Thinking & Learning Skills:

What Do We Expect of Students?

April 25, 2008

Prepared by
John S. Kendall
Susan Ryan
Sandra Weeks
Alan Alpert
Amitra Schwols
Laurie Moore

Mid-continent Research for Education and Learning
4601 DTC Blvd., #500
Denver, CO 80237
Phone: 303-337-0990

April 2008

This project was conducted for the Institute of Education Sciences (IES) under Contract ED-06-CO-0023 by Regional Education Laboratory Central administered by Mid-continent Research for Education and Learning. The content of the publication does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement of the U.S. Government.

ACKNOWLEDGEMENTS

Courtney Pollack and Natalie Voltes contributed to this study.

Thanks to reviewers Zöe Barley and Robert St. Pierre for their thoughtful comments and suggestions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

This descriptive study identifies the thinking and learning skills—such as good decision-making strategies and monitoring one's own learning progress—that students should acquire, as described in standards documents from state departments of education, from national subject-area organizations, and from organizations concerned about adequate student preparation for post-secondary work. Because such skills are frequently embedded within standards that address subject-area content, it is often not clear which thinking and learning skills are commonly expected of students. This project seeks to clarify the scope and characteristics of these skills and to identify how they are addressed in subject-area standards from national organizations, as well as standard documents for the Central Region states. As states conduct their periodic review of standards for students, they seek better understanding of the skills and knowledge expected of students in other influential standards documents. In an effort to address this need, REL Central set out to examine these documents to determine what types of thinking and learning skills are commonly anticipated.

Standards identify what students should know and be able to do by the time they graduate from high school, and what they need to accomplish along the way in order to meet these goals. Standards documents are the primary means by which expectations for students are communicated to educators, to students, and to parents, and have considerable influence on the content of the curriculum and day-to-day schooling. In order to understand what is expected of students at a national as well as a state level, then, standards documents provide a valuable source of information.

This study asks the question, "What is the scope of the thinking and learning skills expected of students as identified in three significant sources of standards—state standards in the Central Region, subject-area standards from national organizations, and standards from post-secondary education across four major areas of study: English language arts, mathematics, science, and the social studies?" To conduct the review, analysts collected standards documents from the seven states in REL Central's service area (Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming); from the national groups that have established specific standards in each of the four subject areas; and from organizations that have identified what graduating seniors should know in order to successfully pursue post-secondary schooling or advanced training. So that we could classify the content we found, and organize our findings – that is, communicate what types of thinking and learning skills appear in these standards documents – we selected and adapted an educational taxonomy (Marzano & Kendall, 2007) that provides useful definitions of and distinctions among these skills. Note that the taxonomy is simply a tool for analysis, and *does not* prescribe what students should learn; its value lies in the comprehensive and systematic way it defines a wide variety of skills related to thinking and learning. The taxonomy is organized in six levels – four in the area of cognition, one in metacognition, and one in the self-system. Each level is further

An *educational taxonomy* is a means for organizing educational objectives for students. A taxonomy serves to identify key distinctions among different types of thinking and learning skills.

organized by type of mental process. So that, for example, the level of cognition called Knowledge Utilization includes the mental process of decision making. For the purposes of this study, another level, the topic level, was developed, in order to more specifically describe each process as it appears in the standards documents. For example, relative to decision-making, a standards document might focus specifically on the requirement that students carefully weigh alternative solutions to a problem. The weighing of alternative solutions was thus identified as one of the elements of decision-making that was addressed within the standards documents. Analysts, who have teaching backgrounds in the subject-area they reviewed and training in the taxonomy and methods of content-analysis, examined the standards documents for statements that expressed or implied thinking or learning skills that students should acquire. Upon finding any such content, they identified the taxonomic level and the process within that level that best described the skill. They completed the process by identifying the topic or chief element of that process that was addressed. Using such a method, analysts reviewed all the documents and assigned it to categories available in the taxonomy. The findings are discussed by cognition, or thinking skills; metacognition, or knowing about learning; and the self-system, or knowing about attention and motivation to learn.

There are limitations to this study; chief among them is the nature of the analysis required to conduct it. References to thinking and learning skills were frequently not overt in the standards, but embedded within descriptions of student activities or demonstrations. It was often only through careful review of the standards that analysts identified the thinking and learning skills expected of students. More than one analyst reviewed each finding to confirm the analysis, but it is the case that documents were often not specific or deliberate about their identification of these skills. It is possible that there were thinking skills in these documents that were inadvertently omitted. It is also possible that, in the process of ensuring that no skills were missed, statements were interpreted as indicating that students should be engaged in a thinking skill, when there was no such intent on the part of the document's authors.

COGNITION—WHICH THINKING SKILLS ARE EXPECTED OF STUDENTS

In our analysis of standards documents, we found that some levels of cognition are required universally, regardless of subject area and type of document: whether from states, subject-area organizations, or those that focus on preparation for post-secondary work. These cognitive skills include: retrieval, which includes recognizing and recalling facts and executing simple procedures; comprehension, which includes integrating information or symbolizing relationships; and analysis, which includes identifying similarities, classifying, forming generalizations, making predictions, and identifying errors.

Our analysis of another type of cognition—knowledge utilization—revealed notable variation in coverage among the subject-areas. The cognitive process of knowledge utilization includes decision making, problem solving, experimenting, and investigating. It is beyond the scope of this study, which is entirely descriptive in purpose, to explain why such differences in cognitive processes might occur between subject areas or types of standards documents. Although readers may well draw their own conclusions (for example, that it is unsurprising that students in English classes are not expected to conduct experiments), the present task is limited to providing a sense of the scope

of processes in these documents and how they present themselves in the standards. Overall, our findings show that topics organized within knowledge utilization appear most frequently in science standards, and least frequently in social studies standards.

METACOGNITION—WHAT STUDENTS ARE EXPECTED TO KNOW ABOUT HOW THEY LEARN

We found some evidence in standards documents that students are expected to engage in metacognition, which includes setting their own learning goals, monitoring their progress toward learning goals, and monitoring their thinking processes for accuracy and for clarity. As in the case with knowledge utilization, however, these expectations do not appear universally across all subject areas.

Across all subject areas, students were most frequently expected to establish their own learning goals in the English language arts. The aspect of metacognition found to be most common across all subjects and documents concerns student monitoring of progress toward a learning goal; in other words, the student monitors how effectively he or she is attaining knowledge or skill. In the English language arts, for example, students are reminded to adjust strategies as necessary to ensure that they are meeting reading, writing, and listening goals. Nearly every document in mathematics, and most in science, also addressed this topic.

Monitoring clarity—that is, the extent to which students monitor how clear they are about what they are learning—was found predominantly in the English language arts, in which clarity is emphasized as an important objective for reading comprehension; other subject-areas do not address reading comprehension. Monitoring accuracy, which refers to the attention students pay to their own accuracy and understanding while engaged in learning, was found principally in mathematics, where it appeared in all but one of the documents reviewed. Students are commonly reminded to check the reasonableness of their mathematical results and verify their work.

SELF-SYSTEM—WHAT STUDENTS ARE EXPECTED TO KNOW ABOUT THEIR ATTENTION AND MOTIVATION TO LEARN

The standards documents indicated few expectations for students relative to the self-system, that is, the attitudes, beliefs, and emotions students hold about themselves as learners and about what they are learning. REL Central reviewed standards documents to determine whether students were expected to examine the importance of their learning, their efficacy as learners, their emotional response to learning, or their motivation to learn.

Although we found few cases in which students are expected to consider the importance of what they are learning, the range of application for this aspect of the self-system was diverse. In the area of mathematics, for example, students are asked consider the importance of the mathematics they are learning to their own lives. They are also asked to consider the importance of knowing how they reached the solution to a particular problem.

Within the standards documents reviewed, students are not typically expected to examine whether or not they are effective in their approach to learning. Such expectations commonly take the form

of asking students to consider whether they create barriers to their own learning, or if they allow external factors to derail their attention, and how they might remedy these distractions.

Of all aspects included under the heading of the self-system, the expectation most frequently found in the documents was that students should be aware of their emotional response in the course of their learning. The common focus of this idea was that students should not allow emotions to cloud their judgment and should consider arguments dispassionately, allowing logic its proper role.

In terms of motivation, there were no clear statements in the documents reviewed that students should examine their motivation to learn. However, a number of standards documents identified value in students demonstrating persistence, which analysts construed as being most closely related to motivation, of all categories identified within the self-system. Standards documents also made clear that students should have the time and opportunity to engage in work that is of interest to them, which suggests a concern that students have the means to connect to their learning in a way that motivates them.

In summary, our review showed that there are expectations among the standards documents that students should demonstrate a variety of thinking and learning skills, and these may be organized under the categories of cognition, metacognition, and attention to the self as learner. Educators or state policymakers who wish to understand whether and how commonly students are expected to acquire cognitive, metacognitive, and self-system skills may find these results of interest..

WHY THIS STUDY?

As states conduct their periodic review of standards for students, they seek better understanding of the skills and knowledge expected of students in other influential standards documents. In an effort to address this need, REL Central set out to examine a set of standards documents to determine what types of thinking and learning skills are commonly anticipated. In REL Central's seven-state service area (Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming), educators and policy makers are committed to ensuring that students acquire the skills and knowledge essential for their future success. Our interviews of leadership groups of principals, superintendents, and chief state school officers all indicated that identifying essential learning for students is a priority.

Standards serve the purpose of describing, with some specificity, what students should know and be able to do by the time they graduate from high school and in the grades along the way. Standards documents are the primary means by which these expectations are communicated to educators, to students, and to parents. State-level standards frequently have the force of legislation behind them and are readily available not only to teachers but to students, parents, and community members through postings on the Web sites of state education agencies. Standards developed by national subject-area organizations often help to inform the development of state standards. Recently, organizations that represent the interests of post-secondary organizations and the high-skills workplace also have promulgated their own standards to make clear what skills students should have in order to succeed in college or the workforce.

An earlier REL Central *Issues & Answers* report, based on a related concern for student preparation, examined whether or not the seven states in the region (Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming) expect all high school students to obtain the knowledge and skills identified as important for success in college or work. That study, "High School Standards and Expectations for the Workplace," (Kendall, Pollack, Schwols, & Snyder, 2006) focused on the extent to which state standards cover mathematics and the English language arts in the Central Region relative to expectations held by post-secondary institutions and the high-skills workplace, focusing on the *academic* content of the disciplines.

No study has yet examined standards documents to determine what expectations are held for students beyond the academic content of the disciplines—specifically, what expectations are held for students related to thinking and learning skills.

All seven Central Region states have published standards in each of the four core subject areas; these documents have varying but indisputable impact on the curriculum in the schools of each state. The standards documents from national subject-area groups, although many are more than a decade old, continue to be cited as influential in the development and revision of state standards and remain the sole national consensus among educators regarding important content for any subject area. Nearly all of these standards documents are readily available online for use by educators. For expectations held for graduating seniors by post-secondary institutions and the world of the high-skills workplace, three organizations have identified important English language arts and mathematics content; one organization addresses science and the social studies content as well.

This report expands the question of academic expectations for all students to consider the processes related to learning—that is, *cognitive* and *metacognitive* processes, as well as processes related to the *self-system*—that may appear across core subject areas (English language arts, mathematics, science, and the social studies) from three sources. We reviewed standards from state departments of education and national subject-area groups, as well as reports on what students should know to be successful in post-secondary education and the high-skills workplace (see Appendix B, Table B1).

In order to identify the types of thinking and learning skills that appear in these standards documents, it is of course necessary to choose a method to organize the range of possible topics that are addressed. Researchers and scholars have published a number of papers and studies in attempts to define the nature and scope of critical thinking skills in addition to those skills that are required for students to take active steps to improve their learning and monitor their current levels of understanding (Bransford & Schwartz, 1999). Attention to one's own learning, sometimes called process monitoring, is among a set of *metacognitive* and related skills that students must acquire in order to learn and adapt to the changing demands of school and the workplace. A student's motivation, part of the *self-system*, is also among the set of skills that are critical to student's learning (Wang, Haertel, & Walberg, 1992). There appears to be little consensus among the studies regarding what each skill set comprises. This is especially true regarding the *metacognitive* and *self-system,* for which definitions in the literature often overlap; in fact, either may appear described as a component of the other (Mosley, et al., 2005; further discussion on how

these ideas appear in research and theoretical studies appears in appendix A.) In order to identify the full range of skills that may be considered, Marzano and Kendall's recent taxonomy (2005) was selected as a useful means for distinguishing among these systems and identifying the possible subcomponents of each (see the "Tool for Analysis" section for definitions of the major categories used in this report).

