



## Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century


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### Summary

Americans have long recognized that investments in public education contribute to the common good, enhancing national prosperity and supporting stable families, neighborhoods, and communities. Education is even more critical today, in the face of economic, environmental, and social challenges. Today's children can meet future challenges if their schooling and informal learning activities prepare them for adult roles as citizens, employees, managers, parents, volunteers, and entrepreneurs. To achieve their full potential as adults, young people need to develop a range of skills and knowledge that facilitate mastery and application of English, mathematics, and other school subjects. At the same time, business and political leaders are increasingly asking schools to develop skills such as problem solving, critical thinking, communication, collaboration, and self-management—often referred to as “21st century skills.”

Private foundations, policymakers, and education organizations use a variety of names for the lists of broad skills seen as valuable. To help the public understand the research related to the teaching and learning of such skills, several foundations charged the National Research Council (NRC) to:

- Define the set of key skills that are referenced by the labels “deeper learning,” “twenty-first century skills,” “college and career readiness,” “student-centered learning,” “next-generation learning,” “new basic skills,” and “higher-order thinking.” These labels are typically used to include both cognitive and non-cognitive skills—such as critical thinking, problem solving, collaboration, effective communication, motivation, persistence, and learning to learn—that can be demonstrated within core academic content areas and that are important to success in education, work, and other areas of adult responsibility. The labels are also sometimes used to include other important capacities—such as creativity, innovation, and ethics—that are important to later success and may also be developed in formal or informal learning environments.
- Describe how these skills relate to each other and to more traditional academic skills and content in the key disciplines of reading, mathematics, and science. In particular, consider these skills in the context of the work of the National Governors Association and the Council of Chief State School Officers in specifying Common Core State Standards for English language arts and mathematics and the work of the NRC in specifying a Conceptual Framework for New Science Education Standards.
- Summarize the findings of the research that investigates the importance of such skills to success in education, work, and other areas of adult responsibility and that demonstrates the importance of developing these skills in K–16 education.

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- Summarize what is known and what research is needed about how these skills can be learned, taught, and assessed. This summary should include both the cognitive foundations of these skills in learning theory and research about effective approaches to teaching and learning these skills, including approaches using digital media.
- Identify features of educational interventions that research suggests could be used as indicators that an intervention is likely to develop the key skills in a substantial and meaningful way. In particular, for learning in formal school-based environments, identify features related to learning these skills in educational interventions in (1) teacher professional development, (2) curriculum, and (3) assessment. For learning in informal environments, identify features related to learning these skills in educational interventions in (d) after-school and out-of-school programs and (e) exhibits, museums, and other informal learning centers. For learning in both formal and informal environments, identify features related to learning these skills in education interventions in (f) digital media.

In approaching this charge, the committee drew on a large research base in cognitive, developmental, educational, organizational, and social psychology and economics for purposes of clarifying and organizing concepts and terms. However, we do not claim to provide precise, scientifically credible definitions of all the various terms that have come to populate this arena of concern and debate. This is due partly to the time constraints of the project and partly to the lack of definitive research on the range of skills and behaviors that have come to fall under the headings of “deeper learning” and “21st century skills.” That said the committee took initial steps toward clarifying the meaning of the term “deeper learning” and its relationship to competency clusters that capture various terms associated with the overarching label “21st century skills.” In contrast to a view of “21st century skills” as general skills that can be applied to a range of different tasks in various academic, civic, workplace, or family contexts, the committee views 21<sup>st</sup> century skills as dimensions of expertise that are specific to—and intertwined with—knowledge within a particular domain of content and performance. To reflect our view that skills and knowledge are intertwined, we use the term “competencies,” rather than “skills.”

### CLARIFYING AND ORGANIZING CONCEPTS AND TERMS

The committee views the various sets of terms associated with the “21st century skills” label as reflecting important dimensions of human competence that have been valuable for many centuries, rather than skills that are suddenly new, unique and valuable today. The important difference across time may lie in society’s desire that all students attain levels of mastery—across multiple areas of skill and knowledge—that were previously unnecessary for individual success in education and the workplace. At the same time, the pervasive spread of digital technologies has increased the pace at which individuals communicate and exchange information, requiring competence in processing multiple forms of information to accomplish tasks that may be distributed across contexts that include home, school, the workplace, and social networks.

