted viewpoints or constructs.

Rather, scholars are driven to churn publications, often through involvement with large teams of co-investigators; chase grant dollars; and compete with their colleagues for citations. This "production-driven" focus leaves, it seems, little time for the kinds of deeply cathartic syntheses necessary for theories, models, or frameworks to be birthed and refined. The time and investment required to build theoretical frameworks, models, or principles, combined with limited training and mentoring, constitute a formidable barrier to enticing many academics in psychology from diving head-first into theory development. Unless the value system that accompanies the hiring, retention, and promotion of faculty in colleges of education or psychology programs undergoes a significant transformation, then it is unlikely that we will see a surge of theoretical pursuits within the educational psychology community anytime soon.

We understand these professional constraints. We lived them ourselves to some degree. Inevitably, there were periods of time when we fought for the credibility of our theoretical ventures (Alexander & the Disciplined Reading and Learning Research Laboratory, 2020; Alexander et al., 2016; Murphy, 2007; Murphy et al., 2009), including the MDL. Until these alternative ways of thinking about academic development, quality discussions, or relational reasoning gained traction in the educational psychology community and in the research literature, we had to accept negative, sometimes scathing, reviews and frequent rejections. Nonetheless, with persistence, refinement, continued experimentation, and the support and encouragement of others, traction was eventually realized, and with it, greater acceptance of our theoretical frameworks, models, or principles.

## Bolsters to Scientific Speculation

We now want to consider more encouraging signs that have appeared on the horizon over the last 30 years that give us reason to hope that scientific speculation and theorizing will become more valued pursuits within the educational psychology community. By mentioning the support and encouragement of others in the prior section, we want to make clear that the "success" of any theoretical endeavor, including the MDL, is never attributable to the efforts of one individual or group of individuals. There are forces within any community of practice, such as educational psychology, and within the broader social, cultural, and even physical context that can help to move theoretical pursuits forward, as they have with

the MDL. Further, in order to remain viable, the MDL, as with other theoretical frameworks, models, or principles, must be able to respond to whatever new conditions or opportunities arise. Here we consider emerging conditions that can support scientific speculations and steps that are or should be pursued to promote the viability and utility of the MDL.

## Reappraisal of What Counts as Viable Evidence

While the admonition of scholars like Suppes (1974, p. 4) to stay on the path of "tough-minded empirical research" still echoes loudly in the halls of academia, there are now other voices that can be heard. Those voices call for a reappraisal of what the community counts as evidence in support of theoretical premises and postulations (McCrudden et al., 2019). The place of honor that "true" experimentation holds comes from the underlying belief that the data produced in tightly controlled environments, free from contaminants found in nature, are the purveyors of "truth." Yet, there is a growing realization among educational researchers that the dictum, "*In numeris veritas*" (truth is in the numbers), has constrained the ability to recognize evidence found in other forms (Matthews & López, 2019; Murphy et al., 2023; Schutz, 2020).

This reappraisal seems critical, especially for those seeking to understand human learning, development, and performance that exist in innumerable habitats and in seemingly infinite varieties, which is the ultimate aim of a theory like the MDL. Although there is merit in searching for evidence with controllable and more easily "testable" conditions, there is power in the ability to discern and describe patterns that emerge from systematic and repeatable observations of phenomena "in the wild" (Greene, 2022). Consider the lasting impact of the descriptive theories of Vygotsky, Piaget, Bronfenbrenner, Bandura, and others that took form through observations of phenomena as they exist in situ. We appreciate that observations without subsequent empirical testing are incomplete (Greene, 2022). Yet so are experimental results that cannot thrive in naturalistic conditions or that do not conform to observable patterns.

We praise the push for studies carried out in more dynamic and more ecologically valid settings in homes, schools, workplaces, and other social spaces where learning happens (Murphy & Cromley, 2015; Murphy et al., 2022). In the past decade, research into academic development has benefited from the re-valuation of evidence (Fives & Dinsmore, 2017; Firetto & van Meter, 2018). Further, the MDL has been investigated qualitatively, quantitatively, and in mixed-method studies; by means of variable-centered and person-centered analysis; and in domains as diverse as teacher education, engineering, educational technology, and special education (Alexander et al., 2004; Kulturel-Konak et al., 2015; Lawless, 2017). In sum, we applaud this reappraisal of what counts as evidence, and the increased acceptance of more dynamic, if less "controlled," environments as naturalistic laboratories for investigation. It is our contention such studies have value *not in spite of* these environmental imperfections *but because of them*.

