# Relating Teaching Behaviors to Cognition

**by**

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## Relating Teaching Behaviors to Cognition

Educational policy in the United States is currently embroiled in a reactionary cycle driven by the growing concern over lackluster student performance, especially when compared to the performance of students in other developed countries. The federal No Child Left Behind legislation has placed accountability in the form of standardized tests scores at the forefront of every educational initiative and is focusing more attention on the connection between educational reform and actual student performance. Educational leaders and policy makers are beginning to recognize that this key connection lies with the actions of the classroom teacher. With this in mind, a central component of NCLB is ensuring a high quality teacher in every classroom by setting specific standards that all teachers must meet, generally educational credentials in the form of degrees and university credits.

This presents an interesting dichotomy within our accountability system. As educators we recognize that because of the wide variance in school effectiveness in our K-12 system we cannot assess student learning based on the attainment of educational credentials. For example, the fact that a student has 'passed' third grade does not guarantee that he has mastered the skill set generally expected of an incoming fourth grader (Dolan, 2005). The administration of national standardized tests is designed to provide external evidence that all of the students of a particular grade level are meeting the same set of expectations. In measuring student academic performance we have established specific performance standards so that students can demonstrate what they have learned. An important assumption in these performance standards is that there is a certain fundamental core of knowledge that it is important for students to master in each of the key content areas. For example, computational fluency is a virtually universal standard for elementary mathematics, and there is an accepted view of what computational fluency is, and how students can demonstrate it.

It is surprising that we have not come to the same conclusion about teacher knowledge. There is no universal accepted notion of what knowledge a teacher must possess in order to be a successful instructor. The reason for this is not that it is not

important, but rather because there is no common knowledge base within education. Consider the current reactionary reform efforts within the United States. These efforts are manifesting themselves in a series of random, fragmented initiatives, each with their own guidelines, structures and vocabularies. Ask ten mathematicians to describe addition and you will get essentially the same answer from all of them. Ask ten educators to describe *Cooperative Learning* and you are likely to evoke ten distinctly different answers. The same is true for numerous other programs; social constructivism, direct instruction, student-centered learning, integrated curriculum, content-area-reading, etc. The list continues.

So, while we have established a commonly accepted knowledge base for the core areas of study within K-12 education, we have no commonly accepted knowledge base for the teachers responsible for ensuring K-12 students succeed. This seems to defy logic. If our vision of education assumes there is a foundational set of knowledge students must master to be successful in life, how is it that we cannot establish a foundational set of knowledge that teachers require to be successful instructors? And what does this say about the educational credentials used to identify high quality teachers? Even if there was an accepted skill set for teachers, there is no agreement on what these skills look like. For example, most would agree that teachers need to be able to develop lesson plans, design appropriate lesson activities, craft questions, and implement assessments. There is, however, very little agreement on what quality performance in these tasks would be. Consider an even more basic definition of a quality teacher. It is obvious that a high quality teacher must know something about student learning?

This paper examines the results of two distinctive studies that highlight the implications of this dichotomy within our educational systems. The first study investigated the degree to which students who were at the end of their teacher education experiences could demonstrate a mastery of the basic teaching tasks that were the focus of their coursework. The second study focused on the relationship between specific verbal teaching behavior and student cognition.

Study 1:

The authors conducted a study to investigate the degree to which students retained knowledge from their learning experiences in a teacher preparation program by gauging participants' abilities to produce an educationally sound lesson plan, including an assessment plan, higher and lower order questions, and specific academic praise statements. The study relied on performance tasks to measure pedagogical knowledge repeatedly reinforced throughout their coursework. The study also examined the degree to which the participants felt prepared by their coursework and felt confident to enter the classroom as a teacher. These results were then compared to their performance on the pedagogical items.

The results of the study were dismal. Although the students were asked to construct lesson plans in all of their core teaching courses, they were largely unable to develop coherent, logically sequenced plans geared toward specific academic learning goals. While most of their courses addressed cognitive processes and critical thinking, only a small number were able to adequately produce higher order questions. Very few were able to describe appropriate assessment activities related to their instructional objectives, yet most thought that they had. In other words, despite extensive coursework designed to help prospective teachers master the so-called 'basic skills' of teaching, almost none of them could perform these tasks. It is perhaps most disturbing that they almost all felt they were prepared to be teachers (see Ashworth, Dolan, Kirsch & Vitale 2004 for full description of study and results).