As a way to organize the various terms for “21st century skills” and provide a starting point for further research as to their meaning and value, the committee identified three broad

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domains of competence—cognitive, intrapersonal, and interpersonal. The cognitive domain involves reasoning and memory; the intrapersonal domain involves the capacity to manage one’s behavior and emotions to achieve one’s goals (including learning goals); and the interpersonal domain involves expressing ideas, and interpreting and responding to messages from others. We then conducted a content analysis, aligning several lists of “21st century skills” proposed by various groups and individuals with the skills included in existing, research-based taxonomies of cognitive, intrapersonal, and interpersonal skills and abilities.<sup>1</sup> Through this process, we assigned the various “21st century skills” to clusters of competencies within each domain. Recognizing that there are areas of overlap between and among the individual “21st century skills” and the larger competency clusters, the committee developed the following initial classification scheme (see Chapter 2):

- The Cognitive Domain includes three clusters of competencies: cognitive processes and strategies; knowledge; and creativity. These clusters include competencies such as critical thinking, information literacy, reasoning and argumentation, and innovation.
- The Intrapersonal Domain includes three clusters of competencies: intellectual openness; work ethic and conscientiousness; and positive core self-evaluation. These clusters include competencies such as flexibility, initiative, appreciation for diversity, and metacognition (the ability to reflect on one’s own learning and make adjustments accordingly).
- The Interpersonal Domain includes two clusters of competencies: teamwork and collaboration; and leadership. These clusters include competencies such as communication, collaboration, responsibility, and conflict resolution.

### IMPORTANCE OF 21st CENTURY COMPETENCIES

The committee examined evidence of the importance of various types of competencies for success in education, work, health, and other life contexts (see Chapter 3) and concluded:

- **Conclusion: The available research evidence is limited and primarily correlational in nature; to date, only a few studies have demonstrated a causal relationship between one or more 21st century competencies and adult outcomes. The research has examined a wide range of different competencies that are not always clearly defined or distinguished from related competencies.**

Despite the limitations of the research evidence, the committee was able to reach three conclusions about the importance of various competencies:

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<sup>1</sup>The committee views the abilities included in these taxonomies as malleable dimensions of human behavior that can change in response to educational interventions and life experiences, in contrast to the common view of them as fixed traits.

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- **Conclusion: Cognitive competencies have been more extensively studied than interpersonal and intrapersonal competencies, showing consistent, positive correlations (of modest size) with desirable educational, career, and health outcomes. Early academic competencies are also positively correlated with these outcomes.**
- **Conclusion: Among interpersonal and intrapersonal competencies, conscientiousness (a tendency to be organized, responsible, and hardworking) is most highly correlated with desirable educational, career, and health outcomes. Anti-social behavior, which has both intrapersonal and interpersonal dimensions, is negatively correlated with these outcomes.**
- **Conclusion: Educational attainment—the number of years a person spends in school—strongly predicts adult earnings and also predicts health and civic engagement. Moreover, individuals with higher levels of education appear to gain more knowledge and skills on the job than those with lower levels of education, and to be able, to some extent, to transfer what they learn across occupations. Since it is not known what mixture of cognitive, intrapersonal, and interpersonal competencies accounts for the labor market benefits of additional schooling, promoting educational attainment itself may constitute a useful complementary strategy for developing 21st century competencies.**

At a time when educational and business leaders are increasingly interested in promoting deeper learning and development of “21st century skills,” and in light of limitations of the available empirical evidence linking such competencies with desirable adult outcomes, we recommend further research:

- **Recommendation 1: Foundations and federal agencies should support further research designed to increase our understanding of the relationships between 21st century competencies and successful adult outcomes. To provide stronger causal evidence about such relationships, the programs of research should move beyond simple correlational studies to include more longitudinal studies with controls for differences in individuals’ family backgrounds and more studies using statistical methods that are designed to approximate experiments. Such research would benefit from efforts to achieve common definitions of 21st century competencies and an associated set of activities designed to produce valid and reliable assessments of the various individual competencies.**