### Changing Perspectives and Shifting Understandings

Among the prominent forces supporting scientific speculation and theoretical pursuits are the changing perspectives that have emerged within the educational psychology community. With those changing perspectives, new insights have entered into the community's consciousness and, with it, shifting standards and understandings. Especially in the last decade, there has been a long overdue sea change in our conscious awareness of the treatment of sociocultural identity markers like race, ethnicity, sociocultural background, and sexual orientation in empirical research and in theorizing (e.g., Boveda & Annamma, 2023; Boveda & Weinberg, 2022; DeCuir-Gunby & Schutz, 2014). For educational psychologists trained in a post-positivist research tradition, such a reframing requires an intentionality to which many of us are unaccustomed. It is no longer viable to assume that the values and standards of what the indigenous philosopher and poet Viola Cordova (1992) called "Euroman"—White, Western colonizers—represent the values and standards for all people. Indeed, such an ideology allowed those who enslaved others and stole their lands to see the non-whites as "less than" (Brayboy, 2005, Murphy & Alexander, 2023; Paris, 2019).

Similarly, although many of us have engaged in international research, much of this work can best be characterized as colonial. That is, the implementation of interventions in novel contexts with little attention, thought, or input from our research partners, much less from those with indigenous knowledge of import. We have seen a shift, albeit emerging, toward decolonizing our scholarship and our journals (e.g., Kumar & DeCuir-Gunby, 2023; Nolen, 2020). We recognize that many educational psychologists will need time to develop their own personal and professional understandings around a truly collaborative, critical pragmatist approach to scholarship. Nonetheless, the creation and promotion of theories, frameworks, or principles about learning, development, and performance that continue to center dominant, Western cultures and peoples are more likely to be negatively scrutinized.

What these new perspectives and values within the educational psychology community have effectively done is to shake the very foundation of empiricism; bring into question long-held theories and models; and pull the proverbial rug from under those who continue to advocate dominant-only paradigms and practices. Consequently, the door is now open for a new order of scientific speculation and theoretical divining—one that lifts the voices of those historically and contemporarily marginalized, values diverse forms of knowledge and ways of knowing, and embraces the local knowers with whom we work and seek to collaborate. This is unquestionably one of the significant shifts to which the MDL must respond if it is to remain useful. Among the relevant questions that merit exploration include whether the interplay of knowledge, strategies, and interest framing the MDL follows a similar trajectory for non-Western populations educated in non-Western educational institutions.

### Global Problems and Interdisciplinary, Intercultural Problem-Solving

Related to the new perspectives and shifting values just described, there has been a concomitant investment in problems of global importance. Even as members of the

community continue to focus on very particular factors and variables like discussion (Chen & Luo, 2021), others embrace broad issues and constructs that iterate across many countries and cultures such as academic flocking and global distress (Ebersöhn et al., 2021). With this push toward learning, development, and performance concerns that cross national borders, efforts to forge theoretical frameworks, models, and principles demand collaboration and cooperation. They also benefit from those with differing areas of expertise and who come to the ongoing collaboration with diverse cultural backgrounds and sensitivities. The pressing concern over the learning and well-being of immigrant and refugee children, youth, and adults that now populate countries across the globe stands as a clear example of worldwide problems that demand international and intercultural theorizing (Cerna, 2019; Gagné et al., 2021; Kim et al., 2023). We have been concerned as to how the developmental trajectories captured in the MDL are impacted by such global events as the pandemic, ongoing conflicts such as those in the Middle East and Europe, and the growing numbers of climate refugees. Of course, these questions not only require international collaboration and cooperation but also the investment in longitudinal investigations.

We have also been part of several global initiatives in recent years. One of those initiatives, which involves dozens of scholars from nine countries from the northern and southern hemispheres, is tackling the issue of students' reasoning and critical thinking when learning from online sources that often can communicate outdated, less credible, poorly substantiated, and even intentionally biased and distorted information (Alexander et al., 2016; Sefhedi et al., 2021; Wei et al., 2021). We are also part of multiple international collaboratives that have the shared mission of creating more student-oriented learning environments (Ebersöhn et al., 2021; Wei & Murphy, 2019). In those learning environments, students are afforded greater interpretative responsibility for what they read, see, or hear (e.g., Chen & Luo, 2021). The ultimate goal is that students, with teacher support, will be the ones who pose and ponder relevant questions about the topics they are studying, who discuss their differing perspectives on those questions through quality discussions, and who seek to come to shared understandings (Murphy et al., 2022).

We are also interested in pursuing studies with colleagues in South Africa that integrate the theoretical predictions and structure of MDL with ongoing research in resilience among struggling populations (Ebersöhn, 2008, 2020). Such global initiatives have fueled scientific speculation and theoretical pursuits because they require participants to balance the shared goals with the sociocultural diversity that will invariably exist. There can be no singular "gold standard" in what topics these researchers, teachers, and students find appropriate; no one-size-fits-all assessment, which carries the same meaning from one country to another or from one cultural enclave to the next.