For the purpose of this paper, the students' responses to questions about cognition will be examined. Students were asked to design three lower and higher order questions for the particular subject matter lesson (see figure 1.) The majority of participants demonstrated competency in designing lower order questions but had difficulty in designing higher order questions. Closer analysis of the lower order questions revealed that what appeared to be a positive attribute was a very narrow skill understanding about cognition and memory (lower order) questions. Using Bloom's Taxonomy, 91% of the questions represented knowledge questions; 8% comprehension questions and only 2% application questions. 93% of the questions required a short 1-3 word answer. When examining the cognitive words in the higher order questions the responses were actually lower order questions. Of the question that could be identified as higher order 25%

focused on the cognitive operation 'compare or contrast.' 28% asked for students' opinion, which in most situations is not a higher order question.

These results are particularly telling within the current context of educational accountability. As noted above, educational leaders and policy makers are focusing attention on teacher quality because they recognize the critical role that teachers play in the success of any reform effort. Yet these results suggest that the majority of the *successful* participants in a teacher education program have very little understanding of basic cognitive operations, despite the fact that it was identified as a central facet of their coursework.

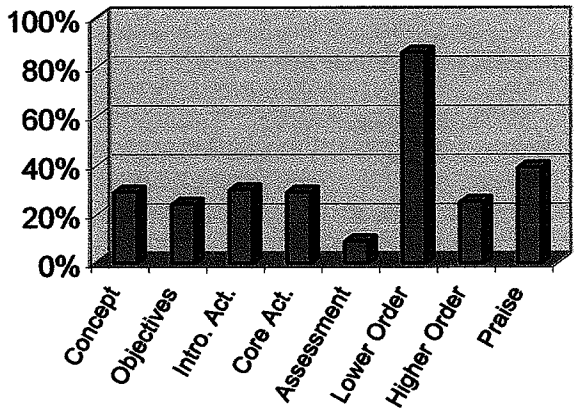


*Figure 1.* Percentage of Appropriate Responses

How is this possible? The researchers concluded that one problem lay with the idiosyncratic manner in which the instructors in this program approached cognition in their classes. Although each required course 'covered' cognition and its application to various subject matters, there was little consistency in reinforcing the same cognitive theory, terms, or application procedures among the different classes. Academic freedom reigned. Consequently, students were exposed to a variety of cognitive theories and each theory had different theoretical understandings, terms, and application procedures. When exposed to ideas in an idiosyncratic, random, scattered, and fragmented manner and when connections among ideas have not been made within a foundational framework, it is impossible, especially for the novice, to know how to retrieve or when to discard seemingly competing ideas.

The core courses for this program had established standards, so while individual syllabi varied to some degree, each instructor was still expected to accomplish the same learning objectives. However, the findings from this study suggest that the actual curricula for these courses were distinctly different from the intended ones. So, while the participants in this study had almost attained the credentials necessary to be considered a

'highly qualified teacher' by the standards set by NCLB, less than half demonstrated a solid understanding of the teaching and learning process.

The participants in this first study demonstrated a paralysis, perhaps an overload, when asked to demonstrate and apply content to which they had been exposed. They had apparently been successful in class assignments that required application of this content within a finite context, but did not possess a coherent framework of cognitive theory that is the hallmark of real understanding. When expected to apply what had been 'covered' in their courses, they were unable to do so because they lacked the fundamental foundational knowledge necessary for application.

This is not surprising. It is no wonder these young prospective teachers were unable to demonstrate mastery of core educational knowledge when there is, in fact, no defined common core. Sciences have foundational knowledge that is fixed. Education does not. The idiosyncratic nature of the field results in wide variance in teacher quality and it produces a dilemma when trying to make improvements. It also means that any standard for teacher quality based on credentials is likely to be flawed and misleading.