Some assert that these "learning-to-learn skills," may be inadequately addressed in academic standards and the curriculum (Cornford, 2002; White & Frederiksen, 2005). Whether or not this is true, it is the case that until we understand whether such expectations are present in current standards, it is not possible to consider whether they are sufficiently addressed or need to be included more systematically.

The information gleaned by reviewing how well learning-to-learn skills are addressed in state-level standards, as well as in expectations held by post-secondary and workplace institutions, is provided for leaders responsible for establishing expectations at the school level (i.e., high school principals, superintendents, and local board chairs); state officials who set graduation standards (i.e., education agency personnel, board members, and legislators); and post-secondary faculty. In short, this report is intended to inform educators and policymakers who seek to understand what skills students are currently expected to acquire related to cognitive, metacognitive, and self-system skills, and how their own state compares to others, to standards established by national organizations, and to the expectations held by post-secondary institutions and the high-skills workplace. How, then, do standards documents address learning-to-learn skills?

THE PROCESS OF ANALYSIS

In order to conduct an analysis of types of thinking and learning skills, we required a system that could allow us to classify and organize any type of thinking and learning skills that might be found in the text of the standards, regardless of subject area or authoring organization. We reviewed possible educational taxonomies that might serve to identify key distinctions among different types of thinking and learning skills (see Appendix A for a discussion of this task) we selected and adapted an educational taxonomy (Marzano & Kendall, 2007) that proved useful both for the analytic work and for organizing and presenting the findings of our work. Note that the taxonomy is simply a tool for analysis, and *does not* prescribe what students should learn; its value lies in the comprehensive and systematic way it defines a wide variety of skills related to thinking and learning. The taxonomy is organized in six levels – four in the area of cognition, one in metacognition, and one in the self-system. Each level is further organized by type of mental process. So that, for example, the level of cognition called Knowledge Utilization includes the mental process of decision making. For the purposes of this study, another level, the topic level, was developed, in order to more specifically describe each process as it appears in the standards documents. For example, relative to decision-making, a standards document might focus specifically on the requirement that students carefully weigh alternative solutions to a problem. The weighing of alternative solutions was thus identified as one of the elements of decision-making that was addressed within the standards documents. Analysts, who have teaching backgrounds in the subject-area they reviewed and training in the taxonomy and methods of content-analysis, examined the standards documents for statements that expressed or implied thinking or learning

skills that students should acquire. Upon finding any such content, they identified the taxonomic level and the process within that level that best described the skill. They completed the process by identifying the topic or chief element of that process that was addressed. Using such a method, analysts reviewed all the documents and assigned it to categories available in the taxonomy. The findings are discussed by cognition, or thinking skills; metacognition, or knowing about learning; and the self-system, or knowing about attention and motivation to learn. (For a description of the protocol, see Appendix C)

The report will present these findings by each of the three systems in the taxonomy used to conduct the analysis — *cognitive*, *metacognitive*, and *self-system.*

COGNITION — WHAT THINKING SKILLS ARE EXPECTED OF STUDENTS

In order to identify the thinking and learning skills within the standards documents, we used a taxonomy that treats cognition as a system of four levels: retrieval, comprehension, analysis, and knowledge utilization. Each level comprises a set of processes. For example, the retrieval level includes the processes of recognizing, recalling, and executing (for a complete list of levels and processes, see Table 1, page 18). Analysts reviewed all the standards documents for the presence of such skills. As they did so, they noted the various ways in which students were expected to demonstrate these skills. This is an example on how the taxonomy was adapted for the purposes of this analysis. This level of organization does not exist in the taxonomy, but was added in order to create categories that more closely reflected the kinds of expectations that appeared in the standards. For example, the analysis level includes the process of analyzing errors. Analysts reviewing the standards identified a number of different ways in which students were asked to analyze errors, such as that they evaluate the accuracy of data, or review content for bias, or critique their own work for flaws. For each process analysts identified a set of topics or elements that seemed to recur across documents. This set of topics or elements provided a means for indicating how any one document touched on the aspects of a process that was found to be present across most of the documents. As described below, at the first three levels—retrieval, comprehension, and analysis—standards documents did not vary significantly in the ways the expected students to apply a mental process to demonstrate their learning. For the process of knowledge utilization, however, differences among the documents were more notable. For example, in decision-making, one document may emphasize only the selection of an appropriate tool or method for a given problem, while another may focus on how making a choice often requires an understanding of the risks and benefits involved. The following section describes all four levels within *cognition*.

LEVEL 1: RETRIEVAL

The first level of the taxonomy is the simplest aspect of learning: Retrieval. Retrieval refers to students' recognition of information, or recall of it when asked. Retrieval also includes simple execution tasks: that is, tasks in which students recall and execute a series of steps, such as is the case in addition, that become routine or automatic. Standards, across document types and

subjects, do not vary in any notable way in their expectations that students have a mastery of basic facts and simple procedures.

LEVEL 2: COMPREHENSION

The second level of the taxonomy, Comprehension, concerns students' ability to integrate knowledge or to represent their integration of knowledge symbolically. For the most part, emphasis on integration of knowledge appears to be common across documents, with no significant differences across document types. For the aspect of comprehension within the taxonomy that addresses symbolic or visual representation, however, there are some slight differences. State standards documents in the English language arts emphasize the use of visual organizers, but documents for post-secondary readiness do not. Across all document types, the greatest variety of ways in which students are asked to represent information appears within mathematics, largely owing to a focus on spatial reasoning and visualizing problems. Science follows next, with a focus on the use of models. For the social studies, attention to the symbolic aspect of comprehension relates to students' understanding and use of maps and charts.

LEVEL 3: ANALYSIS

The third level of the taxonomy, Analysis, is comprised of matching, classifying, analyzing errors, generalizing and specifying (for a discussion of these and all other levels, consult appendix B.) No differences among subject areas or document types appear to be significant. All topics are addressed to some degree.

LEVEL 4: KNOWLEDGE UTILIZATION

Some differences among expectations for students appear when students are asked to apply their knowledge or understanding; in the taxonomy used for this study, this area is known as Knowledge Utilization. Knowledge utilization comprises four areas: decision making, problem solving, experimenting, and investigating. Figure 1 indicates this variation of coverage in the four subject areas for each of the authoring organizations in the area of knowledge utilization. Each process of knowledge utilization is discussed immediately below.

Across all subjects and authoring organizations, decision making appears to be the aspect of knowledge utilization that is most commonly addressed. For example, a common sub-topic in this area is that students should be able to decide among available strategies—typically, from among strategies for reading in the English language arts, or for problem solving in mathematics and science. When decision making appears in the social studies, it is commonly centered on economic decision-making.

In mathematics problem solving was addressed in the greatest variety of ways; this is true whether the standards are authored by a state department of education, the national subject-area group, or organizations focused on preparation for post-secondary work. Science also addresses a number of aspects in problem-solving. This topic also appears in the English language arts, though obliquely; for example, problem-solving is identified as one purpose that can be addressed through reading,

writing, speaking, and listening. The references to problem solving in the social studies center on the idea that complex issues and problems are best approached through understanding multiple perspectives.

Experimenting, as defined by the taxonomy used for this analysis, involves generating and testing hypotheses about a specific physical or psychological phenomenon. A defining feature of experimenting tasks is that data are collected by the student. It is not surprising, then, that nearly all references to experimenting of this type across the documents appear in the subject area of science. Rare references in mathematics or social studies address the use of statistical analyses and surveys.

Investigating is also best represented in science, but is also represented in the English language arts. Investigating, as defined in the taxonomy, does not depend on observable data but on assertions and opinions. In this view of investigating, logical argument plays an important role, and is the focus found among standards for the social studies.

How to Read the Figures

Each column identifies a standards document examined for this report; each row identifies a mental process within the taxonomy. Analysts searched for evidence of each process within all the documents. There were often a number of aspects or elements in a process that could be found in one document, but it was often the case that not every element could found in every document. For example, some documents focused on the fact that students should identify a problem constraint, while in others, the constraint was given. In some documents, students were asked to identify assumptions before solving a problem; in other cases, they were not. Each of these aspects was counted as an element within the process. The intersection of row and column in the graphic indicates how extensively, compared to all other documents, the identified document addressed all the elements that was found associated with that process, here the process of problem solving. An empty circle indicates that a document did not address any of the elements associated with problem solving. A filled circle indicates that the document addressed the topic in as many different ways as appeared in all other documents. Topics varied in the number of ways they were addressed in the documents—this is indicated by the "number of elements" column next to each topic. For example, analysts found that nine different elements of problem solving could be identified across all documents and subject areas. The excerpt in Figure 1 represents the results of analyzing standards documents in the English language arts for their treatment of problem solving. In this analysis, three college work readiness documents were analyzed (in blue in the graph), one document from the national subject-area group (in maroon), and seven documents from the Central Region (yellow).

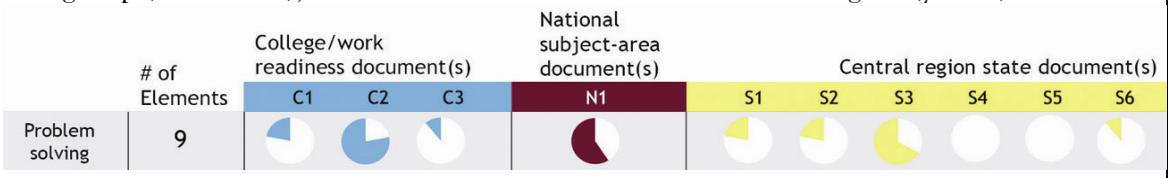
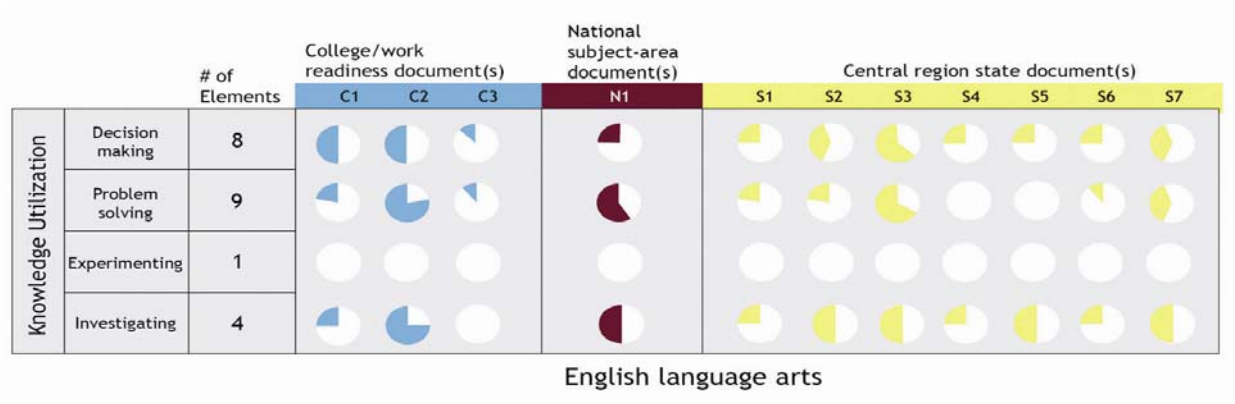
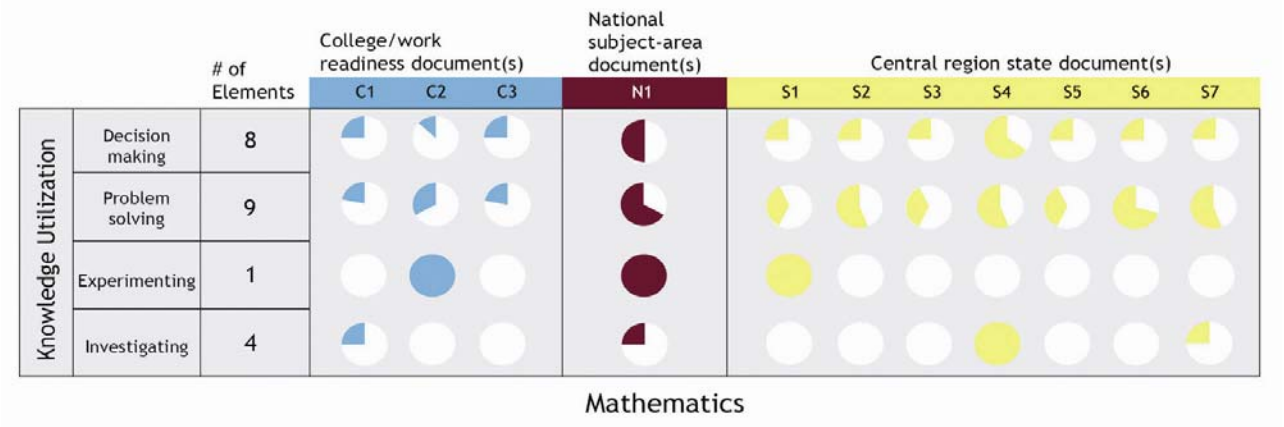


Figure 1. Problem solving in the English language arts.