## How to Foster Scientific Speculation and Theory Building

In light of the insights garnered from the evolution of the MDL and other models we have proposed over the years, we want to conclude this treatise with guidelines that we believe can address the paucity of scientific speculation and theory building

that presently exists in the educational psychology community. We do so with the understanding that struggles to embrace scientific speculation and engage in theory building can be rectified through dedicated effort. Moreover, we focus these guidelines on the nurturance of the next generation of scholars—those whose theoretical frameworks, models, or principles will eventually come to populate the literature in our field.

### Create a Learning Environment Where Students Have More Interpretative Authority

One characteristic of schooling that has been well-documented in the literature for centuries is that the students' role in classrooms is to *listen and learn* (Cazden, 1988; Mehan, 1979; Nystrand, 1997). That dictum can be loosely translated into "speak when permission is granted and respond with answers that teachers expect." Such a learning environment has deep and lasting effects on what students, especially highly successful students, come to believe is the path to excellence (Murphy et al., 2022). Although such compliant behaviors may result in better grades, they can stifle the willingness and ability to engage in scientific speculation and theorizing. This is particularly the case in which graduate students understand there to be a deeply embedded, hierarchical power structure between faculty and students. Learning environments where students feel empowered to *ask* rather than *answer* questions, to *disagree* or *dispute* rather than *accept* or *regurgitate* what they hear as unassailable facts are environments we hold as more conducive to scientific speculation and theory building. Students should also feel that they are free to take risks in their thinking and their ideas; that is, to speculate, explore connections, and build plausible explanations through generalization and analysis (Murphy, 2018). When "right" answers are given in classrooms and acknowledged, the dialogic door is substantively shut. An ongoing discussion must offer space for counterpoints or alternative ideas, and individuals must recognize the value in probing and reframing what others have to say (Murphy & Firetto, 2018).

While learning environments with these attributes are rare indeed in the K-12 system, we also doubt that they are commonplace in college classrooms or even in graduate courses. The doctoral students in our programs, for example, take many classes in research methods but few, if any, classes that center on philosophizing or theorizing about concepts and constructs in ways that entice them to deeply explore and assume interpretative authority of ideas and content. Yet, without environments that welcome students as partners in learning and as individuals whose ideas and questions are to be valued, the potential for fostering the next generation of speculative psychologists and theorists is greatly diminished.

### Make Critical Analytic Thinking a Centerpiece of Learning and Development

Orchestrating a learning environment that promotes student agency and interpretative authority is a necessary but not sufficient step toward fostering scientific speculation and theorizing. Students need to hone their abilities as critical analytic

thinkers (Alexander, 2014; Byrnes & Dunbar, 2014; Miele & Wigfield, 2014; Murphy et al., 2014). There is ample evidence that *higher-order thinking* and *critical thinking* are among those highly prized, often touted, but poorly understood processes of well-educated minds (Alexander, 2023). What these constructs fundamentally signify is individuals' engagement in some manner of reflective thought rather than a more reactive response. Further, the markers of such reflective thought are commonly represented by a litany of cognitive processes presumed to require thoughtful consideration: synthesis, analysis, inferencing, explanation, critique, and evaluation (Alexander, 2023). What we find problematic about this listing of worthwhile mental exercises is *when*, *where*, and *how* students are taught to enact these processes appropriately or to judge the results of that enactment.

Further, although the cognitive effort needed to execute any of these processes would certainly exceed that associated with spontaneous, reactive utterances or behaviors, we hold that even more is required to promote the form of critical-analytic thinking that underlies scientific speculation and theorizing. Specifically, we advocate for critical-analytic thinking—a wedding of critical thinking and analytic reasoning—as an essential component of scientific speculation and theorizing (Alexander, 2023; Murphy et al., 2023). This merger of critical thinking and analytic reasoning should result in "an examined understanding of something known or believed" through "a systematic evaluation of the object of thought and claims, reasons, and evidence forwarded about that object" (Murphy et al., 2014, p. 563).

Such systematic evaluation relies on two critical elements, epistemic competence and epistemic justification. *Epistemic competence* is the determination of the forms and depth of evidence the question, problem, or issue at hand requires (Alexander, 2016; Murphy & Alexander, 2016). *Epistemic justification* is the stance or position that can be rightly held about the question, problem, or issue based on the evidence gathered (Alexander & the Disciplined Reading and Learning Research Laboratory, 2012; Murphy, 2018; Murphy et al., 2011). Neither achieving epistemic competence nor effectively justifying one's stances or positions occurs easily or instinctively for the vast majority of individuals. It comes through guidance, nurturing, and valuing of those complex processes. Nonetheless, if the goals of scientific speculation and theorizing are to become more commonplace within the research community, then guidance, nurturing, and valuing must become hallmarks of the educational experience for all learners.