## Mosston and Ashworth's Spectrum of Teaching Styles

In addition to delineating landmark teaching and learning behaviors, the *Spectrum of Teaching Styles* offers foundational information that is essential for understanding and implementing effective teaching behavior (Mosston & Ashworth, 2002). The *Spectrum* is not the last word about teaching and learning but it can provide a basic knowledge set regarding the function and components that are common to all teaching approaches and to landmark teaching styles. This knowledge base serves as both fundamental and foundational information that must be obtained before any professional begins to develop and expanded his or her teaching-learning repertoire.

Learning requires cognition, and cognition is one function common to all teaching behaviors. The uniqueness of landmark teaching behavior is due to the particular cognitive attributes that are triggered. Therefore, it is essential that teachers have mastered the fundamental knowledge about cognition. For example: What content is intrinsic to cognition?

- Thinking is ubiquitous.
- There are three basic processes: memory, discovery, creativity.
- There is a general model for the flow of conscious thinking, which includes four phases: S→D→M→R
    - S = Stimulus (the trigger)
    - D = Cognitive Dissonance (the need to know)
    - M = Mediation (the search)
    - R = Response (the answer or solution)
- All questions have dominant and supportive cognitive operations.
- Thinking can be convergent and divergent.
- Deliberate development of thinking skills requires awareness of the role of specific cognitive operations.
- Each cognitive operation has its own inherent set of language options.
- Some cognitive operation language is ambiguous.
- Some cognitive operation language bundles a cluster of operations.
- Different cognition processes require different wait time.

The above is fundamental knowledge. The above is relevant knowledge for any and all teaching behaviors. A solid understanding of cognition allows teachers to make informed decisions so that specific landmark teaching and learning behaviors can be implemented appropriately and effectively.

Study 2:

In establishing foundational ideas regarding teaching and learning, the *Spectrum* makes several assertions regarding fundamental knowledge about cognition. One is that there is a relationship between the language used to stimulate cognition and the efficiency of the resulting thought process.

This study used fMRI technology to examine the way in which two different sets of memory questions stimulated brain activity (Jantzen, 2004). One set of questions used non-specific cognitive operation language while the second set of questions used specific cognitive operation language. These two language options are delineated in the *Spectrum*

*of Teaching Styles* theory. Non-specific language uses words that imply or indirectly indicate the question's cognitive intention. Specific cognitive language use words that explicitly, precisely and directly indicate the question's cognitive intention (see .... for full description of study and results).

Additionally this study sought to verify or reject Mosston's *General Model for the Flow of Conscious Thinking*. This flow proposes the inherent phases and sequences while conscious thinking occurs -- "what the brain does when thinking." The phases and sequence are: S→D→M→R

- S = Stimulus (the trigger)
- D = Cognitive Dissonance (the need to know)
- M = Mediation (the search)
- R = Response (the answer or solution)

Participants in the study were asked memory questions with one correct answer while their brain activity was monitored via fMRI technology. When prompted with questions identifying a specific cognitive operation (i.e. Name one necessary component of amino and nucleic acids ) the areas of the brain associated with cognition, information processing and memory retrieval were activated immediately. When prompted with general, ambiguous language (i.e. What does the rate of reactions among atoms and molecules depend on?) only one area of the brain was activated. These distinct responses indicate that when stimulated with specific language, the brain moves rapidly through the phases of cognition, almost as if the phases are simultaneous, while when stimulated with ambiguous language, the brain stalls in the state of cognitive dissonance.

The study also produced interesting results regarding the relationship of stimulus language and memory. Questions with specific language prompted significantly stronger activity than those with more general language in the precaneus area of the brain. This area is associated with memory retrieval. The findings suggest that the more specific questions allow the brain to access known information from memory more efficiently than non-specific questions. Differences were also noted in the ligual gyrus area of the brain, which supports the encoding process for new information into memory to be accessed later. Neural activity was seen in this area of the brain when specific language

was used, but not when general language was used. The stimulation of the ligual gyrus indicates that the brain was able to more rapidly access the answers from memory, because it could quickly identify what information was required.

