Excerpts & Implications for Research on Habits of Mind – Taken from Lesh's & Zawojewski's *Analysis of the Problem Solving Literature* in NCTM's *Second Handbook of Research on Mathematics Teaching and Learning* (Lester, 2008)

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According to Microsoft's on-line dictionary for *WORD*, a "habit" is defined to be a regularly repeated behaviors, an addiction, or a growth pattern. Synonyms include tendency, inclination, leaning, preference, and custom.

In the NCTM's *Handbook*, Cuoco, Goldenberg, and Mark (1996) describe *habits of mind* as "mental habits that allow students to develop a repertoire of general heuristics and approaches that can be applied in many different situations" (p. 378). The assumption is evident that teaching habits of mind can be a means to help students emulate the problem-solving/research processes of professional mathematicians.

The habits of mind that are listed in the table below were drawn from Levasseur and Cuoco (2003) and Goldenberg, Sheingold, and Feurzeig (2003). As the table illustrates, most of these habits of mind are easy to map to conventional problem-solving strategies and metacognitive behaviors. So, they appear to be simply be new names for old conceptions of problem-solving strategies, heuristics and metacognitive behaviors.

Commonly Emphasized *Habits of Mind* and their Counterparts in the Literature on *Problem Solving Strategies* or *Metacognitive Strategies*	
Habit of Mind	**Metacognitive (M) or Problem Solving (PS) Strategies**
Guessing is not necessarily bad (Levasseur & Cuoco, 2003, p. 28)	Guess and test (PS)
Challenge solutions, even correct ones (Levasseur & Cuoco, 2003, p. 29)	Look back (PS) Check the reasonableness of your answer (PS)
Analyzing answers, problems, and methods (Goldenberg et al., 2003, p. 26)	
Look for patterns (Levasseur & Cuoco, 2003, p. 29) Conserve memory (Levasseur & Cuoco, 2003, p. 30)	Look for a pattern (PS)
Specialize (Levasseur & Cuoco, 2003, p. 31)	Use simpler numbers (PS)
Use alternative representations (Levasseur & Cuoco, 2003, p. 31) Think about word meanings (Goldenberg et al., 2003, p. 16)	Draw a picture (PS) Act it out (PS) Write an equation (PS)
Carefully classify (Levasseur & Cuoco, 2003, p. 32)	Make a table (PS) Organize the data (PS)
Justifying claims and proving conjectures (Goldenberg et al., 2004, p. 21) Seeking and using heuristics to solve problems (Goldenberg et al., 2004, p. 28)	What are you doing? (M) Why are you doing it? (M) Is it helping? (M) What strategy/tactic/principle can be used in order to solve the problem/task? (M)

A few of the habits of mind that were sited by the original authors are not listed in the preceding table. These include "distinguishing between agreement and logical necessity" (Goldenberg et. al., p. 25) and "think algebraically" (Levasseur & Cuoco, p. 33). They are not included here because they are different than the others. They are more closely linked to the learning of specific content (e.g., geometry or algebra). By focusing on such content specific strategies, Driscoll and colleagues (Driscoll, 1999; Driscoll, Moyer, & Zawojewski, 1998; Driscoll et al., 2001;) created professional development materials that more narrowly specified the "think algebraically" habit of mind by addressing "generalize from

computation" and "build rules to describe functions." This specification process is similar to what Schoenfeld suggested in 1992 when he encouraged the development of more detailed and specified problem-solving strategies - which would have prescriptive power (for telling inexperienced problem solvers what to do next) rather than simply descriptive power (for describing past behaviors of experts). But, even these kinds of content-specific habits of mind appear to be renamed compilations of problem-solving strategies and metacognitive strategies that have been investigated in the past research. Consequently, the construct of *habits of mind* appears to have the same strengths and weaknesses as their traditionally named counterparts. For example, if metacognitive processes (or problem solving strategies and heuristics) are thought of a lists of behaviors, then:

- Short lists of general behaviors have descriptive power. That is, they have "face validity" for describing past problem solving activities of experienced problem solvers. But, they lack prescriptive power. That is, they are not sufficiently specific to guide the next steps of inexperienced problem solvers.
- For longer lists of more specific behaviors, "understanding them" depends heavily on knowing when and why to use them. That is, most such behaviors can be unproductive if they are used at the wrong time or for the wrong purposes.
- Do relevant processes, strategies, heuristics, beliefs, attitudes, dispositions, and habits of mind always function explicitly? Or, do they often function implicitly? And, if so, how can productive implicit functioning be developed?
- Teaching studies generally have shown that small "treatments" produce small effects (i.e., evidence of learning is low); whereas, large "treatments" leave it unclear what "causes" are responsible for observed "effects". So, learning gains have been unimpressive; transfer of learning has been extremely limited; and, long term retention has been extremely low.

Whatever was it that led us to believe that language that is useful for describing the past behaviors of experts should also prescribe "next steps" for inexperienced problem solvers? Are relevant processes, strategies, heuristics, beliefs, attitudes, dispositions, and habits of mind really reducible to lists of behaviors (or explicitly learned rules)? Do students develop rigid and unchanging profiles of habits, dispositions, and attitudes? Or, do productive problem solvers manipulate their own profiles to suit circumstances? In normal everyday language, the word *habit* generally refers to rules or procedures that are executed without much conscious thought, and, they are usually are associated with simple condition-action behaviors. Is this really what we want to invoke when switching from the language of metacognitive processes to habits of mind?

Our own research is based on *models and modeling perspectives (MMP)* of mathematical problem solving, learning, and teaching. And, one of the most important distinguishing characteristics of MMP research is its emphasis on the fact that, in virtually every field where learning science researchers have investigated what it means to develop competence, it has become clear that highly competent individuals not only *do* things differently but they also *see* (or *interpret*, or *conceptualize*) things differently. So, in our brief presentation to the working group on *Habits of Mind* at PMENA-Atlanta, we will describe evidence showing that (a) productive-but-implicitly-functioning *habits of mind* can be developed using reflection activities similar to those used by athletes, performing artists, and teachers when analyzing videotapes or transcripts of their past performances, (b) the main purpose of the most productive habits of mind is to help students develop more powerful ways of *seeing* (or interpreting) their own problem solving experiences, and only function indirectly to proscribe "next steps" during ongoing problem solving activities, (c) instead of first learn ideas and processes separately, and then putting them together to solve problems, both develop synchronously during mathematical model-development activities, (d) the productivity of relevant processes, beliefs, dispositions, and habits of mind vary across time (even within single 60-90 minute model development activities); so, productive students learn to manipulate their own profiles to suite circumstances.