## Healthy Skepticism and Doubt

To this point, the keys to fostering scientific speculation and theorizing that we have described have been focused on learning environments and experiences. There are also characteristics of individuals that interface with those environments and experiences to augment or abate their benefits. One of those characteristics that we have found vital to our empirical endeavors and integral to our theorizing is the maintenance of a healthy level of skepticism (Burnyeat, 1983; Putnam, 1981) or Peircean "doubt" (1877). If individuals approach learning with the notion that what they read,

hear, or see should be taken at face value, they are unlikely to critically analyze information they encounter or to share their thinking publicly.

In some of our curricular intervention work in schools with teachers and students, we have students query what they read or see with questions about the nature of reasons ("Why do you think that?") and sources of evidence ("How do you know that?"; Murphy & Firetto, 2018). We also developed an approach to assist students in carefully weighing the viability of evidence called the ARC test. In submitting evidence to this test, students learn to query the A-accuracy, R-reliability, and C-credibility from a wide range of oral and written sources. We found that students readily invoked this test and increased their argumentative reasoning abilities (Murphy et al., 2018). In essence, healthy skepticism opens the mind to scientific speculation when doubt gives rise to alternatives that are congruent with experiences and supported by sound evidence.

Researchers who include measures such as Need for Cognition (Cacioppo & Petty, 1982) in their studies seemingly understand that there are individuals who draw pleasure from challenging their minds. However, healthy skeptics allow room for doubt in their mental pursuits. They are the ones who are prone to interrogating, reframing, or evaluating rather than just accepting—individual characteristics that seem invaluable to scientific speculation and theorizing (Steup & Neta, 2020). As with any individual characteristic, healthy skepticism may take the form of a rather stable trait. However, it is rare to find young minds who are not naturally inquisitive and prone to asking when, where, or how questions as they try to make sense of the world. Perhaps such natural curiosity or healthy skepticism fades over time as students become practiced in the ways of schooling. We hold to the position that healthy skepticism is a malleable characteristic that can be shaped to an extent by the conducive learning environments and experiences previously described.

## Final Thoughts

The birth of the Model of Domain Learning did not occur in a flash of insight. Nor was the MDL built solely from quantitative analysis. Rather, as with any theoretical frameworks, models, or principles that deal meaningfully with human learning, behaviors, or development, the MDL was formed from the marriage of life experiences and empirical evidence. Its birthing was a labor that extended over many years and was a consequence of many steps and missteps. Moreover, due to its focus on the trajectory of human learning, which is a fluid construct, we do not ascribe unwavering certainty or finality to the MDL. This theoretical model must remain unfinished and open to whatever new findings emerge about the nature of human learning and its development.

Despite these cautions and caveats about MDL and its formation, there are certain understandings we have garnered from this valued undertaking and from the theoretical reminiscence that this special issue has afforded. Moreover, revisiting the MDL in this manner has afforded us a platform to praise the role of theorizing and scientific speculation not solely in terms of the MDL but as it relates to theory building for the educational psychology community and the health of educational research.

At its core, our message is simply that the educational psychology community cannot hope to revitalize theory building until we, as members of that community, embrace scientific speculation and the risks inherent in questioning the accepted and venturing into the empirical unknown. Such a journey is not for the faint of heart nor for any traveler who is not equipped with an insatiable desire to understand deeply, well-honed perceptiveness, a logical mind, and a rich, diverse knowledge base.

As human animals, we are not gifted with these essential attributes at birth. We do not emerge from the womb ready and willing to become theory builders. Nonetheless, it is possible for the young to grow and thrive in the realm of scientific speculation and theory building. However, for that to happen the young must receive guidance and mentoring from more knowledgeable others. They must be continuously fed through experiences that whet their appetites; hone their perceptiveness; value their healthy speculations; demand reasoning and appropriate justifications, and ultimately broaden and diversify their knowledge. No simple recipe, we acknowledge. Yet, these goals can be accomplished. We, as members of the educational research community, can wait no longer if we want to end the drought of theory building that currently plagues the health of the field. We must accept the challenge and alter the practices that have stifled scientific speculation and theorizing for far too long.

## References


Achinstein, P. (1963). Theoretical terms and partial interpretation. *The British Journal for the Philosophy of Science, 14*(54), 89–105.

Achinstein, P. (2018). *Speculation: Within and about science*. Oxford University Press.

Achinstein, P. (2022). Scientific speculation and evidential progress. In Y. Shan (Ed.), *New philosophical perspectives on scientific progress* (pp. 355–373). Routledge.