Figure 1 indicates that two state documents (S4 & S5) did not reference problem-solving skills in standards for the language arts. State document S6 addressed one just one aspect—in this case, the document identified students' use of multiple resources to address a research problem. A college readiness document (C3) similarly addressed one aspect of the topic. Hence, the wedge at the intersection of C3 and S6 and problem solving, graphically represents that each document addressed one of the nine elements. Across all documents, the number of aspects or elements for a given topic ranged from as little as one—in experimenting—to as many as nine elements, as in problem solving. The portion filled of each circle reflects how many of those elements a specific document addressed for the identified subject area. (See Table B1 for the codes used in each table to identify the documents examined for this report.)

Figure 2 represents how each given document, by authoring agency, within a subject area, addresses these four processes within the cognitive level called knowledge utilization. Some mental processes—such as experimenting—are somewhat narrowly defined and found to be either completely addressed within a document or completely absent; thus, the associated circle in the graph is either completely filled or empty. Other areas, such as decision making, had a variety of aspects or topics associated with them in the standards documents reviewed (for a discussion, see *How the taxonomy of educational objectives was used to classify content related to cognition, metacognition and the self-system in the "Tool for Analysis" section.).* The degree to which a circle is filled reflects the variety of aspects found in the document for that subject when compared against all other documents for that subject.





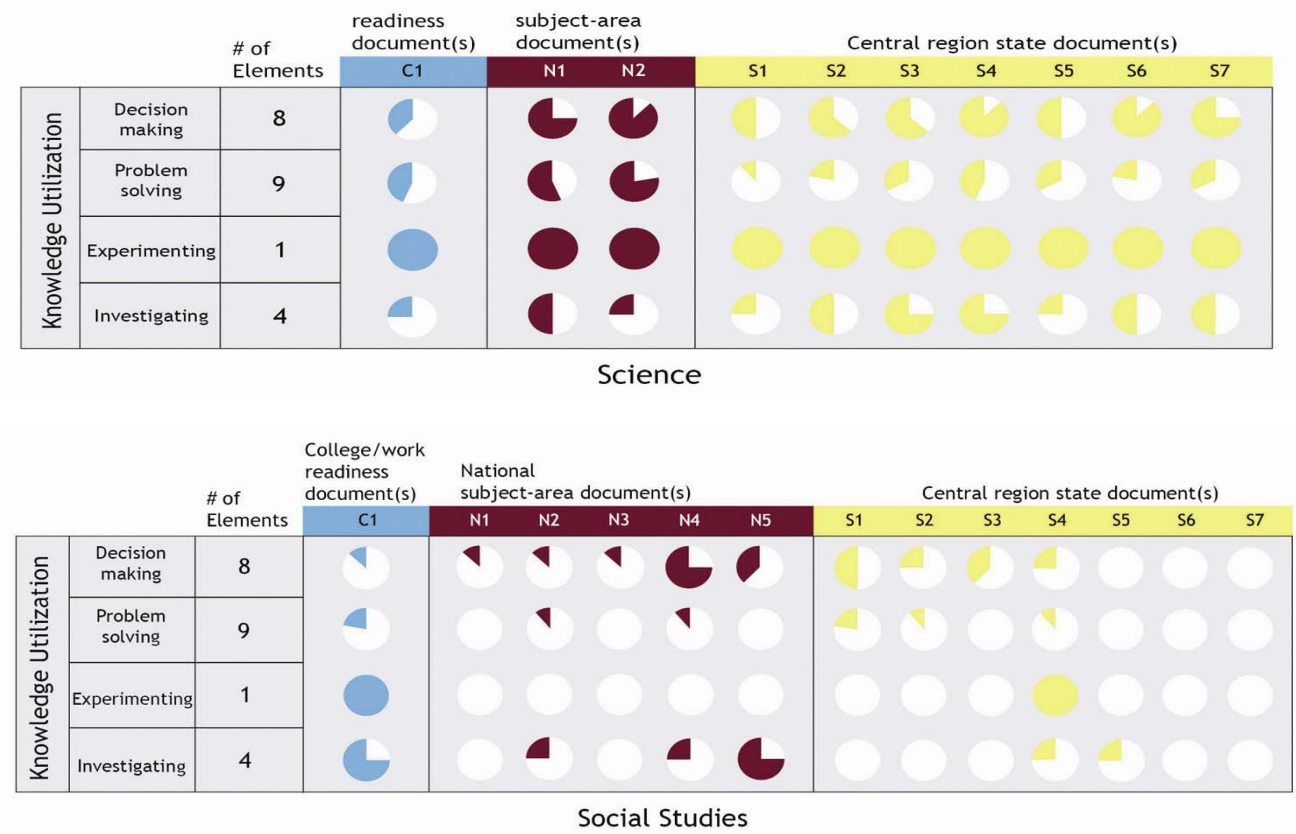


Figure 2. Extent to which expectations for students relative to knowledge utilization appear in a varitey of standards documents in English language arts, mathematics, science, and social studies

Note: Each column represents a document; the document type is indicated by the color key. For each process, the portion of the filled circle represents how much a document contains in comparison to the variety of ways in which the same process is addressed across all documents in that category.

METACOGNITION — WHAT STUDENTS ARE EXPECTED TO KNOW ABOUT HOW THEY LEARN

Metacognition can be described as knowledge or awareness of learning. It may refer to the process of monitoring one's cognition *or* the knowledge one has about strategies for learning *or* characteristics of a task that affect cognition. For purposes of identifying the kinds of expectation held for students in the standards documents, metacognition is divided into four areas of student activity: specifying goals, monitoring process, monitoring accuracy, and monitoring clarity. Each aspect will be addressed in turn. In order to identify the thinking and learning skills within the standards documents, we used a taxonomy that divides metacognition into four areas of student activity: specifying goals, monitoring process, monitoring accuracy, and monitoring clarity. Documents were analyzed in order to identify how whether they addressed these areas.

In order to capture the full range of possible topics identified from the research literature, analysts adapted the taxonomy in order to analyze metacognition for the extent to which it addressed

subject-specific and non-subject-specific metacognitive knowledge and processes. In other words, documents may (and did) address specifying goals as either generally useful, for example, or as particularly useful for the subject area at hand; similarly, standards could (and did) emphasize students' engagement in the activity of monitoring their work for accuracy as they engaged in a mental activity, or, alternatively, identify that students should know or understand the value there is in monitoring their activity for accuracy. The findings are represented graphically in Figure 3.

SPECIFYING GOALS

The metacognitive process of specifying goals involves setting specific goals relative to one's understanding or skill and developing a plan for accomplishing those goals. Very few documents, regardless of subject area or authoring agency, expect students to be able to set specific learning goals. In the English language arts, such references focus on personal improvement, such as setting a goal for reading or setting a goal for improved communication. The national subject area document for mathematics notes that "Students learn more and learn better when they can take control of their learning by defining their goals and monitoring their progress" (p. 21).

MONITORING PROCESS

The area of metacognition for which standards documents most commonly hold expectations is students' ability to monitor their own work or mental processes. English language arts standards showed the most variety in addressing this skill, focusing specifically on student self-reflection during the reading and writing process. These same standards also were the most likely to address process monitoring as an explicit part of the learning process. For example, the national subject area group states that the conscious process of learning how to learn is an essential element in students' language arts education. A number of expectations for students focus on their adjusting strategies as needed during the process of reading, writing, and listening. All such expectations concerned students' contemporaneous monitoring of their learning process. However, what might be termed a *post facto* approach to process monitoring was also found within the documents. Documents in mathematics, in a few cases, value students' reflection on their past thinking as a way to improve the problem-solving process. Science and social studies also had a few statements of this type. All such cases regarded the process itself as the topic for learning; that is, the expectation was that students should examine their past actions, rather than conduct "real-time" monitoring of their activities. For example, students were asked to consider and evaluate the processes they had used in recognizing and solving problems which, broadly understood, could be interpreted as an expectation that students revisit—monitor after the fact—the process they employed in the solution of a problem. This aspect represents fully a third of the items identified in this section.

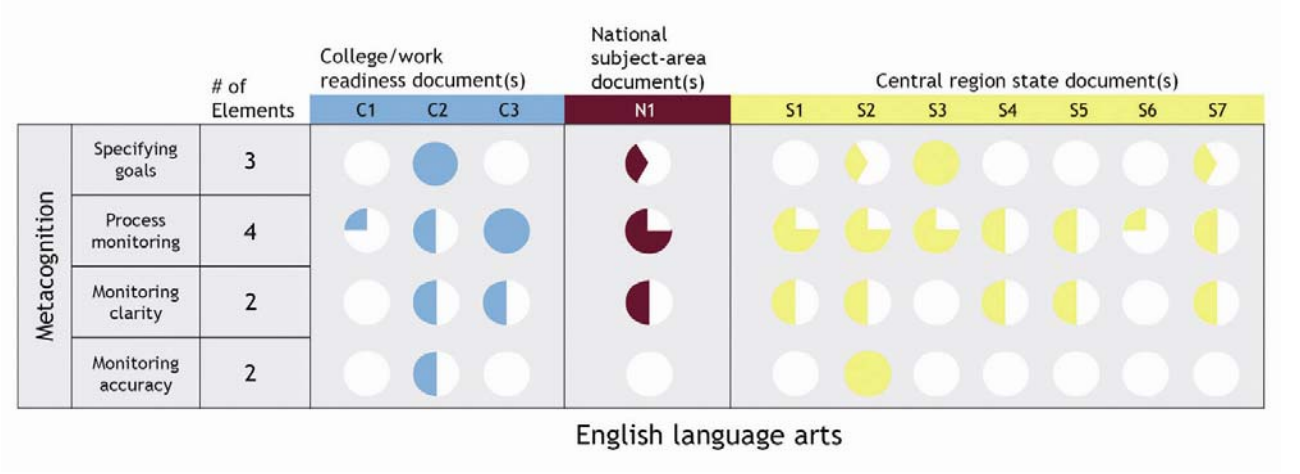
MONITORING CLARITY

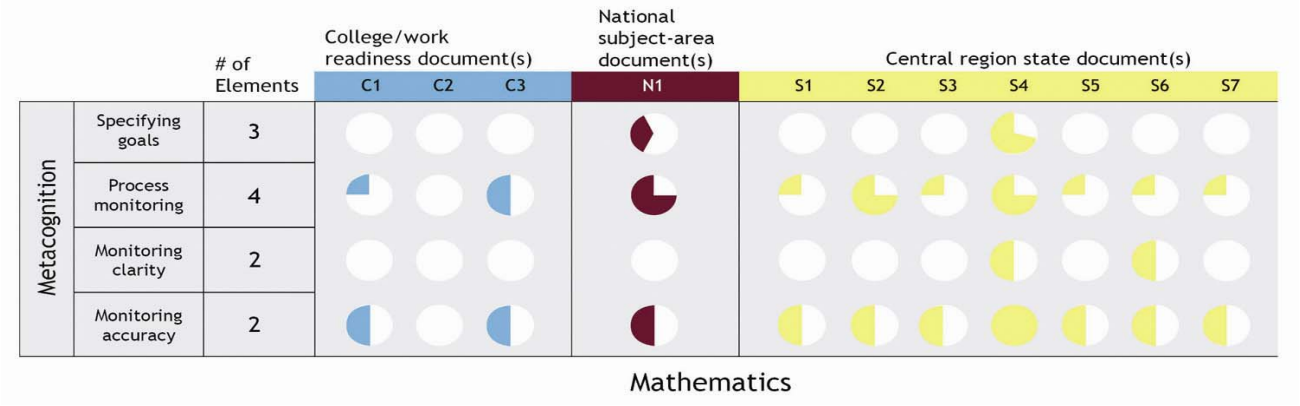
Monitoring clarity involves the extent to which the student maintains clarity about a skill or knowledge. Most documents in the English language arts addressed this topic—not surprisingly, because monitoring the reading process is principally about ensuring that one has a clear understanding of what one is reading. In mathematics, the citations are general statements

enjoining teachers to ensure that students continue to refine and clarify their thinking. The national science documents, but no other documents, encourage students to ask specific clarifying questions as the work, such as "How certain are you of those results?", a question that might be to encourage students to monitor for how clearly they understand the skill or knowledge.

