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EDITORIAL

Special Issue
A Response to the Deans for Impact Report: The Science of Learning

Wonder-Ful Questions: Introduction to a Response to the DFI Report
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How do we learn? We can find roots of the evolving answer to this question as far back as recorded ancient civilization. Plato (440's BC to 420's BC), the reported founder of the academy (or "school") in Athens, is documented to have first posed this question. Even earlier, his teacher, Socrates (470's to 399 BC) who to our best knowledge, did not write anything down, is credited for a method of teaching still vibrant today, the Socratic Method, a pedagogy of questioning to cultivate learning. Our deep interest in the question of how we learn has evolved over time from these earliest recorded thoughts to more formal approaches and theories of learning. From John Locke's (1632 – 1704) "blank slate theory" to the birth of the field of Psychology, the science of behavior, to the more recent explosion of knowledge from the neurosciences, our desperation to learn how we learn arguably rivals that of our curiosity about the cosmos. Socrates claimed that "wisdom begins in wonder." What is wonder? As a verb, the Oxford Dictionary states that it is a curiosity or desire to know something. The natural result of wonder would be questioning. And so we come full circle as our questioning about learning and how we learn began with and continues through the important role of questioning in learning.

The *Deans for Impact Report: The Science of Learning* was released in December 2015 and its stated purpose is to "summarize the existing research from cognitive science related to how students learn, and connect this research to its practical implications for teaching and learning." It intends to offer our "best scientific understanding of how learning takes place." The report appropriately includes 6 Key Questions for colleges of education to ponder regarding learning and what should be included in curriculums about learning when teaching future teachers. These questions are asked within the framework of their potential impact on colleges of education whose job it is to teach other humans how to teach other humans. The 6 Key Questions are:

- How do students understand new ideas?
- How do students learn and retain new information?
- How do students solve problems?
- How does learning transfer to new situations in or outside of the classroom?
- What motivates children to learn?
- What are common misconceptions about how students think and learn?

To address these Key Questions from a scientific standpoint, the DFI report proposes that colleges of education investigate a claimed existing scientific consensus regarding some basic

cognitive principles. The even deeper underpinning principles selected have emerged not actually through education research, but largely through research in the field of cognitive science. As educational leaders, we found that when grappling with these principles, we were also drawn into the question of how the brain learns. Adding the word "brain" to this inquiry both specifies it, and moves it beyond the realm of what educators are typically trained or some would argue, are capable of addressing in colleges of education teacher training programs. We tried to limit our responses to the DFI report to existing, and in some cases, more recent cognitive science research but did on occasion necessarily step into the neuroscience literature, as carefully as we could dare.

First, kudos to Dr. Wilingham, Mr. Bruno, and the deans of colleges of education across the country for signing on to take concrete steps toward moving the art of teaching and learning further into the realm of the science of learning in the first place. We were encouraged in 2007, through a National Institute for Child Health & Human Development report that shed light on this important concept. That report stated "current research points to the fact that aspects of development – neural, cognitive, social, psychological, physical, and ethical – have far-reaching effects on children's ability to learn" (NICHD, 2007). Consequently and fortunately, the National Council for Accreditation of Teacher Education published a report in 2010 claiming that in spite of an "explosion of developmental sciences knowledge, too little of this important research is influencing how schools of education prepare teachers for the classroom" (Pianta, Hitz, & West, 2010, p 3). This report goes on to state, "there is additional evidence to support the argument that teacher preparation and the developmental sciences are not connected" (Pianta, Hitz, & West, 2010, p 4). The result? The *Deans for Impact: The Science of Learning* report.

In this special issue of the *Journal for Applied Educational Policy and Research,* we investigate more deeply the cognitive science based principles upon which the 6 Key Questions were formulated, and further explore additional literature that has the potential to inform the field of education. Moving beyond studies of one-college-student-at-a-time teaching and learning, to classrooms of 30 or 40 children and adolescents, adds a level of complexity to the process which affects outcomes. Who is "we?" Doctoral students at the University of North Carolina at Charlotte from the Spring and Fall 2016 sections of ADMN 8660: Seminar in Instructional Leadership responded to each Key Question from the DFI Report in two ways. First, they delved into the literature upon which the cognitive science principles which informed the Key Questions were based, analyzing them regarding their relevancy to the questions, and added from a half dozen to a dozen or more additional scholarly sources which further strengthened, or in some cases, expressed differing viewpoints to the principles presented. Secondly, the students, themselves form a diverse spectrum of educational leadership perspectives from elementary teachers to higher education administrators, authored research-to-practice ideas for implementation of the strategies for potentially answering the Key Questions. The articles appear chronologically based on the DFI Report Key Questions; Key Question 1, Literature Review to Key Question 1, Research-to-Practice article for Key Question 1, etc.