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). JAI.

Alexander, P. A. (2003). The development of expertise: The journey from acclimation to proficiency. *Educational Researcher, 32*(8), 10–14. https://doi.org/10.3102/0013189X032008010

Alexander, P. A. (2006). Evolution of a learning theory: A case study. *Educational Psychologist, 41*(4), 257–264. https://doi.org/10.1207/s15326985ep4104_6

Alexander, P. A. (2014). Thinking critically and analytically about critical-analytic thinking: An introduction. *Educational Psychology Review, 26*, 469–476. https://doi.org/10.1007/s10648-014-9283-1

Alexander, P. A. (2016). The arguments for and the reasoning about epistemic cognition: A response to the chapters on psychological perspectives. In J. A. Greene, W. A. Sandoval, & I. Bråten (Eds.), *Handbook of epistemic cognition* (pp. 100–110). Routledge.

Alexander, P. A. (2017). Into the future: A prospective look at the Model of Domain Learning. In H. Fives & D. L. Dinsmore (Eds.), *The Model of Domain Learning: Understanding the development of expertise* (pp. 195–214). Routledge.

Alexander, P. A. (2023). "Here be dragons!" Mapping the realm of higher-order, critical, and critical-analytic thinking. *Educational Psychology Review, 35*(2), 42. https://doi.org/10.1007/s10648-023-09762-0

Alexander, P. A., the Disciplined Reading and Learning Research Laboratory. (2012). Reading into the future: Competence for the 21st century. *Educational Psychologist, 47*(4), 1–22. https://doi.org/10.1080/00461520.2012.722511

Alexander, P. A., the Disciplined Reading and Learning Research Laboratory (2020). Relational reasoning: The bedrock of integration within and across multiple presentations, documents, and perspectives. In P. N. Van Meter, A. List, D. Lombardi,& P. Kendeou (Eds.), Handbook of learning from multiple representations and perspectives (pp. 401-424). Routledge

Alexander, P. A., Jablansky, S., Singer, L. M., & Dumas, D. (2016). Relational reasoning: What we know and why it matters. [Special Issue on Education]. *Policy Insights from the Behavioral and Brain Sciences, 3*(1), 36–44. https://doi.org/10.1177/2372732215622029

Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Educational Research, 58*(4), 375–404. https://doi.org/10.3102/00346543058004

Alexander, P. A., Kulikowich, J. M., & Schulze, S. K. (1994). How subject-matter knowledge affects recall and interest. *American Educational Research Journal, 31*(2), 313–337. https://doi.org/10.3102/0002831203100231

Alexander, P. A., Murphy, P. K., & Greene, J. A. (2012). Projecting educational psychology's future from its past and present: A trend analysis. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *Educational psychology handbook Theories, constructs, and critical issues* (Vol. 1, pp. 3–32). American Psychological Association. https://doi.org/10.1037/13273-001

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*(3), 397–406. https://doi.org/10.1037/0022-0663.90.3.397

Alexander, P. A., Murphy, P. K., & Woods, B. S. (1996). Of squalls and fathoms: Navigating the seas of educational innovation. *Educational Researcher*, *25*(3), 31–36, 39. https://doi.org/10.3102/0013189X02500303

Alexander, P. A., Murphy, P. K., Woods, B. S., Duhon, K. E., & Parker, D. (1997). College instruction and concomitant changes in students' knowledge, interest, and strategy use: A study of domain learning. *Contemporary Educational Psychology, 22*(2), 125–146. https://doi.org/10.1006/ceps.1997.0927

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*(3), 283–325. https://doi.org/10.1016/1041-6080(89)90014-9

Alexander, P. A., Schallert, D. L., & Reynolds, R. E. (2009). What is learning anyway? A topographical perspective considered. *Educational Psychologist, 44*(3), 176–192. https://doi.org/10.1080/00461520903029006

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*(3), 545–557. https://doi.org/10.1037/0022-0663.96.3.545

Boveda, M., & Annamma, S. A. (2023). Beyond making a statement: An intersectional framing of the power and possibilities of positioning. *Educational Researcher, 52*(5), 306–314. https://doi.org/10.3102/0013189X231167149

Boveda, M., & Weinberg, A. E. (2022). Centering racialized educators in collaborative teacher education: The development of the intersectionally conscious collaboration protocol. *Teacher Education and Special Education, 45*(1), 8–26. https://doi.org/10.1177/08884064211062874

Brayboy, B. M. J. (2005). Toward a Tribal Critical Race Theory in education. *The Urban Review, 37*(5), 425–446. https://doi.org/10.1007/s11256-005-0018-y

Burnyeat, M. F. (Ed.). (1983). *The skeptical tradition*. California University Press.