## PERSPECTIVES ON DEEPER LEARNING

We define “deeper learning” as the process through which an individual becomes capable of taking what was learned in one situation and applying it to new situations (i.e., transfer). Through deeper learning (which often involves shared learning and interactions with others in a community), the individual develops expertise in a particular domain of knowledge and/or performance (see Chapters 4 and 5). The product of deeper learning is transferable knowledge, including content knowledge in a domain and knowledge of how, why, and when to apply this

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knowledge to answer questions and solve problems. We refer to this blend of both knowledge and skills as “21<sup>st</sup> century competencies.” The competencies are structured around fundamental principles of the content area and their relationships rather than disparate, superficial facts or procedures. It is the way in which the individual and community structures and organizes the intertwined knowledge and skills—rather than the separate facts or procedures per se—that supports transfer. While other types of learning may allow an individual to recall facts, concepts, or procedures, deeper learning allows the individual to transfer what was learned to solve new problems.

The new Common Core State Standards in mathematics and English language arts and the NRC *Framework for K-12 Science Education* are likely to strongly influence educational policy and practice in the coming decades. The committee reviewed these documents and compared them with our definition of deeper learning and with recent lists of “21st century skills,” revealing important areas of overlap. The goals included in the new standards and the NRC Framework reflect each discipline’s desire to promote deeper learning and develop transferable knowledge and skills within that discipline. For example, both the mathematics standards and the science framework include a “practices” dimension, calling for students to actively use and apply—i.e., to transfer—knowledge, and the English language arts standards call on students to synthesize and apply evidence to create and effectively communicate an argument. Our review leads to three conclusions (see Chapter 5):

- **Conclusion: Goals for deeper learning and some 21st century competencies are found in standards documents, indicating that disciplinary goals have expanded beyond their traditional focus on basic academic content. A cluster of cognitive competencies – including critical thinking, non-routine problem solving, and constructing and evaluating evidence-based arguments—is strongly supported across all three disciplines.**
- **Conclusion: Coverage of other competencies – particularly those in the intrapersonal and interpersonal domains – is uneven. For example, standards documents across all three disciplines include discourse and argumentation (which includes both cognitive and interpersonal facets), but the disciplines differ in their view of what counts as evidence and the rules of argumentation. This uneven coverage could potentially lead to learning environments for different subjects that vary in their support for development of 21st century competencies.**
- **Conclusion: Development of the full range of 21st century competencies within the disciplines will require systematic instruction and sustained practice. It will be necessary to devote additional instructional time and resources to advance these sophisticated disciplinary learning goals over what is common in current practice.**

The standards and framework documents demonstrate each discipline’s desire to develop skills and knowledge that will transfer beyond the classroom. However, the goals for transfer are specific to each discipline. For example, the NRC Framework aims to prepare high school graduates to engage in public discussions on science-related issues and, to be critical consumers of scientific information. Research is lacking on how to help learners transfer competencies learned in one discipline or topic area outside the discipline or topic area:

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- **Conclusion: Teaching for transfer within each discipline aims to increase transfer within that discipline. Research to date provides little guidance about how to help learners aggregate transferable competencies across disciplines. This may be a shortcoming in the research or a reflection of the domain-specific nature of transfer.**

To fill this gap, we recommend further research:

- **Recommendation 2: Foundations and federal agencies should support programs of research designed to illuminate whether, and to what extent, teaching for transfer within an academic discipline can facilitate transfer across disciplines.**

Deeper learning can be supported through teaching practices that create a positive learning community, in which students gain content knowledge and also develop intrapersonal and interpersonal competencies. For example, an integrated science-literacy curriculum was tested in 94 fourth-grade classrooms in one Southern State. The curriculum combined collaborative, hands-on science inquiry activities with reading text, writing notes and reports, and small group discussions. When teachers were randomly assigned to either implement the integrated curriculum or to teach science and literacy separately (using their regular materials), students exposed to the integrated curriculum demonstrated significantly greater gains on measures of science understanding, science vocabulary, and science writing. At the same time, the students developed intrapersonal competencies of oral communication and discourse, as well as intrapersonal competencies of metacognition and positive dispositions toward learning (see Chapter 5). Other research also illuminates how intrapersonal and interpersonal competencies support deeper learning of school subjects. For example, the process of deeper learning to develop expertise in a domain of knowledge and performance requires months, or even years, of sustained, deliberate practice; such sustained effort is supported by the intrapersonal competency of conscientiousness. Development of expertise also requires feedback to guide and optimize practice activities—and an individual with strong interpersonal skills will best understand and apply such feedback. Metacognition—the ability to reflect on one’s own learning and make adjustments accordingly—also enhances deeper learning. We conclude (see Chapter 4):