For example, the first Key Question in the DFI report is "How do students understand new ideas?" It is based on 3 cognitive principles. In our first pair of articles, the authors review the literature on these 3 principles from the DFI report upon which this first Key Question is derived. When students face new ideas, having experienced references to prior knowledge when facing these new ideas causes learning to be enhanced. Further, for teachers to teach in a manner that creates such a learning environment in classrooms, they need a deeper understanding of both the structure of their disciplines, and knowledge of the types of teaching activities that will assist

students in understanding these discipline structures for themselves (Bransford, et al. 2000). Carefully incorporating the prior knowledge of their students creates a better opportunity for this to occur.

Investigating the impact of socio-economic standing on learning, specifically math achievement of ethnically minority, Title I students, Algodini et al (2009) found that these students performed significantly lower than their more advantaged peers. In this study, teacher preparation again surfaced as a factor which contributed to learning, along with small group instruction and hands-on learning for mastering the math skills. When brought to the level of cognition and memory, Richland, Zur, and Holyoak (2007) again found that understanding abstract math relations could be enhanced by having students draw conceptual parallels to the examples they were trying to learn. Finally, Baxter, Woodward, and Olson (2001) found that when students helped to create and develop the ideas that were needed to understand the math problems using open-ended discussions, this activity helped support the math learning.

The authors reviewed additional literature not included in the DFI report which supports this Key Question. Kilpatrick, Swafford, and Findell (2001) point out that children begin learning math concepts even before they enter elementary school. Students are able to understand more from guided discovery than independent discovery, and explanatory feedback significantly increased student understanding of the concepts (Moreno, 2004).

The second cognitive principle addressed the use of transfer of information from the working memory to the long-term memory. Since students have limited working memory capacity, they are at risk of cognitive overload which can actually impede learning. The work of Sweller (1998, 2006, 2010, 2015) is reviewed suggesting that using worked examples is superior to solely conventional problem working as a teaching strategy for students. This way, as students study worked examples alongside problems to be solved, less working memory capacity would be needed and transfer could more likely be facilitated. In addition, when students use working examples they become less focused on simply finding an answer but on learning the steps to find the correct answer (Von Gog et al, 2010).

Combining verbal narration and visual graphics is a more effective strategy than just using text and visuals together (Morena & Mayer, 1999). Another strategy to improve learning by decreasing cognitive load was to space learning out across weeks or months (Pashler et al, 2007). This way, worked examples and actual problem solving can be interleaved to increase learning. Using closed book quizzes to repeatedly expose students to the material helped with retention of the material. Selected works of Paula Goolkasian, to whom this special issue is dedicated are reviewed. Dr. Goolkasian founded the Cognitive Science Academy at the University of North Carolina at Charlotte and, at the end of her career, worked to incorporate cognitive science principles into teacher and administrator preparation programs there.

Finally, these authors review the research involving the pace at which cognitive development progresses. This research suggests that cognitive development does not simply move through what has been considered a traditional progression of age-related stages, but through episodes of “fits and starts” (Willingham, 2008; Gray & Reeve, 2016; Holmes & Dowker, 2013). It is also dependent upon, according to Willingham (2008), “the details of what they are asked to understand and how they are asked to show that they understand it” (p37). All of the research from the DFI report as well as additional research cited point to the fact that applying cognitive science principles into classrooms of students, rather than testing them one student at a time in a lab, introduce many additional complexities and variables and this translational research needs further study.

The research-to-practice article which follows offers concrete, practical, research-based (& some creative) options for educators to consider to better apply the cognitive science principles into classrooms and in some cases, increase student engagement from math class to band class. If nothing more, it provides a jumping off platform for teacher reflection, discussion and professional learning that in and of itself has been shown to improve learning. When teachers learn, students typically learn as well.

Each additional Key Question is explored through both a literature review framework followed by a research-to-practice article. The literature reviews include additional research to support and in some cases, question the principles as they might be applied in schools. Each is written by a team of doctoral students and then each underwent a blind, peer-editing process by a different team of students, and finally by outside peer reviewers. What follows is our response to the important DFI report, in hopes of furthering this important discussion and ultimately helping to promote and deepen the relationships between colleges of education (and educators) and the research (and researchers) surrounding the sciences of learning.

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