Byrnes, J. P., & Dunbar, K. N. (2014). The nature and development of critical-analytic thinking. *Educational Psychology Review, 26*, 477–493. https://doi.org/10.1007/s10648-014-9284-0

Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology, 42*(1), 116–131. https://doi.org/10.1037/0022-3514.42.1.116

Cazden, C. B. (1988). *Classroom discourse: The language of teaching and learning*. Heinemann.

Cerna, L. (2019). *Refugee education: Integration models and practices in OECD countries (Report No. 203). OECD Publishing*. OECD Publishing. https://doi.org/10.1787/a3251a00-en

Chen, C., & Luo, M. (Eds.). (2021). *The theory and practice of group discussion with Quality Talk*. Springer. https://doi.org/10.1007/978-981-16-1409-5

Cordova, V. F. (1992). *The concept of monism in Navajo thought*. [Doctoral dissertation, University of New Mexico] https://digitalrepository.unm.edu/phil_etds/29

DeCuir-Gunby, J. T., & Schutz, P. A. (2014). Researching race within educational psychology contexts. *Educational Psychologist, 49*(4), 244–260. https://doi.org/10.1080/00461520.2014.957828

Dickmeyer, N. (1989). Metaphor, model, and theory in education research. *Teachers College Record, 91*(2), 151–160.

Dinsmore, D. L., & Alexander, P. A. (2012). A critical discussion of deep and surface processing: What it means, how it is measured, the role of context, and model specification. *Educational Psychology Review, 24*, 499–567. https://doi.org/10.1007/s10648-012-9198-7

Dinsmore, D. L., Fryer, L. K., & Parkinson, M. M. (Eds.). (2020). *Handbook of strategies and strategic processing*. Routledge. https://doi.org/10.4324/9780429423635

Ebersöhn, L. (2008). Children's resilience as assets for safe schools. *Journal of Psychology in Africa, 18*(1), 11–17. https://doi.org/10.1080/14330237.2008.10820167

Ebersöhn, L. (2020). Collective resilience to global challenge: A collective wellbeing agenda to transform towards sustained equitable education. *Praxis Educativa*, *15*. https://doi.org/10.5212/praxeduc.v.16344.082

Ebersöhn, L., Omidire, F., & Murphy, P. K. (2021). Academic flocking and global distress: Equitable south-north research partnering to promote quality education in diverse contexts and cultures. *Zeitschrift Für Erziehungswissenschaft, 25*(3), 745–764. https://doi.org/10.1007/s11618-022-01084-1

Ericsson, K. A. (Ed.). (2014). *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games*. Psychology Press.

Ericsson, K. A., & Smith, J. (Eds.). (1991). *Toward a general theory of expertise: Prospects and limits*. Cambridge University Press.

Eronen, M. I., & Bringmann, L. F. (2021). The theory crisis in psychology: How to move forward. *Perspectives on Psychological Science, 16*(4), 779–788. https://doi.org/10.1177/17456916209705

Firetto, C. M., & Van Meter, P. N. (2018). Inspiring integration in college students reading multiple biology texts. *Learning and Individual Differences, 65*, 123–134. https://doi.org/10.1016/j.lindif.2018.05.011

Fives, H., & Dinsmore, D. L. (Eds.). (2017). *The model of domain learning: Understanding the development of expertise*. Routledge. https://doi.org/10.4324/9781315458014

Fodor, J. A. (1975). *The language of thought* (Vol. 5). Harvard University Press.

Fong, C. J., Alejandro, A. J., Krou, M. R., Segovia, J., Johnston-Ashton, K. (2019). Ya'at'eeh: Race-reimaged belongingness factors, academic outcomes, and goal pursuits among Indigenous community college students. *Contemporary Educational Psychology*, *59*. https://doi.org/10.1016/j.cedpsych.2019.101805.

Gagné, M., Guhn, M., Janus, M., Georgiades, K., Emerson, S. D., Milbrath, C., ... & Gadermann, A. M. (2021). Thriving, catching up, falling behind: Immigrant and refugee children's kindergarten competencies and later academic achievement. *Journal of Educational Psychology*, *113*(7), 1387–1404.