MONITORING ACCURACY

Monitoring accuracy, which addresses the extent to which the student determines he or she is accurate about specific knowledge, appears at least once across all subject areas. In the English language arts, the standards documents focus on the accuracy of student's understanding of the text—that is, self-correcting for meaning, especially to ensure that bias has not skewed one's understanding of what has been read. In mathematics, students are reminded to check the reasonableness of results during the execution of a process. In science, a shared idea among the documents is that the careful review of one's completed process to verify results encourages careful checking of one's thinking, which includes monitoring for bias. In the social studies students are encouraged to monitor accuracy by analyzing issues from multiple and historically objective perspectives.





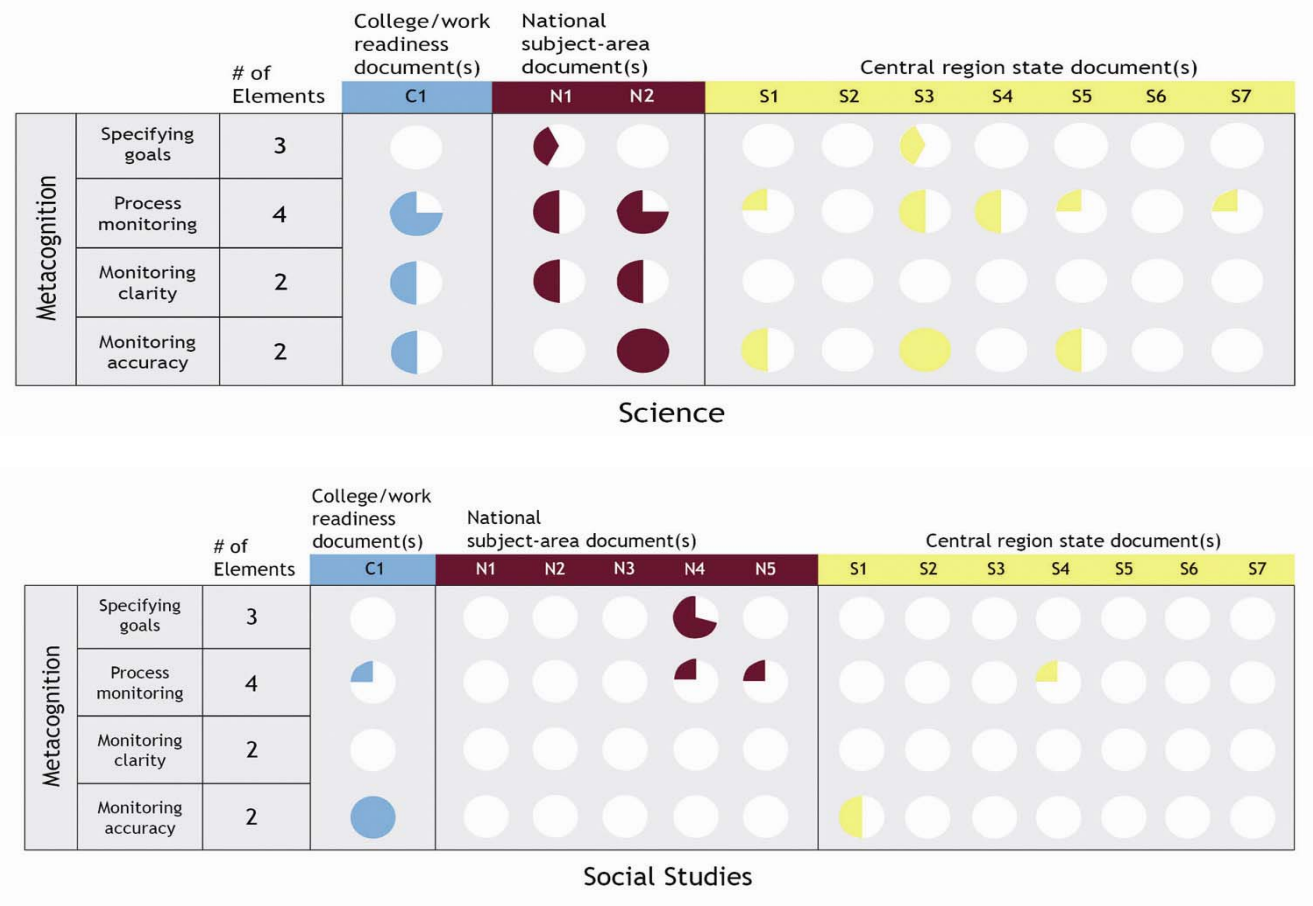


Figure 3. Extent to which expectations for students relative to metacognition appear in a varitey of standards documents in English language arts, mathematics, science, and social studies

Note: Each column represents a document; the document type is indicated by the color key. For each process, the portion of the filled circle represents how much a document contains in comparison to the variety of ways in which the same process is addressed across all documents in that category.

SELF-SYSTEM — WHAT STUDENTS ARE EXPECTED TO KNOW ABOUT THEIR ATTENTION AND MOTIVATION TO LEARN

The self-system can be described as the principal and first level of student engagement: that is, when or whether a student chooses to learn is a necessary first step for learning. Only if the self-system is engaged and the student has enlisted in an effort to learn is there sufficient reason to invoke the metacognitive system and establish or learning goals relative to knowledge or skill of interest. The taxonomy used for this analysis identifies the self-system as a set of interrelated attitudes, beliefs and emotions, the interaction of which determine an individual's motivation and attention. There are four self-system processes: examining importance, examining efficacy, examining emotional response, and examining motivation. The findings are represented graphically in Figure 4.

EXAMINING IMPORTANCE

The process of examining the relative importance of a task or undertaking is expected of students in just a few standards documents, although at occurs at least once in each subject area. It commonly appears in the form of students being asked to consider the importance of an activity; for example, the importance of asking questions, of reading a variety of texts, of reflecting on their thinking, and learning from their mistakes. Subject-specific concerns also appear in this category, such as students understanding of the importance of mathematics in their own life, and for the social studies, the value of understanding historical arguments in order to better understand present-day issues and concerns.

EXAMINING EFFICIENCY

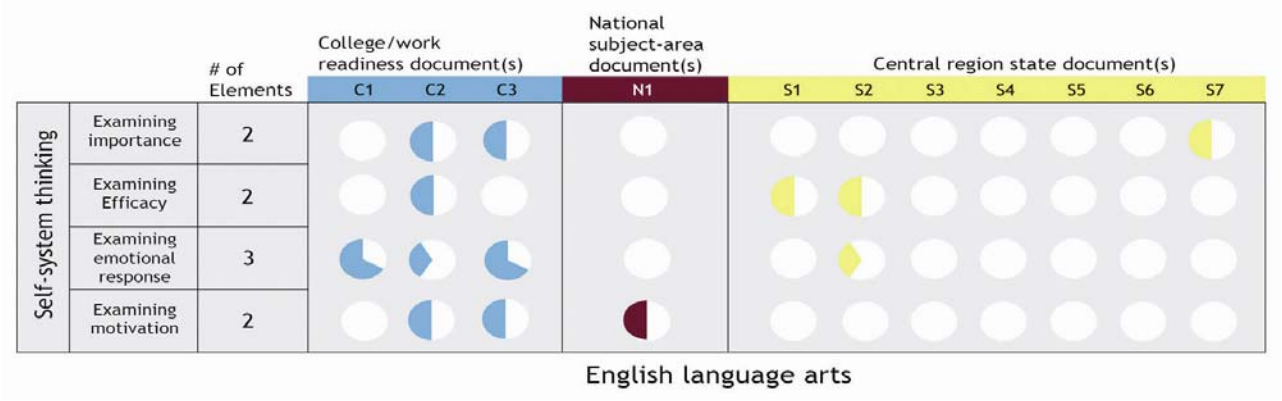
Examining efficacy — that is, attending to the task of improving one's knowledge or skill in a particular area — differs from process monitoring in that the central question is not observing to how knowledge or skill is used, but how effectively one manages the acquisition of knowledge and skill. This category, along with the category on examining importance just described, revealed the fewest expectations for students across all subject areas and authoring agencies. As in almost all categories, analysts often were required to make inferences in order to identify the kind of examination that appeared to be required. For example, under examining efficacy, knowing when to ask for help was taken as an indication that students are expected to examine how well they are managing a task.

EXAMINING EMOTIONAL RESPONSE

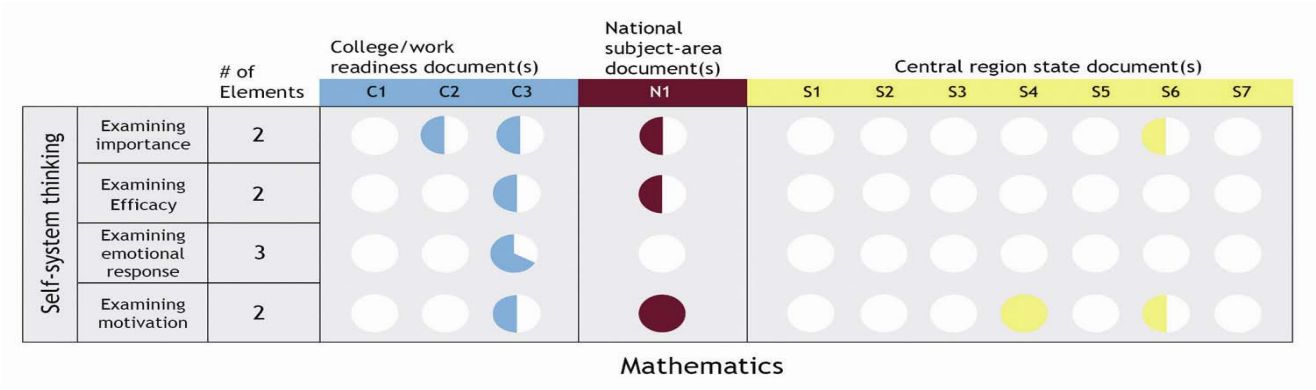
Content related to examining emotional response also required that analysts make certain inferences from the text. For example, in the subject-area of science, more than one document notes that it is helpful for students to develop a tolerance for ambiguity. We inferred that such an activity requires that students resolve emotional responses in situations that might otherwise be frustrating. More direct descriptions related to examining the emotions are commonly found in language arts texts, for example, when students are asked to understand how their emotions shape their response to texts. A less direct example appears when students are asked how a particular speech made them feel, and thereby analyze how the speech appealed to their emotions.

EXAMINING MOTIVATION

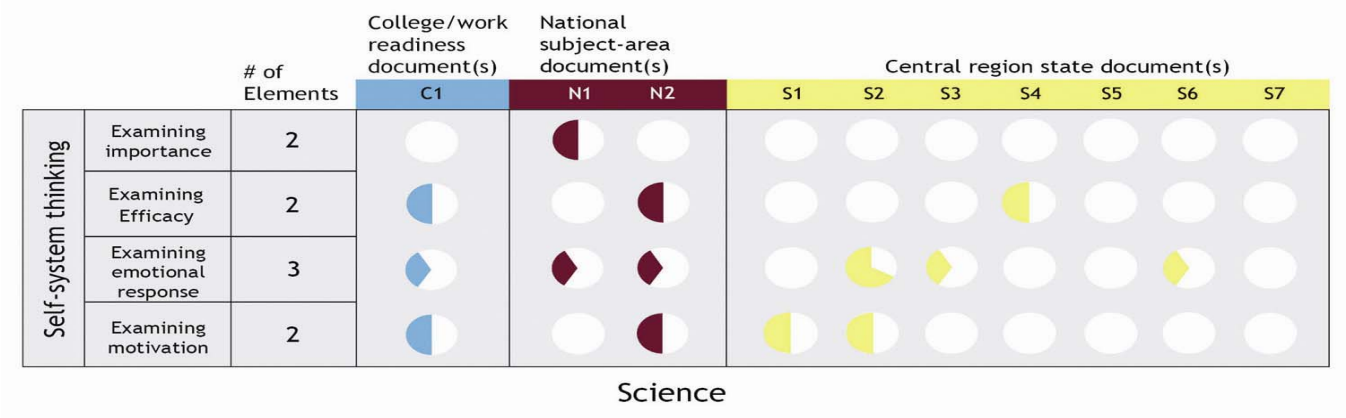
In the category of examining motivation analysts often inferred an expectation in the documents based on closely related content. For example, an expectation that on students' develop perseverance suggests that students should be well motivated. There were no explicit expectations that students examine their motivations directly, but motivation was valued for students ("persistence is vital") and how students might become motivated was clearly a concern, as made clear in the observation that students should have the time and opportunity to investigate scientific questions that interest them. Some standards touched on the value of persisting in the face of difficulties; this appeared most often in the mathematics standards.