- **Conclusion: The process of deeper learning is essential for the development of transferable 21st century competencies (including both knowledge and skills) and the application of 21st century competencies in turn supports the process of deeper learning, in a recursive, mutually reinforcing cycle.**

## INSTRUCTIONAL FEATURES FOR DEEPER LEARNING

The committee’s review of the evidence on teaching and learning of cognitive, intrapersonal, and interpersonal competencies supported the following conclusion (see Chapter 6):

- **Conclusion: Although the absence of common definitions and quality measures poses a challenge to research, emerging evidence indicates that cognitive,**

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### **intrapersonal, and interpersonal competencies can be taught and learned in ways that promote transfer.**

The most extensive and rigorous research related to deeper learning comes from the learning sciences. Although this research has focused on acquisition of cognitive knowledge and skills, it indicates that deeper learning and complex problem-solving involves the interplay of cognitive, intrapersonal, and interpersonal competencies. Over a century of research on transfer has yielded little evidence that teaching can develop general cognitive competencies that are transferable to any new discipline, problem or context, in or out of school. Nevertheless, it has identified features of instruction that are likely to substantially support deeper learning and development of 21st century competencies within a topic area or discipline. For example, we now know that transfer is supported when learners understand the general principles underlying their original learning and the transfer situation or problem involves the same general principles—a finding reflected in the new Common Core standards and the NRC Framework, which highlight learning of general principles. Similarly, in solving problems, transfer is facilitated by instruction that helps learners develop deep understanding of the structure of a problem domain and applicable solution methods, but is not supported by rote learning of solutions to specific problems or problem-solving procedures. This kind of deep, well-integrated learning develops gradually and takes time, but it can be started early: recent evidence indicates that even preschool and early elementary students can make meaningful progress in conceptual organization, reasoning, problem solving, representation, and communication in well-chosen topic areas in science, mathematics, and language arts. In addition, teaching that emphasizes the conditions for applying a body of factual or procedural knowledge also facilitates transfer.

For instruction focused on development of cognitive competencies, whether delivered in within or outside of school, and irrespective of support by digital media, the committee recommends (see Chapter 6):

- **Recommendation 3: Designers and developers of instruction targeted at deeper learning and development of transferable 21st century competencies should begin with clearly delineated learning goals and a model of how learning is expected to develop, along with assessments to measure student progress toward and attainment of the goals. Such instruction can and should begin with the earliest grades and be sustained throughout students' K-12 careers.**
- **Recommendation 4: Funding agencies should support the development of curriculum and instructional programs that include research-based teaching methods, such as:**
  - **Using multiple and varied representations of concepts and tasks**, such as diagrams, numerical and mathematical representations, and simulations, combined with activities and guidance that support mapping across the varied representations.
  - **Encouraging elaboration, questioning, and explanation**—for example, prompting students who are reading a history text to think about the author's intent and/or to explain specific information and arguments as they read—either silently to themselves, or to others.



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- **Engaging learners in challenging tasks**, while also supporting them with guidance, feedback, and encouragement to reflect on their own learning processes and the status of their understanding.
- **Teaching with examples and cases**, such as modeling step-by-step how students can carry out a procedure to solve a problem and using sets of worked examples; and
- **Priming student motivation** by connecting topics to students' personal lives and interests, engaging students in collaborative problem solving, and drawing attention to the knowledge and skills students are developing, rather than grades or scores.
- **Using formative assessment** to: a) make learning goals clear to students; b) continuously monitor, provide feedback, and respond to students' learning progress; and c) involve students in self- and peer-assessment.