Gray, K. (2017). How to map theory: Reliable methods are fruitless without rigorous theory. *Perspectives on Psychological Science, 12*(5), 731–741. https://doi.org/10.1177/1745691617691949

Greene, J. A. (2022). What can educational psychology learn from, and contribute to, theory development scholarship? *Educational Psychology Review, 34*(4), 3011–3035. https://doi.org/10.1080/00461520903029006

Henrich, J., Heine, S., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature, 466*(7302), 29. https://doi.org/10.1038/466029a

Kant, I. (1781). *Critique of pure reason*. Johann Friedrich Hartknoch, Riga

Kim, H. Y., Brown, L., Tubbs Dolan, C., Gjicali, K., Deitz, R., Prieto Bayona, M. D. S., & Aber, J. L. (2023). Testing the impact of a skill-targeted social and emotional learning curriculum and its variation by pre-and postmigration conflict experiences: A cluster randomized trial with Syrian refugee children in Lebanon. *Journal of Educational Psychology, 115*(3), 502–522. https://doi.org/10.1037/edu0000775

Kulturel-Konak, S., Konak, A., Kremer, G. O., & Esparagozza, I. E. (2015). Professional skills assessment: Is a model of domain learning framework appropriate? *International Journal of Quality Assurance in Engineering and Technology Education (IJQAETE), 4*(1), 33–60.

Kumar, R., & DeCuir-Gunby, J. (2023). What is the role of race in educational psychology? A review of research in Educational Psychologist. *Educational Psychologist, 58*(1), 1–17. https://doi.org/10.1080/00461520.2022.2137804

Lawless, K. A. (2017). Exploring the model of domain learning as a guide to understanding learning with, in, and through technology. In H. Fives & D. L. Dinsmore (Eds.), *The Model of Domain Learning* (pp. 108–124). Routledge.

López, F. (2022). Can educational psychology be harnessed to make changes for the greater good? *Educational Psychologist, 57*(2), 114–130. https://doi.org/10.1080/00461520.2022.2052293

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

Matthews, J. S., & López, F. (2019). Speaking their language: The role of cultural content integration and heritage language for academic achievement among Latino children. *Contemporary Educational Psychology, 57*, 72–86. https://doi.org/10.1016/j.cedpsych.2018.01.005

Matthews, J. S., & López, F. (2020). Race-reimaging educational psychology research: Investigating constructs through the lens of race and culture. *Contemporary Educational Psychology*, *61*. https://doi.org/10.1016/j.cedpsych.2020.101878

McCrudden, M. T., Marchand, G., & Schutz, P. (2019). Mixed methods in educational psychology inquiry. *Contemporary Educational Psychology, 57*, 1–8. https://doi.org/10.1016/j.cedpsych.2019.01.008

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Harvard University Press.

Miele, D. B., & Wigfield, A. (2014). Quantitative and qualitative relations between motivation and critical-analytic thinking. *Educational Psychology Review, 26*, 519–541. https://doi.org/10.1007/s10648-014-9282-2

Mills, T., & Fives, H. (2017). Examining teachers' professional learning: The Model of Domain Learning as an analytic lens to examine exemplary programs. In H. Fives & D. L. Dinsmore (Eds.), *The Model of Domain Learning* (pp. 175–194). Routledge.

Murphy, P. K. (2003). The philosophy in thee: Tracing philosophical influences in educational psychology. *Educational Psychologist, 38*(3), 137–145. https://doi.org/10.1207/S15326985EP3803_3

Murphy, P. K. (2007). The eye of the beholder: The interplay of social and cognitive components in change. *Educational Psychologist, 42*(1), 41–53. https://doi.org/10.1080/00461520709336917

Murphy, P. K. (Ed.). (2018). *Classroom discussions in education*. Routledge.

Murphy, P. K., & Alexander, P. A. (2016). Interrogating the relation between conceptual change and epistemic beliefs. In J. A. Greene, W. A. Sandoval, & I. Bråten (Eds.), *Handbook of epistemic cognition* (pp. 439–459). Routledge.

Murphy, P. K., & Alexander, P. A. (2023). Centering muted philosophical voices in educational psychology. In F. López, J. DeCuir-Gunby, & D. Gray (Eds.), *Handbook on equity, asset-based, race-reimaged theories, methods, practices, and policies.* Routledge.

Murphy, P. K., Alexander, P. A., & Muis, K. R. (2011). Knowledge and knowing: The journey from philosophy and psychology to human learning. In K. Harris (Ed.), *American Psychological Association handbook of educational psychology.* (Vol. 1). American Psychological Association.

Murphy, P. K., Alexander, P. A., & Ogata, T. (2024). Hast thee any philosophy? Unearthing the value of philosophy for educational psychology. In P. Schutz & K. R. Muis (Eds.), *Handbook of educational psychology* (4th ed.). Routledge.

Murphy, P. K., & Cromley, J. (Eds). (2015). Examining innovations—Navigating the dynamic complexities of school-based intervention research. *Contemporary Educational Psychology*, *40*, 1–130.