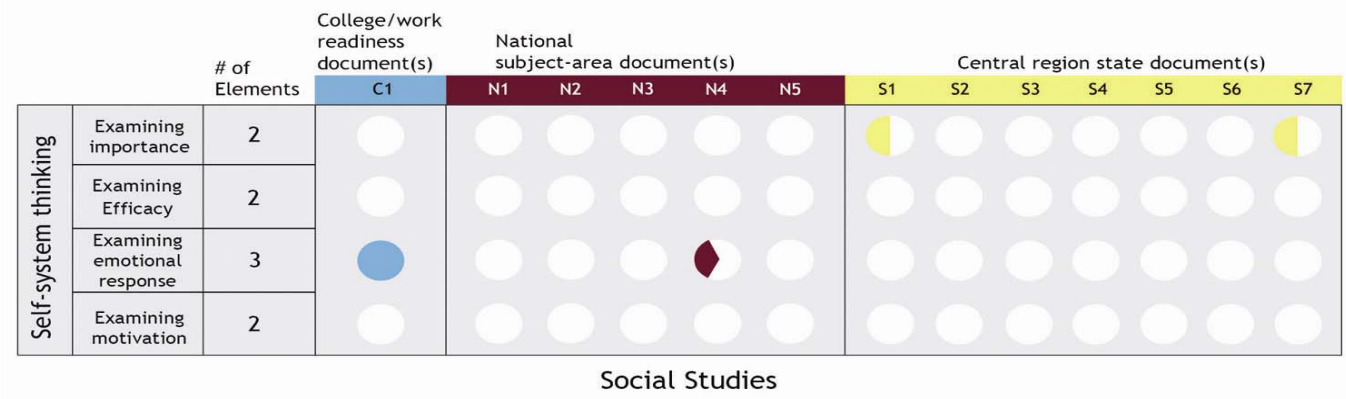
English language arts



Mathematics



Science



Social Studies

Figure 4. Extent to which expectations for students relative to self-system appear in a varitey of standards documents in English language arts, mathematics, science, and the social studies.

Note: Each column represents a document; the document type is indicated by the color key. For each process, the portion of the filled circle represents how much a document contains in comparison to the variety of ways in which the same process is addressed across all documents in that category.

IMPLICATIONS

This study provides an overview of expectations held for students regarding thinking and learning skills as they are expressed in standards documents that currently in use or influential at the state and national levels. Standards documents commonly represent the consensus of many educators. This agreement among experts in the field accounts, in part, for the authority and influence of standards in the day-to-day curriculum. It should be noted, however, that standards documents that identify subject-area content typically communicate specific statements about student knowledge and skill that are unambiguous and readily understood. Identifying skills related to thinking and learning in these standards documents often required a close analysis of the text and careful inferences on the part of analysts; examples of such inferences have been provided through this report. The level of inference required to complete the analysis indicates that there remains some uncertainty about the actual extent of standards expectation for this area, and additional studies may be warranted to confirm or disconfirm what has been identified here.

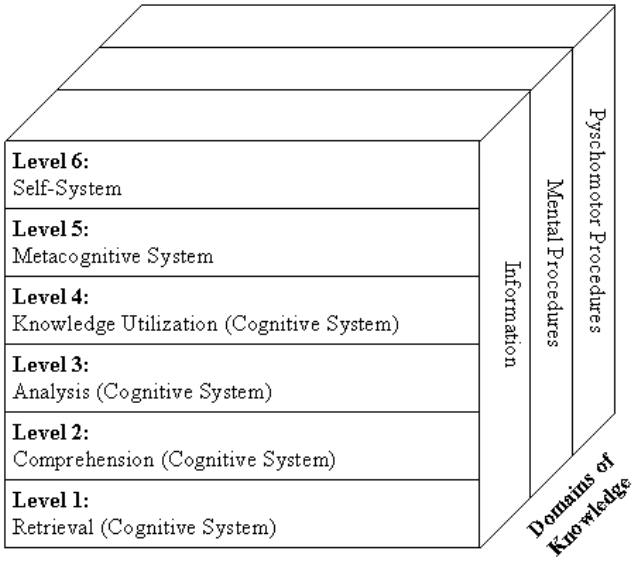
TOOL FOR ANALYSIS: A TAXONOMY OF EDUCATION OBJECTIVES

In order to determine whether a taxonomy of educational objectives could be used to identify and code content in the standards documents, REL Central examined research reviews and theoretical studies related to cognition, metacognition, and the self-system to determine the potential scope of these topics. The review served not to reconcile views on these topics comprise, but to determine whether, given the range of topics found organized beneath these topics across a variety of theoretical studies and research surveys, a taxonomy could be successfully adapted to capture the full range of ways in which such content might appear in standards documents. In the course of this study, the suitability of other taxonomies to this purpose was also considered. (See Appendix A for a discussion.) A taxonomy of educational objectives from Marzano & Kendall (2007) was adapted to serve as the tool by which to identify to whether and to what degree students were expected to engage in a variety of activities at the *cognitive*, *metacognitive*, and *self-system* levels (see Figure 5 for an overview of the taxonomy and Table 1 for a description of the levels).

The taxonomy of Marzano & Kendall used for this study is described in Table 1; an overview of the structure is provided in Figure 5. Among the advantages of the taxonomy for this study are the distinctions it provides among the cognitive system, the metacognitive system, and the self-system. As discussed in Appendix A, aspects of each of these systems appear in recent research literature and theoretical work on metacognition, motivation, and affect. Of interest, as well, is that the taxonomy is hierarchical by system, based on control and flow of processing. Briefly, the self-system can be described as the first level of student engagement: that is, when or whether a student

chooses to learn is a necessary first step for learning. Only if the self-system is engaged and the student has determined to engage in the effort to learn is it reasonable to expect that he or she will take a metacognitive interest in the effort – that is, to invest the energy required to monitor how well a task is being executed, whether that be a low-level skill or a higher-level thought process such as decision making. That is, under the direction of the metacognitive system, the elements of the cognitive system can then be monitored. The cognitive system includes processes ranging something as simple as retrieving information to the task of applying knowledge in an unfamiliar context.

The three systems within the taxonomy are also hierarchical relative to the level of awareness required to effectively control their execution. Cognitive processes require a degree of awareness, of conscious thought, on the part of students–although this may be minimal in the case of routine addition. Observing the cognitive process–whether to check for accuracy, to question whether the task can be done more efficiently, and the like–requires more conscious effort, which is why the metacognitive system is considered more demanding. Finally, self-system processes such as examining importance of the task, checking one's emotional response, and questioning one's motivation for a task, represent a level of introspection and conscious thought that places still greater demands on a student's attention.



Levels of Processing

Figure 5. The organization of the taxonomy. Reprinted from Marzano, Robert & Kendall, John (2007). *The New Taxonomy of Educational Objectives.*

Table 1. The cognitive, metacognitive, and self-systems. Adapted from Marzano, Robert & Kendall, John (2007). The New Taxonomy of Educational Objectives.

LEVEL 1: RETRIEVAL (COGNITIVE SYSTEM)	
Recognizing	The student recognizes features of information but does not necessarily understand the structure of the knowledge or can differentiate critical from noncritical components.
Recalling	The student produces features of information but does not necessarily understand the structure of the knowledge or can differentiate critical from noncritical components.
Executing	The student performs a procedure without significant error but does not necessarily understand how and why the procedure works.
LEVEL 2: COMPREHENSION (COGNITIVE SYSTEM)	
Integrating	The student identifies the basic structure of knowledge and the critical as opposed to noncritical characteristics.
Symbolizing	The student constructs an accurate symbolic representation of the knowledge differentiating critical and noncritical components.
LEVEL 3: ANALYSIS (COGNITIVE SYSTEM)	
Matching	The student identifies important similarities and differences between knowledge.
Classifying	The student identifies superordinate and subordinate categories related to knowledge.
Analyzing Errors	The student identifies errors in the presentation or use of knowledge.
Generalizing	The student constructs new generalizations or principles based on knowledge.
Specifying	The student identifies specific applications or logical consequences of knowledge.
LEVEL 4: KNOWLEDGE UTILIZATION (COGNITIVE SYSTEM)	
Decision Making	The student uses the knowledge to make decisions or makes decisions about the knowledge.

Problem Solving	The student uses the knowledge to solve problems or solves problems about the knowledge.
Experimenting	The student uses the knowledge to generate and test hypotheses or generates and tests hypotheses about the knowledge.
Investigating	The student uses the knowledge to conduct investigations or conducts investigations about the knowledge.
LEVEL 5: METACOGNITIVE SYSTEM	
Specifying Goals	The student establishes a goal relative to the knowledge and a plan for accomplishing the goal.
Process Monitoring	The student monitors the execution of a specific goal as it relates to the knowledge.
Monitoring Clarity	The student determines the extent to which he or she has clarity about the knowledge.
Monitoring Accuracy	The student determines the extent to which he or she is accurate about the knowledge.
LEVEL 6: SELF-SYSTEM	
Examining Importance	The student identifies how important the knowledge is to him or her and the reasoning underlying this perception.
Examining Efficacy	The student identifies beliefs about his or her ability to improve competence or understanding relative to knowledge and the reasoning underlying this perception.
Examining Emotional Response	The student identifies emotional responses to knowledge and the reasons for these responses.
Examining Motivation	The student identifies his or her overall level of motivation to improve competence or understanding relative to knowledge and the reasons for this level of motivation.

The taxonomy is organized by knowledge domain as well as the cognitive system, the metacognitive system, and the self-system (Figure 5). The knowledge domain comprises information, mental procedures, and psychomotor procedures. For the purpose of the analysis, it is not necessary to use categories of the knowledge domain, but it should be noted that the knowledge domain identifies the type of content on which the processes identified in the three systems operate. Thus, a learner may retrieve or comprehend (a process of the cognitive system) information about content that, in almost all models of thinking and learning, would be characterized as metacognitive (such as the knowledge that approaches to listening should vary by purpose, setting, and content). Normally, the taxonomy employed here would organize this content under the process of cognition (comprehension), not as metacognition, because it is comprehension process that is expected of the student, even though it is comprehension about a metacognitive process. However, because the taxonomy is being adapted in this study to organize and display all information related to metacognition and self-system, it has been altered to better suit these needs. In the example provided above, content that relates to metacognition, regardless of the type of mental process involved, is categorized under the metacognitive system. The fact that it may be actually more appropriately described as part of the knowledge domain is ignored.

A similar case occurs in the self-system. Consider the observation that students "should understand math is an academic activity that requires time, sustained engagement, patience, and persistence" from the Standards for Success document (Conley, 2004, p. 31). This comment could not be categorized in the taxonomy as a self-system process, yet it addresses many aspects that the research literature associates with the self in learning. In the Marzano taxonomy, such content would be considered "information," and part of the knowledge domain. That the information happens to be about the self-system would be of interest if the taxonomy were employed as part of a critical thinking curriculum, and organized by the mental process that operates upon it: here, simply comprehension; that is, student should comprehend – or perhaps simply recognize – that math as an academic activity requires certain personal dispositions and behaviors in order for the

student to find success. Again, in order to present findings organized by the topics of interest in this study – cognition, metacognition, and self-system – this attention to the knowledge domain is ignored, and what might be strictly be considered knowledge domain content about the self-system is instead organized as one of the processes of the self-system.

How the Taxonomy of Educational Objectives Was Used to Classify Content Related to Cognition, Metacognition and the Self-system.

Our analysts reviewed each standards document against each level within the taxonomy, providing excerpted text as evidence for the presence of related content appropriate to that level. Analysts focused on the knowledge, skills, and dispositions expected of students, whether this was communicated through explicit descriptions of content, through examples, student activities, or introductory sections intended for teacher guidance. The primary role of the content analysts, who have training in the analytic method and a degree or significant standards experience in the subject area they reviewed, was to make a fair inference as to the absence or presence of content within each document and to provide evidence for that judgment. Each assignment of content to a topic was reviewed by a second analyst. In the case of discrepant judgments, which were rare, the issue was resolved through deliberations or by a third analyst. (For the protocol employed, see Appendix C)

The taxonomy was adapted to account for the variety of cognitive, metacognitive and self-system processes found in the standards documents through the development of topics that account for the variety of ways in which thinking skills (the cognitive system) appear across the documents. The elements added to the taxonomy for the purpose of represent content of the metacognitive and self-systems were developed from the categories common to the research and theoretical literature relating to these areas. For example, one aspect of metacognition is that it may be subject specific – as when students are reminded to monitor and self correct during the reading process – yet it might also appear generically stated, as when students are asked to refine and clarify their thinking. Such a distinction between subject-specific and generic descriptions of metacognition is commonplace in the literature. Similarly, metacognition may refer to the process of monitoring one's cognition, or the knowledge one has about strategies for learning, or the characteristics of a task that affect cognition. Self-monitoring, strategy learning, and task analysis are also categories that appear in the literature (for a discussion, see Appendix A). In order to reflect the degree to which any one document holds expectations for students in these aspects of metacognition and the self-system, their content was organized against topics developed in this way. Such an approach provides a way to economically represent to what degree any one document touches on shared aspects of metacognition and the self-system, even when the documents otherwise have widely varying approaches in their treatment of these two systems.