This preliminary fMRI study suggests that Mosston's initial theoretical conception and application details about cognition have withstood a preliminary investigation. It also suggests that the use of specific cognitive language leads to more efficient cognitive processing, which may have critical implications for teaching behavior. This study offered a unique opportunity to monitor the internal thinking process, and while more research will need to be conducted, the findings support the direct relationship between verbal behavior and cognition.

## Conclusion

The first study presented in this paper chronicled the confusion students have in learning and applying professional knowledge when information is randomly and arbitrarily distributed within a teacher education program. Based on the findings, it is not at all surprising that educators across the United States are expressing panic in the face of stringent accountability systems such as NCLB. It is almost as if the education community is stalled in the state of cognitive dissonance, because there is a surfeit of conflicting signals and information regarding the best way to improve student learning.

The second study examined a narrow yet critical topic within cognitive theory relating the kind of language used in questioning to the resulting cognitive process. The results of this study suggest that there is a direct connection between the specificity of language used and the efficiency of the brain in responding. This is the kind of knowledge that could have tremendous implications for teaching behavior, and could be included in a core set of fundamental ideas about teaching and learning.

Indeed more studies need to be conducted so that foundational and fundamental knowledge can be agreed upon by the educational profession. Establishing a foundational knowledge base, that the majority of professionals adhere to, will invigorate professional effects, invite a growing information core that not only encompasses new and seemly opposing ideas but that serves to evolve the profession from its existing

historical stalemate where fads and movements direct the profession. Creating a foundational content will produce a professional climate where a common language and definable classroom practices exist rather than continuing the current deluge of tangential and temporary ideas. Because there is no solid framework new ideas get lost. Constantly 'replacing ideas' such as constructivism with the now popular social constructivism or the Kipp method rather than the basic skills movement will not enhance or legitimize our profession.

Such movements serve as band aids. Colleges of education in the USA are generally considered the less relevant college on the campus, public schools lag behind other industrialized nations, educational professional journals and conferences have more presentation slots than the rest of the world put together. What is missing to improve the Quality of Teachers so that improved learning results? What is needed to stop the influx of educational controls and bombardment of rules and regulations by the political arenas? The problem is not the willingness of our young teachers or the dedication of our veterans. Nor is it the differences in our student population. It is the revolving door of professional ideas that are not connected to a stable, consistent, reliable framework that serves the profession with a common language and beginning point for understandable conversation, research, and practice. With a reliable foundation of agreed upon knowledge, educators will be able to dialogue with understanding and investigate issues and produce an evolving educational system that removes us from replacing ideas to creating an integrated universal system that embraces new developments and opposing views. With a reliable foundation of agreed upon knowledge, educators will be able to dialogue with understanding and investigate issues and produce an evolving educational system that removes us from replacing ideas to creating an integrated comprehensive system that embraces new developments and opposing views; thus a foundational framework from command to discovery and from theory to reliable practice.

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# Current USA Educational Policy

- Driven by NCLB
  - Focuses on student performance
  - Accountability in the form of standardized tests
  - Highlighting Teacher Quality

# Achieving Reform Efforts

Focus on the Quality of the teacher:

- Standards for teacher quality based on credentials
- Standardizing content area knowledge so that teacher are consistently presenting worthwhile information
  - *Common tests require common curricula; therefore, teachers need a shared knowledge-base about content*

# Discrepancy

- Common Content Knowledge-base for core K-12 subjects …
  but
- No Universally Accepted Fundamental and Foundational Knowledge-base for the theory of teaching and learning

# Shared Terms…Lacking Common Definitions

- Cooperative Learning
- Social Constructivism
- Direct teaching
- Guided Discovery
- Feedback
- Cognition
- ….