Murphy, P. K., Croninger, R. M. C., Baszczewski, S. E., & Tondreau, C. L. (2022). Enacting Quality Talk discussions about text: From knowing the model to navigating the dynamics of dialogic classroom culture. *The Reading Teacher, 75*(6), 713–731. https://doi.org/10.1002/trtr.2110

Murphy, P. K., & Firetto, C. M. (2018). Quality Talk: A blueprint for productive talk. In P. K. Murphy (Ed.), *Classroom discussions in education: Promoting productive talk about text and content* (pp. 101–134). Routledge.

Murphy, P. K., Greene, J. A., Allen, E. M., Baszczewski, S., Swearingen, A. K., & Butler, A. M. (2018). Fostering high school students' scientific argumentation and conceptual understanding through Quality Talk discussions. *Science Education, 102*(6), 1239–1264. https://doi.org/10.1002/sce.21471

Murphy, P. K., Ogata, T. M., & Schoute, E. C. (2023). "Valued" thinking in education: Liberating the narrative. *Educational Psychology Review, 35*(1), 35. https://doi.org/10.1007/s10648-023-09754-0

Murphy, P. K., Rowe, M. L., Ramini, G., & Silverman, R. (2014). Promoting critical-analytic thinking in children and adolescents at home and in school. *Educational Psychology Review, 26*(4), 561–578. https://doi.org/10.1007/s10648-014-9281-3

Murphy, P. K., Wilkinson, I. A. G., Soter, A. O., Hennessey, M. N., & Alexander, J. F. (2009). Examining the effects of classroom discussion on students' high-level comprehension of text: A meta-analysis. *Journal of Educational Psychology, 101*, 740–764.

Nolen, S. B. (2020). Challenging research norms in educational psychology. *Educational Psychologist, 55*(4), 267–272. https://doi.org/10.1080/00461520.2020.1810043

Nystrand, M. (1997). *Opening dialogue: Understanding the dynamics of language and learning in the English classroom*. Teachers College Press.

Paris, D. (2019). Naming beyond the white settler colonial gaze in educational research. *International Journal of Qualitative Studies in Education, 32*(3), 217–224. https://doi.org/10.1080/09518398.2019.1576943

Pate, P. E., Alexander, P., & Kulikowich, J. (1989). Assessing the effects of training social studies content and analogical reasoning processes on sixth-graders' domain-specific and strategic knowledge. *Middle School Research Selected Studies, 14*(1), 19–29. https://doi.org/10.1080/08851700.1989.11670298

Peirce, C. S. (1877). The fixation of belief. *Popular Science Monthly, 12*, 1–15.

Putnam, H. (1981). *Reason, truth, and history*. Cambridge University Press.

Schutz, P. A. (2020). Race focusing and reimaging research: Where do we go from here? *Contemporary Educational Psychology*, *61*. https://doi.org/10.1016/j.cedpsych.2020.101871

Sefhedi, S. T., Omidire, F., Ebersöhn, L., & Murphy, P. K. (2021). Promoting critical-analytic-thinking through teacher discourse moves: The case of a rural South African secondary school. *Journal for Language Teaching, 54*(2), 95–117. https://doi.org/10.4314/jlt.v54i2.5

Shan, Y. (Ed.). (2022). *New philosophical perspectives on scientific progress*. Routledge.

Steup, M., & Neta, R. (2020). *Epistemology*. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Fall 2020 ed.). Stanford University. https://doi.plato.stanford.edu/archives/fall2020/entries/epistemology

Suppes, P. (1974). The place of theory in educational research. *Educational Researcher, 3*(6), 3–10. https://doi.org/10.3102/0013189X003006003

Thorndike, E. L. (1910). The contribution of psychology to education. *Journal of Educational Psychology*, *1*(1), 5–12. https://psycnet.apa.org/doi/10.1037/h0070113

Thorndike, E. L. (1924). *The evolution of the human intellect*. University of Minnesota.

Vargas, J. H., & Saetermoe, C. L. (2023). The antiracist educator's journey and the psychology of critical consciousness development: A new roadmap. *Educational Psychologist*. https://doi.org/10.1080/00461520.2023.2243329

Wei, L., & Murphy, P. K. (2019). Recontextualising discourse-intensive interventions for multilingual contexts: Implementing Quality Talk in China. In M. F. Omidere (Ed.), *Multilingualism in challenging education settings: Supporting learning and development* (pp. 57–81). UCT Press.

Wei, L., Murphy, P. K., & Wu, S. (2021). Recontextualizing Quality Talk for an eighth-grade English classroom in China. *ECNU (East China Normal University) Review of Education*. https://doi.org/10.1177/2096531120970174

Williams, G. (2023). Kant's account of reason. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Fall 2023 ed.). https://plato.stanford.edu/archives/fall2023/entries/kant-reason/

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