APPENDIX A. A SURVEY OF COGNITION, METACOGNITION, AND SELF-SYSTEM IN THE LEARNING PROCESS

The principal interest of this study is to identify the extent to which standards documents address student skills related to cognition and learning. In order to identify a taxonomy that would adequately address all salient aspects, it was necessary to identify the ways in which these terms and phrases are used and discussed. Differing conceptions about these topics became apparent during a review of the literature.[1] Three categories capture the range of discussion on student thinking and self-directed learning, namely: cognition, metacognition, and affect, or motivation (also known as the self-system). Two overviews of the research (Pintrich, 2000; Yuruk, Ozdemir, Beeth, 2003) touch on all three separate aspects.

COGNITION

There are several taxonomies of educational objectives that can be or have been adapted to organize and specify the range of cognition, or thinking skills. Bloom's taxonomy is the most widely known (named for the principal editor of this highly influential work) and is still in common use today.

Bloom's Taxonomy

The oldest and the most widely-known educational taxonomy, Bloom's taxonomy, identifies a set of broadly defined cognitive skills. The taxonomy is problematic for two principal reasons. First, the levels of cognition are argued to be organized hierarchically by levels of relative difficulty. In Bloom's design, levels (such as retrieval, comprehension, evaluation, and the like) are distinguished by degrees of complexity, on the assumption that complex tasks are inherently more difficult. However, it has been well established that very complex processes can be learned at a skill level that demands little or no conscious effort – that is, to a level of automaticity. Using such a taxonomy for standards analysis, then, would communicate that some documents or subject areas are more cognitively challenging than others, yet the research on Bloom's structure does not support such a hierarchy. In addition, the identification of knowledge as equivalent to and including cognitive processes creates a category confusion that renders the taxonomy problematic for distinguishing content within the standards. Further, as a reflection of the level of work done on the topic in Bloom's day, the taxonomy provides no means for categorizing metacognitive knowledge or processes, let alone processes related to the self in learning.

[1] We review studies published since 2000 to ensure that the overviews and theoretical work would address established research and theories that have established some authority or influence. We also included studies published before 2000, when it appeared clear that they were seminal in the development of the constructs in which we are interested and added new information not available in the original set of documents.

Bloom's taxonomy organizes content into six levels by the difficulty of the mental processes in which the student engages:

1.00 Knowledge
2.00 Comprehension
3.00 Application
4.00 Analysis
5.00 Synthesis
6.00 Evaluation

Although organized as one among a list of cognitive processes, "knowledge," of course, is not usually considered a process, but information on which or about which cognitive processes operate. Although Bloom defines knowledge as including "those behaviors and test situations which emphasize the remembering, either by recognition or recall, of ideas, materials or phenomena," (Bloom et al., 1956, p. 62), he includes within it the objects of the process as well, for example, the generalizations, principles, and the like that may be remembered or recalled (for a full discussion see Marzano & Kendall, 2007, p. 5 ff.).

A recent taxonomy has as its subtitle "A Revision of Bloom's Taxonomy of Educational Objectives" (Anderson et al., 2001) and expands on the original.

Anderson and Krathwohl, et al., Taxonomy

A recent revision of Bloom's taxonomy (Anderson et al., 2001) acknowledges and addresses the category problem through the creation of a knowledge dimension as distinct from a cognitive process dimension. In addition, metacognition is added to the taxonomy. It is identified as knowledge and "awareness," however, not as a process. An aspect commonly associated with metacognition—monitoring—appears in this taxonomy under the category of Evaluation: Checking, which effectively means that the activity of monitoring one's own actions and learning is functionally equivalent to the monitoring of any event or behaviors not related to the self. This conflation weakens the taxonomy as a tool for identifying types of self-monitoring activities. Metacognitive knowledge is also defined to include references to the self as learner, which means that metacognition, in this scheme, encompasses but does not identify a number of potentially useful categories, such as motivation and student examinations of self-efficacy, which appear as important constructs in the literature on self-regulation. This limits its usefulness for identifying the full scope of material that appears in the research literature on metacognition and other skills associated with learning-to-learn.

Cognitive processes are organized in the following categories:

1. Remember
2. Understand
3. Apply
4. Analyze
5. Evaluate
6. Create

Beneath each category are from 2 to 7 cognitive processes, for a total of 19, from *recognizing* in the first category to *producing* in the last. The taxonomy is also two-dimensional, the knowledge domain forming the second axis. This domain comprises factual, conceptual, procedural, and metacognitive knowledge. The distinction of knowledge and process addresses a problem in the original work and greatly increases the utility of this work. However, Anderson et al. identify metacognition as a type of knowledge, "knowledge of cognition in general as well as awareness of one's own cognition" (p. 46). Awareness connotes self-monitoring – a process rather than knowledge – thus, this taxonomy does not include a means for identifying the processes of metacognition.

The taxonomy adapted for this study (Marzano & Kendall, 2007), also uses a two-dimensional structure to improve upon Bloom's original work. The structure is somewhat more complex than Anderson et al.'s design, but has a number of similarities. There are four levels of cognitive processing:

1. Retrieval
2. Comprehension
3. Analysis
4. Knowledge Utilization

Beneath each level are from 2 to 5 cognitive processes for a total of 14, from *recognizing* in the first level to *investigating* in the last. (For the structure of the taxonomy, see table 1; for an overview, see figure 6.) In addition to the first four levels, which make up the cognitive system, the taxonomy adds another two:

5. Metacognitive System
6. Self-system

These additional systems include four processes each, bringing to 22 the total processes available in the taxonomy. As we will note in the discussion on metacognition and self-system, the scope of categories in this taxonomy allows a level of analysis not available in Anderson or any other approach. In this taxonomy, metacognition represents a type of processing that is applied to subject matter content. In this approach, metacognitive knowledge is treated as the "subject matter" for mental processing, and therefore both metacognitive processing and metacognitive knowledge may be categorized using this taxonomy.

Metacognition

On the topic of metacognition the field is still somewhat inchoate and unsettled. There emerges no clear definition of metacognition that would reflect a consensus view among the studies. Metacognition can be described as knowledge or awareness of learning, as is the case for the Anderson & Krathwohl taxonomy, or may include this knowledge as well as including a student's regulation or control over tasks (see Baker & Cerro for a discussion). However, as a recent survey of models of self-regulation demonstrates, metacognition can also appear organized as one of a number of processes – including cognition, behavior, and affect – that the student regulates in the process of learning (Pintrich, 2000). Metacognition may also refer to monitoring or evaluating

one's progress during an activity (Donovan, M.S., & Bransford, J. D., 2005, p. 10; Pintrich, 2000, p. 459; Prins, Veenman, and Elshout, 2006, p. 375). The term is also used to refer to activities or learned-strategies that are content-bound and acquired exclusively in a subject-specific context (Balin, 2002; Kuhn & Dean Jr., 2004, p. 270; National Research Council, 1999, p. 15). However, other characterizations of metacognitive strategies assert they may apply across all areas (White & Frederiksen, 2005), or more than one subject-area, though perhaps not every area (Bransford et al., 2006, handbook, p. 31). Researcher Davies (2006) succinctly captures the issue as a debate between the specifists—those who stress the importance of critical thinking understood as a subject-specific discourse—and the 'generalists'—those who stress the importance of critical thinking understood independently of disciplinary context. For example, while listening to a political speech for a civics class, or the dialogue in a film, a student would profit by actively considering the speaker's perspective and motivation, while such monitoring would be less useful for the student in a mathematics lecture.

As noted in the discussion of taxonomies, the Anderson et al. taxonomy, although it alludes to the awareness component of metacognition, organizes metacognition as a type of knowledge, rather than a mental process. In this taxonomy, metacognition may be one of three types: strategic knowledge – for example, knowledge of the use of heuristics; task knowledge – for example, knowledge of the cognitive demands of different tasks, and self-knowledge, for example, knowledge that writing essays is a personal weakness (p. 46). This design recalls an influential model of cognition developed by Flavell (1979), who identified types of metacognitive knowledge in terms of strategic, task, and person variables.

The Marzano & Kendall taxonomy organizes the metacognitive system by means of the following mental processes:

- Specifying Goals: establish clear learning goals for specific types of knowledge
- Process Monitoring: determine how effectively a plan or procedure is being carried in real time
- Monitoring Clarity: determine the extent to which one is clear about specific aspects of knowledge
- Monitoring Accuracy: determine the extent to which one is correct in terms of understanding specific knowledge

In summary, metacognition may refer to the process of monitoring or of regulating one's cognition, *or* the knowledge one has about strategies for learning, *or* characteristics of a task that affect cognition. Another aspect, the role of the self – specifically, motivation and affect – is addressed in the next section.

The Self-system: Motivation and Affect

Most models of metacognition include a component about the self in relation to what is being learned. The earliest example is Flavell's influential model (1979), which organized metacognition by aspects of person, task, and strategy. As we found to be the case in the literature regarding metacognition, there are differing ways in which theoreticians and researchers think about what

Marzano & Kendall call the self-system: students' attitudes, beliefs, and motivations. Discussions of motivation for learning and the self in relation to in the research literature often address student's motivation and concept of self as learner (White, B. & Frederikson, J. 2005).

The constructs most commonly associated with the idea of the self in relation to learning are self-directed and self-regulated learning. These terms are not clearly distinguished in the literature –of the two, self-regulation appears the preferred term, but conceptions of self-regulation are far from unitary – there appears no emerging consensus regarding what it may include (see, for example, Boekarts, 1995; Linnenrink, E. A., & Pintrich, P. R. (2004); Zimmerman B. J., & Schunk, D.H., 2004). In an examination of the commonalities found among models of self-regulated-learning, Pintrich (2000) identifies one feature that we have earlier identified as associated primarily with metacognition – namely, the capacity to monitor aspects of cognition. Self-regulation also concerns those aspects over which students have actual or potential control, which includes motivation/affect and behavior. In the Marzano & Kendall taxonomy these are addressed in this way:

- Examining importance: analyzing the extent to which one believes that learning specific knowledge is important and then examining one's beliefs relative to that issue.
- Examining efficacy: examining the extent to which one believes one can improve one's own understanding or competence relative to a specific type of knowledge.
- Examining emotional response: identifying what emotions, if any, one associates with specific knowledge, whether these emotions interfere with learning, and the logic behind those associations.
- Examining motivation: examining overall motivation to improve one's understanding of or competence in a specific type of knowledge.

Thus, the Marzano & Kendall taxonomy structures this exclusively as mental processes – self-system thinking. Yet not all characteristics associated with self-regulation in the literature or the standards documents reviewed can be characterized as a process. For example, the statement that students "should understand math is an academic activity that requires time, sustained engagement, patience, and persistence" (Conley, 2004, p. 31) could not be categorized as one of the processes outlined above, yet addresses the self-system. Adaptations in the Marzano & Kendall taxonomy were made in order to account for this, as described in the section Tool for analysis: A taxonomy of education objectives.

In sum, the self-system includes those areas related to motivation and affect. These include aspects of interest or importance, personal efficacy, emotional response, and motivation.

APPENDIX B: DATA SOURCES AND THE LIMITATIONS OF THIS STUDY

In order to identify the thinking and learning skills expected of all students, analysts reviewed three types of documents: state standards, national subject area standards, and standards that communicate the expectations held for graduating students by post-secondary institutions, including colleges and the high-skills workplace. For an overview of the source documents by subject area, see table B1; for a bibliography of all the standards documents analyzed, see the end of this section.

DOCUMENT SOURCES

States Standards

The state standards selected for analysis were those of states in the Central Region. States commonly establish expectations for students in the form of academic standards. These standards describe, with some specificity, what students should know and be able to do by the time they exit 12th grade. Such standards are commonly developed by and represent a consensus of stakeholders in the success of schools. These include not only educators, but parents and community and business leaders. In addition, state standards, either by policy, legislation, or both, have significant influences on daily instruction. Such standards are made readily available not only to teachers but to students, parents, and others through postings on the web sites of state education agencies. For this study, we identified the standards currently in force in the Central Region states for the four core subject areas—English language arts, mathematics, science, and the social studies.