# The **Big** Question

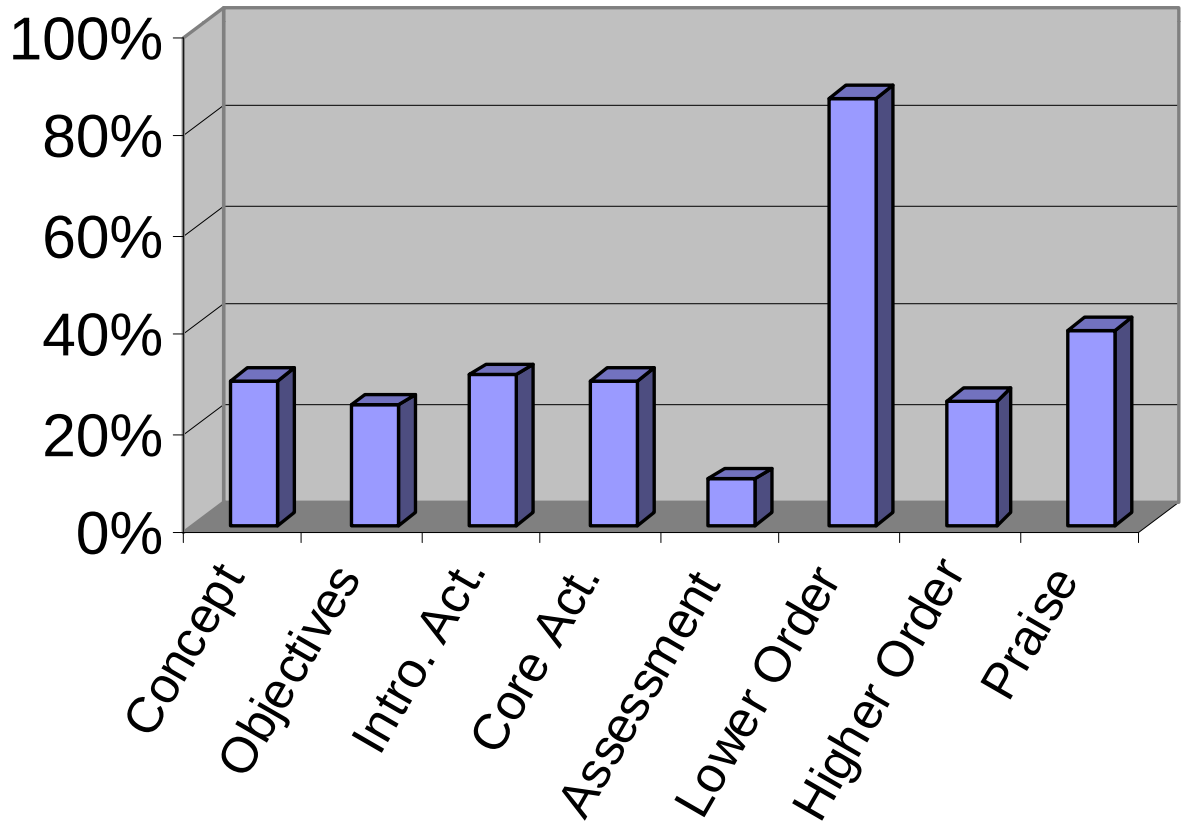
How does this lack of commonly accepted fundamental and foundational knowledge-base affect the profession?

# Study #1

- 3 year study
- Graduating student teacher candidates
- Program Knowledge Retention
- Performance Tasks:
  - Lesson plans
  - Activities
  - Assessment plans
  - Questions
  - Praise statements

# The Results? *Dismal*

*Percentage of Appropriate Responses per Task*



# Lower Order Questions

- **91%** were **knowledge** questions
- **8%** were **comprehension** questions
- **2%** were **application** questions
- **93%** required a short 1-3 word answer.

**Evaluated using Bloom's Taxonomy*

# *How can the results be dismal?*

- When….
  - Students constructed lesson plans in every core course
  - Every core course taught or reinforced the content in this study, including cognition
  - Students highly rated themselves as prepared and confident to teach

# *How can the results be dismal?*

- When….
  - Teacher Education has more honor students than all other departments combined
  - ALL students in this study had passed the credentialing requirements

# The Problem?

- Although every course reinforced the common lesson plan terms, the definitions and implementation practices were idiosyncratically presented
- There was no fixed or commonly agreed upon foundational or fundamental knowledge-base in teacher education program.