For instruction focused on development of problem-solving and metacognitive competencies, the committee recommends (see Chapter 6):

- **Recommendation 5: Designers and developers of curriculum, instruction and assessment in problem-solving and metacognition should use modeling and feedback techniques that highlight the processes of thinking rather than focusing exclusively on the products of thinking. Problem-solving and metacognitive competencies should be taught and assessed within a specific discipline or topic area, rather than as a stand-alone course. Teaching and learning of problem-solving and metacognitive competencies need not wait until all of the related component competencies have achieved fluency. Finally, sustained instruction and effort is necessary to develop expertise in problem solving and metacognition—there is no simple way to achieve competence without time, effort, motivation, and informative feedback.**

Research on teaching and learning of competencies in the intrapersonal and interpersonal domains is less extensive and less rigorous than the research on deeper learning of cognitive knowledge and skills. Our review of the emerging research on these domains, as well as the more extensive cognitive research, suggests that the instructional features supporting development of transferable competencies in the cognitive domain may also support transfer in these domains (see Chapter 6):

- **Conclusion: The instructional features listed above, shown by research to support the acquisition of cognitive competencies that transfer, could plausibly be applied to the design and implementation of instruction that would support the acquisition of transferable intrapersonal and interpersonal competencies.**

To test this hypothesis, the committee recommends further research:

- **Recommendation 6: Foundations and federal agencies should support research programs designed to fill gaps in the evidence base on teaching and assessment for deeper learning and transfer. One important target for future research is how to design instruction and assessment for transfer in the intrapersonal and**

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**interpersonal domains. Investigators should examine whether, and to what extent, instructional design principles and methods shown to increase transfer, derived from research in the cognitive domain, are applicable to instruction targeted to the development of intrapersonal and interpersonal competencies. Such programs of research would benefit from efforts to specify more uniform, clearly-defined constructs and produce associated measures of cognitive, intrapersonal, and intrapersonal competencies.**

### OPPORTUNITIES AND CHALLENGES

Current educational policies and associated accountability systems rely on assessments that focus primarily on recall of facts and procedures, posing a challenge to wider teaching and learning of transferable 21st century competencies. However, recent policy developments offer opportunities to address this challenge (see Chapter 7). In particular, as noted above, the Common Core State Standards and the NRC Framework for Science Education provide a deeper conceptualization of the knowledge and skills to be mastered in each discipline, including various facets of 21st century competencies.

While new national goals that encompass 21st century competencies have been articulated in the standards and the NRC Framework, the extent to which these goals are realized in educational settings will be strongly influenced by the nature of their inclusion in district, state, and national assessments. Because educational policy emphasizes the results of summative assessments within accountability systems, teachers and administrators will focus instruction on what is included in state assessments. Thus, as new assessment systems are developed to reflect the new standards in English language arts, mathematics, and science, significant attention will need to be given to the design of tasks and situations that call on students to apply a range of 21st century competencies that are relevant to each discipline.

Although improved assessments would facilitate wider uptake of interventions that support the process of deeper learning, developing such assessments faces several challenges. First, research to date has focused on a plethora of different constructs in the cognitive, intrapersonal, and interpersonal domains. Our taxonomy offers a useful starting point, but further research is needed to more carefully organize, align, and define these constructs. Second, there are psychometric challenges. Progress has been made in assessing a range of simple and complex cognitive competencies, yet much further research is needed to develop assessments of intrapersonal and interpersonal competencies. Such research should initially focus on developing assessments for research purposes, and later on assessments for formative purposes. If these efforts are successful, then summative assessments of intrapersonal and interpersonal competencies could possibly be developed for later use in educational settings. Experiences during the 1980s and 1990s in the development and implementation of performance assessments and assessments with open-ended tasks offer valuable insights, but assessments must be reliable, valid, and fair if they are to be widely used in formal and informal learning environments.

A third challenge is posed by political and economic forces that influence assessment development and use. Policy makers have favored standardized, on-demand, end-of-year tests that are easily scored and quantified for accountability purposes. Composed largely of selected response items, these tests are relatively cheap to implement but are not optimal for assessing 21st century competencies (see Chapter 7). In the face of current fiscal constraints at the federal

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and state levels, assessment systems may seek to minimize costs by using these types of tests, rather than incorporating the richer, performance- and curriculum-based assessments that can better support the development and assessment of 21st century competencies.