National Subject Area Standards

Like state standards, national subject-area standards represent the consensus of numerous professional educators in the subject areas, typically at all levels of the education system. Representatives of business, industry, and the broader community typically contribute to the establishment of these standards. For this study, we selected significant and well-known documents representing what is commonly accepted as the national standards in the subject areas of language arts, mathematics, sciences, and the social studies.

Expectations from Post-secondary Institutions

Finally, in order to identify the expectations held in common by many employers of high-skilled workers and post-secondary institutions for high school students, we also examined studies produced by the American Diploma Project, The College Board, and Standards for Success. These documents identify the knowledge and skills that have been identified as essential for students to master if they are to succeed in post-secondary and the high-skills workplace. Like state standards, such documents describe what students need to know and do, in terms of specific knowledge and skills. Taken together, they represent the consensus of hundreds of professionals in universities and business and industry regarding what they believe students should have acquired by exit.

These studies are also national in scope, rather than specific to a region, a particular university, or an industry.

The American Diploma Project (ADP) shares a similar purpose—connecting secondary and postsecondary expectations for success—but its focus is on "what it takes for graduates to compete successfully beyond high school—either in the classroom or in the workplace" (2004, p. 1). The Project, a partnership of Achieve, Inc., The Education Trust, and the Thomas B. Fordham Foundation, spent nearly two years working with two- and four-year postsecondary faculty and front-line managers in high-growth, high-skill occupations to define the core knowledge and skills that high school graduates need in order to be ready to succeed in their organizations. The results of the study are presented in *Ready or Not: Creating a High School Diploma that Counts* (ADP, 2004), which describes student expectations (termed "benchmarks") for English and mathematics. The report also includes sample workplace tasks and post-secondary assignments, which illustrate in real terms how the knowledge and skills captured in the benchmarks might be applied beyond high school, whether in the workplace or in the college classroom.

The College Board has developed a set of standards for English language arts and mathematics to assist schools in providing the "rigorous education that will prepare them for success in college, opportunity in the workplace, and effective participation in civic life" (p. iv). "The purpose of the project is to vertically align curriculum, instruction, assessment, and professional development across six levels beginning in middle school leading to AP and college readiness. The College Board Standards for College Success is, therefore, more specific than most standards documents because it is intended to provide sufficient guidance for curriculum." (p. vi).

Standards for Success, commonly abbreviated as S4S, is a project sponsored by the Association of American Universities in partnership with The Pew Charitable Trusts. One of the project's primary goals was to identify what graduating high school students need to know and be able to do in order to succeed in entry-level university courses. These student expectations, termed "Knowledge and Skills for University Success," are presented in *Understanding University Success* (Conley, 2003), the product of a two-year study in which more than 400 faculty and staff members from 20 research universities participated in extensive meetings and reviews. The disciplines covered included English, mathematics, natural sciences, social sciences, second languages, and the arts. (McREL participated as a consultant in this project.)

LIMITATIONS

The chief limitations in this study relate to the numbers and types of documents analyzed, which varied with each subject area; the level of analysis required to identify thinking and reasoning skills. Furthermore, some adaptations of the taxonomy were necessary in order to present the findings of our analysis.

Each subject area differed markedly in the number and types of documents available for analysis. Because we selected the four core subject area standards for each of the seven states in the Central Region, the same number of state documents were subject to analysis for all subject areas. However, the number of national documents and documents that identified standards for post-

secondary success differed considerably. The subject areas of language arts and mathematics each have but a single document published by a nationally recognized body, while the social studies has five documents, and science, two. For post-secondary (college readiness), by contrast, the language arts and mathematics each have three documents, while science and the social studies have a single document. (See table B1 for a summary; a list of documents analyzed follows that table.)

Another limitation was the level of scrutiny that was required to identify the presence of thinking and learning skills in these documents. Content directly related to subject-matter was readily identifiable and organized under predictable headings—such as editing in the language arts, or biology in science. By contrast, content related to thinking and learning skills was often subsumed within discussions of the content itself, and so could only be identified after careful analysis. Even when the standards addressed thinking and learning skills more deliberately, it was rare that such discussions were signaled by text headings or other organizational cues.

Finally, some adaptations had to be made to the taxonomy used to analyze the content. In the interests of identifying and coding all content related to metacognition and the self-system in a format that was meaningful across all documents, the method used to develop aspects or elements of each topic within these levels was different from that used for developing aspects for each cognitive process. Instead of developing a set of elements for each process directly from the standards documents themselves, as analysts did for the cognitive processes, we organized the elements of metacognition and the self-system primarily from the ways in which they are commonly addressed in the research literature—for example, to account for subject-specific metacognitive knowledge as well as metacognitive processes that are believed applicable to any subject area. (See Appendix A for a discussion.) We found that, perhaps because of an incomplete appreciation of the role of metacognition and self-system within standards, there were as many different aspects about these topics as the number of documents that addressed them. In order to keep the organization of findings easier to communicate, we elected to use categories common in the research rather than the many different categories that would arose from the documents themselves.

Table B1. Sources of documents analyzed for the study by subject area.

Note: The number in brackets following the name of the authoring organization is the document identifier used in report figures. Full citations follow this table.

	English Language Arts	Mathematics	Science	Social studies
State standards	All seven Central Region states [S1–S7]			
National subject area standards	National Council of Teachers of English (1995) [N1]	National Council of Teachers of Mathematics (2000) [N1]	National Research Council (1996) [N1] American Association for the	Center for Civic Education (1994) [N1] National Center for History in the

			Advancement of Science(Project 2061, 1993) [N2]	Schools (1996) [N2] National Council on Economic Education (1997) [N3] National Council for the Social Studies (1994) [N4] National Geographic Research & Exploration (1994) [N5]
Expectations related to college readiness/ high-skills workplace	American Diploma Project (2004) [C1] The College Board (2006a) [C2] Standards for Success (Conley, 2003) [C3]	American Diploma Project (2004) [C1] The College Board (2006b) [C2] Standards for Success (Conley, 2003) [C3]	Standards for Success (Conley, 2003) [C1]	Standards for Success (Conley, 2003) [C1]

BIBLIOGRAPHY OF DOCUMENTS ANALYZED FOR THIS STUDY

Standards for College Readiness & the High-skills Workplace

The American Diploma Project (2004). *Ready or not: Creating a high school diploma that counts.* Washington, DC: Achieve, Inc. Retrieved September 5, 2004, from http://www.achieve.org/achieve.nsf/AmericanDiplomaProject?openform

The College Board (2006). *College Board standards for college success: English language arts.* Author. Retrieved May 1, 2007, from www.collegeboard.com/prod_downloads/about/association/academic/english-language-arts_cbscs.pdf

The College Board (2006). *College Board standards for college success: Mathematics and statistics.* Author. Retrieved May 1, 2007, from http://www.collegeboard.com/prod_downloads/about/association/academic/mathematics-statistics_cbscs.pdf

Conley, D. T. (2003). *Understanding university success: A report from Standards for Success.* A project of the Association of American Universities and The Pew Charitable Trusts. Retrieved August 15, 2004, from http://www.s4s.org/03_viewproducts/ksus/pdf/Understanding_Success.pdf

Standards from state departments of education

Colorado Department of Education. (1998, Sept.). *Colorado model content standards: Civics.* Author. Retrieved June 13, 2007, from

http://www.cde.state.co.us/cdeassess/documents/standards/civics.pdf

Colorado Department of Education. (1998, Aug.). *Colorado model content standards: Economics.* Author. Retrieved June 13, 2007, from http://www.cde.state.co.us/cdeassess/documents/standards/economic.pdf

Colorado Department of Education. (1995, Nov.). *Colorado model content standards: Geography.* Author. Retrieved June 13, 2007, from http://www.cde.state.co.us/cdeassess/documents/standards/geogrphy.pdf

Colorado Department of Education. (1995, Sept.) *Colorado model content standards: History.* Author. Retrieved June 13, 2007, from http://www.cde.state.co.us/cdeassess/documents/standards/history.pdf

Colorado Department of Education. (1995, July). *Colorado model content standards: Reading and writing.* Author. Retrieved June 13, 2007, from http://www.cde.state.co.us/cdeassess/documents/standards/reading.pdf

Colorado Department of Education. (2005, Sept.). *Colorado model content standards: Mathematics.* Author. Retrieved June 13, 2007, from

http://www.cde.state.co.us/cdeassess/documents/standards/math.pdf

Colorado Department of Education. (2007, Feb.). *Colorado model content standards: Science.* Author. Retrieved June 13, 2007, from

http://www.cde.state.co.us/coloradoscience/Science_Standards_July_2007.pdf

Kansas Department of Education. (2005, Aug.). *Kansas curricular standards for history & government; economics & geography education.* Author. Retrieved August 2, 2007, from http://www.ksbe.state.ks.us/Default.aspx?tabid=143

Kansas Department of Education. (2004, Jan.). *Kansas curricular standards for mathematics education.* Author. Retrieved February 1, 2006, from http://www.ksde.org/outcomes/9th10thgrindrev.doc

Kansas Department of Education. (2003, July). *Kansas curricular standards for reading.* Author. Retrieved August 25, 2007, from http://www.ksde.org/Default.aspx?tabid=142

Kansas Department of Education. (2007, Aug.). *Kansas curricular standards for science.* Author. Retrieved July 9, 2007, from http://www.ksde.org/Default.aspx?tabid=144

Kansas State Department of Education. (2004, Dec.). *Kansas curricular standards for writing.* Author. Retrieved January 27, 2006, from http://www.ksde.org/outcomes/ kswritingstd.html

Kansas State Department of Education. (2003, July). *Kansas curricular writing standard 2, research.* Author. Retrieved January 27, 2006, from http://www.ksde.org/outcomes/std2research.doc

Missouri Department of Elementary and Secondary Education. (1996). *The Show Me Standards: Missouri's framework for curriculum development in communication arts K–12.* Author. Retrieved August 30, 2007, from http://dese.mo.gov/divimprove/curriculum/index.html

Missouri Department of Elementary and Secondary Education. (1996, January). *The Show Me Standards: Performance standards.* Author. Retrieved August 30, 2007, from http://dese.mo.gov/divimprove/curriculum/index.html

Missouri Department of Elementary and Secondary Education. (1996, January). *The Show Me Standards: Framework for curriculum development in mathematics.* Author. Retrieved February, 1, 2006, from http://dese.mo.gov/divimprove/curriculum/index.html

Missouri Department of Elementary and Secondary Education. (1996, January). *The Show Me Standards: Framework for curriculum development in science.* Author. Retrieved July, 9 2007, from http://dese.mo.gov/divimprove/curriculum/index.html

Missouri Department of Elementary and Secondary Education. (1996, January). *The Show Me Standards: Framework for curriculum development in social studies.* Author. Retrieved July, 9 2007, from http://dese.mo.gov/divimprove/curriculum/index.html

Nebraska Department of Education. (2000, Dec.). *Nebraska mathematics standards.* Author. Retrieved July 9, 2007, from http://www.nde.state.ne.us/ndestandards/AcademicStandards.htm

Nebraska Department of Education. (2001, Sept.). *Nebraska reading and writing standards.* Author. Retrieved July 9, 2007, from http://www.nde.state.ne.us/ndestandards/AcademicStandards.htm

Nebraska Department of Education. (1998, May). *Nebraska science standards.* Author. Retrieved July 9, 2007, from http://www.nde.state.ne.us/ndestandards/AcademicStandards.htm

Nebraska Department of Education. (2003, Sept.). *Nebraska social studies/history standards*. Author. Retrieved July 9, 2007, from http://www.nde.state.ne.us/ndestandards/AcademicStandards.htm

North Dakota Department of Education. (2005, Apr.). *North Dakota English language arts content and achievement standards.* Author. Retrieved August 21, 2007, from http://www.dpi.state.nd.us/standard/content/ela/

North Dakota Department of Public Instruction. (2005, April) *North Dakota mathematics content and achievement standards* Author. Retrieved February 1, 2006, from http://www.dpi.state.nd.us/standard/content/math/

North Dakota Department of Education. (2006, Nov.). *North Dakota social studies content and achievement standards.* Author. Retrieved August 21, 2007, from http://www.dpi.state.nd.us/standard/content/sstudies/index.shtm

North Dakota Department of Education. (2006, Mar.). *North Dakota English science content and achievement standards* Author. Retrieved August 21, 2007, from http://www.dpi.state.nd.us/standard/content/science/index.shtm