# The Future

*How would Education benefit from a non-idiosyncratic structure?*

# A Fundamental and Foundational Knowledge-base

- Provides a common language for professional dialogue, reliable research, and meaningful advancements
- Preserves knowledge rather than routinely discarding information
- Provides the framework for augmenting knowledge

# A Fundamental and Foundational Knowledge-base

- Provides a beginning level of competence that is essential to advanced knowledge and application
- Promotes a profession that is managed by its own constituents rather than outside sources—politicians, parents, private enterprise, etc.

***Fixed information is fundamental and foundational information***

***The Spectrum of Teaching Styles***

***Offers fixed entry-level information***

# Content Intrinsic to Cognition

- Thinking is ubiquitous
- Three basic processes:  memory, discovery, creativity
- General model for the flow of conscious thinking
- All questions have dominant and supportive cognitive operations

# Content Intrinsic to Cognition

- Thinking can be convergent or divergent
- Deliberate development of thinking skills requires awareness of the role of specific cognitive operations

# Content Intrinsic to Cognition

- Each cognitive operation has a discrete definition and word choices
- Questioning language has cognitive implications
  - Specific language or non-specific (ambiguous) language
- Different cognitive process require different wait time

# Next Step

*What must be done to have a common fundamental and foundational knowledge-base?*

**RESEARCH THEORY**

# Study #2

- Tested assertions made by the *Spectrum* about cognition
- Compared Cognitive Operation language in memory questions
  - **Specific** vs. **Non-Specific**

# Study #2

- Verify or Reject Mosston's *General Model for the Flow of Conscious Thinking*
  - $S \rightarrow D \rightarrow M \rightarrow R$
    - **S** = Stimulus (the trigger)
    - **D** = Cognitive Dissonance (the need to know)
    - **M** = Mediation (the search)
    - **R** = Response (the answer or solution)

# Findings

- Specific CO Qs immediately accessed brain area associated with cognition and memory retrieval
- Non-specific CO Qs only activated neural activation (a state of information gathering rather than cognitive retrieval)

- While reading specific CO Qs brain activations occurred for encoding information into memory in order to facilitate retrieval later; suggesting..
  - Specific CO Qs require less processing for the retrieval of memory information
- Provides preliminary support for Mosston's initial theoretical conception and application details about cognition ($S \rightarrow D \rightarrow M \rightarrow R$)

# Summary

- ***Study 1:*** Prospective teachers are lost in confusion resulting from random and arbitrarily distributed knowledge within a teacher education program.
- ***Study 2:*** There is worthwhile fixed knowledge that provides students with foundational information.

# More Research

- Can foundational knowledge assist in the successful retrieval of information for novice (and experienced) teachers?
- Can the establishment of an accepted knowledge-base for education lead to improved K-12 student learning?

# Improved Student Learning

**Requires Improved Teaching!**

***Are we ready for the challenge???***

Broadly summarizing, the fMRI findings indicated that when asking memory questions that had correct answers the following differences resulted:

1. "When reading specific cognitive operation questions subjects immediately began accessing brain areas associated with cognition, information processing and memory retrieval" which implies that upon reading the specific question" the phases and sequence of the S→D→M→R were triggered. However, when presented with non-specific questions, subjects showed neural activation in a single area during the reading condition which indicated that the brain activity was still in the Stimulus or the cognitive dissonance phase of the sequence.

2. "..specific questions produced significantly stronger neural activation within the precuneus (area of the brain) when compared to the non-specific questions." This finding strengthens the implication that a relationship exists between memory retrieval and the language used in the specific questions and suggests that specific questions may "promote a more efficient pathway for the retrieval of information, than does the language used for non-specific questions."

3. While reading the question, the lingual gyrus area of the brain, which is "involved in encoding information into memory in order to facilitate retrieval later" was activated for the specific cognitive operation questions but not for the non-specific questions during the reading condition. Studies by Jacoby and Kelly (1992) suggest that the familiarity associated with information that has been seen before arises because such information is easier to process." Therefore specific questions require less processing for the retrieval of the memory information.