The fourth challenge is teacher capacity. The principles of instruction we outline above are rarely reflected in the knowledge and practices of teachers, students, and school administrators and in administrators' expectations of teachers and teacher evaluation rubrics. Teacher preparation programs will need to help teacher candidates develop specific visions of teaching and learning for transfer and also the knowledge and skills to put these visions into practice. Both novice and experienced teachers will need time to develop new understandings of the subjects they teach as well as understanding of how to assess 21<sup>st</sup> century competencies in these subjects, making ongoing professional learning opportunities a central facet of every teacher's job. Certainly, teachers will need support from administrators as they struggle with the complexity and uncertainty of revising their teaching practice within the larger effort to institutionalize a focus on deeper learning and effective transfer.

- **Recommendation 7: Foundations and federal agencies should support research to more clearly define and develop assessments of 21st century competencies. In particular, they should provide sustained support for the development of valid, reliable, and fair assessments of intrapersonal and interpersonal competencies, initially for research purposes, and later for formative assessment. Pending the results of these efforts, foundations and agencies should consider support for development of summative assessments of these competencies.**

Two large consortia of States, with support from the U.S. Department of Education, are currently developing new assessment frameworks and methods aligned with the Common Core State Standards in Mathematics and English language Arts. If these assessment frameworks include the facets of 21st century competencies represented in the Common Core State Standards, they will provide a strong incentive for States, districts, schools, and teachers to emphasize these competencies as part of disciplinary instruction. Next Generation Science Standards based on the NRC Framework are under development, and assessments aligned with these standards have not yet been created. When new science assessments are developed, inclusion of facets of 21st century competencies will provide a similarly strong incentive for States, districts, schools, and teachers to emphasize those facets in classroom science instruction (see Chapter 7).

- **Recommendation 8: As the State consortia develop new assessment systems to reflect the Common Core State Standards in Mathematics and English language arts, they should devote significant attention to the design of tasks and situations that call upon a range of important 21st century competencies as applied in each of the major content areas.**
- **Recommendation 9: As States and test developers begin to create new assessment systems aligned with new science standards, they should devote significant attention to designing measures of 21st century competencies properly reflecting a blend of science practices, crosscutting concepts, and core ideas.**

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Because 21st century competencies support deeper learning of school subjects, their widespread acquisition could potentially reduce disparities in educational attainment, preparing a broader swathe of young people for successful adult outcomes at work and in other life arenas. However, important challenges remain. For educational interventions focused on developing transferable competencies to move beyond isolated promising examples and flourish more widely in K-12 schooling, larger systemic issues and policies involving curriculum, instruction, assessment and professional development will need to be addressed. In particular, new types of assessment systems, capable of accurately measuring and supporting acquisition of these competencies will be needed. A sustained program of research and development will be required to create assessments that are capable of measuring cognitive, intrapersonal, and interpersonal competencies. In addition, it will be important for researchers and publishers to develop new curricula that incorporate the research-based design principles and instructional methods we describe above. Finally, new approaches to teacher preparation and professional development will be needed to help current and prospective teachers understand these instructional principles and methods, as well as the role of deeper learning and 21st century competencies in mastering core academic content. If teachers are to not only to understand these ideas, but also translate them into their daily instructional practice, they will need support from school and district administrators, including time for learning, shared lesson planning and review, and reflection (see Chapter 7).

- **Recommendation 10: The states and the federal government should establish policies and programs—in the areas of assessment, accountability, curriculum and materials, and teacher education—to support students’ acquisition of transferable competencies. For example, when reauthorizing the Elementary and Secondary Education Act, the Congress should facilitate the systemic development, implementation, and evaluation of educational interventions targeting deeper learning processes and the development of transferable competencies.**



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# **Education for Life and Work: Developing Transferable Knowledge and Skills in the 21<sup>st</sup> Century**

Committee on Defining Deeper Learning and 21<sup>st</sup> Century Skills

James W. Pellegrino and Margaret L. Hilton, Editors

Board on Testing and Assessment

Board on Science Education

Division of Behavioral and Social Sciences and Education

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following individuals for their review of this report: Diane F. Halpern, Department of Psychology, Claremont McKenna College; Karen R. Harris, Department of Special Education and Literacy,

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James Pellegrino, Chair  
Margaret Hilton, Study Director  
Committee on Defining Deeper Learning and 21<sup>st</sup> Century Skills

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