South Dakota Department of Education. (2004). *South Dakota mathematics standards, 9-12*. Author. Retrieved August 21, 2007, from http://doe.sd.gov/contentstandards/math/standards.asp

South Dakota Department of Education. (2005, Sept.). *South Dakota reading content standards.* Author. Retrieved August 21, 2007, from http://doe.sd.gov/contentstandards/languagearts/docs/Reading9_12.pdf

South Dakota Department of Education. (2005, Sept.). *South Dakota communication arts content standards.* Author. Retrieved August 21, 2007, from http://doe.sd.gov/contentstandards/languagearts/docs/Communication%20Arts%209-12.pdf

South Dakota Department of Education. (2005, March). *South Dakota science content standards.* Author. Retrieved August 21, 2007, from

http://doe.sd.gov/contentstandards/science/newstandards.asp

South Dakota Department of Education. (2005, May). *South Dakota social studies content Standards.* Author. Retrieved August 21, 2007, from http://doe.sd.gov/contentstandards/social/index.asp

Wyoming Department of Education. (2003, July). *Wyoming mathematics content and performance standards.* Author. Retrieved January 25, 2006, from http://www.k12.wy.us/SAA/standards.asp

Wyoming Department of Education. (2005, July). *Wyoming language arts content and performance standards.* Author. Retrieved February 1, 2006, from http://www.k12.wy.us/SAA/standards.asp

Wyoming Department of Education. (2003, July). *Wyoming science content and performance standards.* Author. Retrieved February 1, 2006, from http://www.k12.wy.us/SAA/standards.asp

Wyoming Department of Education. (2003, July). *Wyoming social studies content and performance standards.* Author. Retrieved February 1, 2006, from http://www.k12.wy.us/SAA/standards.asp

Standards from national subject area organizations

Center for Civic Education. (1994). *National standards for civics and government.* Calabasas, CA: Author.

Economics America: National Council on Economic Education. (1997). *Voluntary National Content Standards. In Virtual Economics Version 2.0* [CD-ROM]. New York, NY: Author.

Geography Education Standards Project. (1994). *Geography for life: National geography standards.* Washington, DC: National Geographic Research and Exploration.

International Reading Association and the National Council of Teachers of English. (1996). *Standards for the English Language Arts.* Newark, DE: International Reading Association, and Urbana, IL: National Council of Teachers of English.

Myers, Miles, & Spalding, Elizabeth (Eds.). (1997). *Exemplar series: Grades 6-8.* Urbana, IL: National Council of Teachers of English.

Myers, Miles, & Spalding, Elizabeth (Eds.). (1997). *Standards exemplar series: Assessing student performance grades 9-12.* Urbana, IL: National Council of Teachers of English.

National Center for History in the Schools. (1996). *National standards for history.* (Basic ed.). Los Angeles: Author

National Council for the Social Studies. (1994). *Expectations of excellence: Curriculum standards for social studies*. Washington, DC: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Project 2061, American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* New York: Oxford University Press.

APPENDIX C. PROTOCOL USED FOR THE ANALYSIS

The protocol for analysis of the documents using the taxonomy consists of four major elements, as follows:

1. Examine each document for any statement that indicates that students should engage at the cognitive, metacognitive, or self-system levels. Standards are the primary text for analysis, but introductory front matter (i.e., preface, introduction, rationale) should also be reviewed and included if this is where the content is solely or most clearly addressed.

2. Excerpt the text of such statements and place it, along with the page number, in the input grid. This excerpt provides evidence for the presence of content and the means for quality assurance review by other analysts.

    a. Input Grid: Columns indicate subject area and source document (e.g., math: NCTM). Rows indicate the taxonomic level and sublevels. The taxonomic level is organized by system (such as cognitive system), the category within that system (such as knowledge utilization), the process within that category (such as Decision making). For the cognitive system, a subtopic is assigned or created by the analyst. For example, the following text is from North Dakota Science, grades 11-12:

        i. Explain how designing and implementing technology requires weighing trade-offs between positive and negative impacts on humans and the environment E64.

    b. The excerpted text from this example would be placed in the grid at the intersection of North Dakota science and Cognitive System: Knowledge Utilization: Decision Making: Consequences and Trade Offs.

    c. Topics in Cognitive System: In the cognitive system, create a topic based upon the focus of the benchmark. The Consequences and Trade-offs topic identified above was based on the aspect of decision making that was the focus of the benchmark. Before creating a new topic, review all previously created topics should be reviewed to determine whether they may address the material. If a topic should be revised so that it can better accommodate other material, analysts will negotiate topic revisions.

    d. Categories in the Metacognitive and Self-System: We find that the metacognitive and self systems are sporadically addressed in the documents and, as a consequence, the topics they address are too diverse to be useful in organizing the material. In other words, each excerpt typically presents a unique topic for the process, so there are as many topics as there are instances. Instead of organizing processes by topics as in the cognitive system, the processes are organized by types. For the metacognitive and self-system, assign content to one of the following three types:

        i. Content is applicable across subject areas (for example, “learners understand the importance of reflecting on their thinking”)

        ii. Content is made specific to this subject (for example, “it is important to understand the connection of mathematics to life outside the classroom”)

iii. Content relates primarily to student disposition (for example, "the student develops flexibility and perseverance").

e. Evidence for students' engagement at a topic (or type) within a taxonomic level only need be established once for each document. For example, it is trivial to establish that students are expected to retrieve information about science. There will likely be hundreds, if not thousands, of examples that indicate that students are expected to recall information. This only need be coded once for each document. For example, evidence of recall in a science document would be categorized only once for that document under Cognitive System: Retrieval: Recalling

3. Format

a. Edit large statements to delete content that isn't relevant to the question.

b. Split up statements that include ideas related to several topics/types and using ellipsis to indicate content has been moved elsewhere or deleted. If deleting content would create a vague or confusing statement, use bold text to indicate what content is of interest for the current cell assignment.

4. Quality Assurance

a. To conduct a review of another analyst's work, first review all mappings and topic/type assignments. If you disagree with a mapping or topic/type assignment, confer with the original analyst. If you cannot resolve the issue, make a note in the cell. The Principal Investigator (P.I.) will assign a third analyst or conduct the additional review, making edits with rationale. We have been able to reach consensus on all coding.

b. For those cells that are empty, review the original standards document to satisfy yourself that indeed the content does not appear. If you find material that you believe is evidence that the skill is covered, provide the excerpted text in the appropriate skill level and topic/type. This will be reviewed by the original analyst & the P.I.

REFERENCES

Anderson, L.W., and Krathwohl, D. R.; Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., et al. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Bailin, Sharon. (2002). Critical Thinking and Science Education. *Science & Educat*ion, 11, 361-375.

Baker, L & Cerro L. C. (2000). Assessing metacognition in children and adults. In G. Schraw & J. C. Impara (Eds.), *Issues in the measurement of metacognition* (pp. 99-145). Lincoln, NE: The University of Nebraska Press.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill,W. H., & Krathwohl, D. R. (Eds.). (1956). *Taxonomy of educational objectivities: The classification of educational goals. Handbook I: Cognitive domain.* New York: David McKay.

Boekaerts, M. (1995). Self-Regulated Learning: Bridging the Gap between Metacognitive and Metamotivation Theories. *Educational Psychologist, 30*(4), 195-200.

Bransford, J., & Schwartz, D. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education, 24*, 61–100.

Bransford, J., Stevens, R., Schwartz, D., Meltzoff, A., Pea, R. Roschelle, J., Vye, N., Kuhl, P., Bell, P., Barron, B., Reeves, B., Sabelli, N. (2006). Learning theories and education: Toward a decade of synergy. In Alexander, P. A. & Winne, P. H. (Eds.), *Handbook of Educational Psychology* (2nd Ed.) (pp. 209-244). Mahwah, NJ: Lawrence Erlbaum.

Commission on Behavioral and Social Sciences and Education (1999). The Changing Nature of Work: Implications for Occupational Analysis. National Research Council. Washington, D.C.: National Academy Press.

Cornford, I.R. (2002). Learning-to-learn strategies as a basis for effective lifelong learning. *International Journal of Lifelong Education, 21*(4), 357-368.

Conference Board, The; Corporate Voices for Working Families; The Partnership for 21st Century Skills; The Society for Human Resource Management (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce*. New York, NY, Washington, DC, Tucson, AZ and Alexandria, VA: The Conference Board, Corporate Voices for Working Families, the Partnership for 21st Century Skills and the Society for Human Resource Management.

Davies, W. Martin. (2006). An 'infusion' approach to critical thinking: Moore on the critical thinking debate. *Higher Education Research & Development, 25*(2), 179–193.

Donovan, M.S., & Bransford, J. D. (2005) Introduction. In National Research Council, *How students learn,* (pp. 1-28). Washington, DC: National Academy Press.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*, 906-911.

Karoly, L. A. & C. W. A. Panis. (2004). *The 21st Century at Work: Forces Shaping the Future Workforce and Workplace in the United States*, MG-164, Santa Monica, California: The RAND Corporation.

Kendall, J. S., Pollack, C., Schwols, A., & Snyder, C. (2007). High school standards and expectations for college and the workplace. *Issues & Answers Report, REL 2007–No. 001.* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Central. Retrieved from http://ies.ed.gov/ncee/edlabs.

Kendall, J.S., Richardson, A. T., & Ryan, S. E. (2005). *The systematic identification of performance standards.* (Tech. Rep.). Aurora, CO: Mid-continent Research for Education and Learning.

Kuhn, D. and Dean Jr., D. (2004). Metacognition: A bridge between cognitive psychology and educational practice. *Theory into Practice 43*(4), 268-273.

Linnenrink, E. A. & Pintrich, P. R. (2004). Role of Affect in Cognitive Processing in Academic Contexts. In Day, D. Y. & Sternberg, R. J. (Eds.) *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development.* (pp. 57-87) Mahwah, NJ: Lawrence Erlbaum.

Marzano, R. J. & Kendall, J. S. (2007). *The new taxonomy of educational objectives.* (2nd ed.) Thousand Oaks, CA: Corwin Press.

Mosley, D., Baumfield, V., Elliott, J., Gregson, M., Higgins, S., Miller, J., & Newton, D. P. (2005). *Frameworks for thinking*. New York: Cambridge University Press.

National Research Council. (1999). *How people learn: Bridging research and practice*. M. S. Donovan, J. D. Bransford, & J. W. Pellegrino (Eds.), Committee on Learning Research and Educational Practice. Washington, DC: National Academy Press.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. Pintrich, and M. Zeidner, (Eds.), *Handbook of self-regulation* (pp. 451-502). San Diego: Academic Press.

Pintrich, P. R., Wolters, C. A., & Baxter, G. P. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. C. Impara (Eds.), *Issues in the measurement of metacognition* (pp. 43-97). Lincoln, NE: The University of Nebraska Press.

Porter, A. C. (2002, October). Measuring the content of instruction: Uses in research and practice. *Educational Researcher 31*(7), 3–14.

Prins, F., Veenman, M., & Elshout, J. (2006). The impact of intellectual ability and metacognition on learning: New support for the threshold of problematicity theory. *Learning and Instruction, 16*, 374–387.

Secretary's Commission on Achieving Necessary Skills. (1991). *What work requires of schools: A SCANS report for America 2000.* Washington, DC: U.S. Department of Labor.

Stein, S. (2000). *Equipped for the future content standards: What adults need to know and be able to do in the 21st century.* National Institute for Literacy. Retrieved from July 3, 2007 http://eff.cls.utk.edu/PDF/standards_guide.pdf

Wang, M., Haertel, G., & Walberg, H. (1992). Toward a knowledge base for school learning. *Review of Educational Research, 63*(3), 249-294.

Webb, N. L. (1997, April). *Criteria for alignment of expectations and assessments in mathematics and science education*. Research monograph No. 8. Washington, DC: Council of Chief State School Officers.

White, B. & Frederikson, J. (2005). A Theoretical Framework and Approach for

Fostering Metacognitive Development. *Educational Psychologist 40*(4), 211–223

Yuruk, N., Ozdemir, O., and Beeth, M. The role of metacognition in facilitating conceptual change. Paper presented at the annual Meeting of the National Association for Research in Science Teaching (Philadephia, PA, March 23-26, 2003).

Zimmerman B. J., & Schunk, D.H. (2004). Self-Regulating Intellectual Processes and Outcomes: a Social Cognitive Perspective In Day, D. Y. & Sternberg, R. J. (Eds.) *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development.* (pp. 57-87) Mahwah, NJ: Lawrence Erlbaum.