P21 PARTNERSHIP FOR 21ST CENTURY LEARNING

What We Know About CRITICAL THINKING

Part of the 4Cs Research Series

ABOUT THE PARTNERSHIP FOR 21ST CENTURY LEARNING

P21, the Partnership for 21st Century Learning, recognizes that all learners need educational experiences in school and beyond, from cradle to career, to build knowledge and skills for success in a globally and digitally interconnected world. Representing over 5 million members of the global workforce, P21 unites business, government and education leaders from the U.S. and abroad to advance evidence-based education policy and practice and to make innovative teaching and learning a reality for every child.

ABOUT THE RESEARCH SERIES

P21, in collaboration with its research partners, produced a series of research briefs and annotated bibliographies on key aspects of conceptualizing, developing, and assessing the 4Cs.

The research briefs in this series start with an overview of key conceptual issues related to the 4Cs of Creativity, Critical Thinking, Collaboration, and Communication, review research on interventions designed to increase student proficiency within each of the 4Cs, describe recent work on how to assess on the 4Cs, and conclude with major take-away points from the available research.

The series is edited by Helen Soulé, Executive Director at P21, and Jonathan Plucker, Neag Endowed Professor of Education at the University of Connecticut.

The 4Cs Research Series is dedicated to Dr. Ronald Thorpe, president and CEO of the National Board for Professional Teaching Standards. A friend and visionary we lost too early.

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INTRODUCTION

How do we think? What mechanisms do we use to solve problems, and can these mechanisms be learned? Philosophers, educators, and psychologists have been grappling with these questions perhaps since we first began thinking. Although many aspects of human cognition are still a mystery, psychologists have begun to flesh out the strategies we use to think in organized ways to analyze and solve problems. This systematic style of thinking is generally referred to as "critical thinking."

Critical thinking has been studied since at least the 1910s, when John Dewey first published his landmark book, How We Think (1910/1933), and it is included in many models of skills that are important for education and workforce success (Trilling & Fadel, 2009), including the P21 Framework for 21st Century Learning as one of the Learning and Innovation Skills (www.P21.org/Framework). Also known as the "4 Cs," these skills include critical thinking, creativity, collaboration, and communication. Reasoning, logic, and judgment are all widely understood to be useful cognitive skills, in both schools and the workplace, and as these are important components of critical thinking, it becomes clear why educators have pushed for the inclusion of critical thinking instruction within their classrooms (see Wagner, 2008).

DEFINITIONS AND MODELS

Researchers and educators have conceptualized critical thinking in a number of ways over the past century. Dewey's How We Think (1910/1933) was an early attempt to define and model critical thinking. In the book, Dewey philosophized about the process of thinking and discussed stereotypes and prejudice, decisions based on faulty information, and other obstacles to productive thinking. He argued that thought without proper reflection is uncritical thinking, and that to make better decisions, self-reflection is vital. The cultivation of curiosity was considered to be important, as he believed it led to more reflexive thought and, therefore, to more critical thinking. Based on Dewey's conceptualization, critical thinking is analogous with metacognition, or thinking about one's own thinking.

Another major, theoretical milestone was Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Krathwohl, Bloom, & Masia, 1964), which for much of the past 50 years has been considered an essential model for educators interested in critical thinking. The taxonomy was split into three sections—cognitive, affective, and psychomotor—and is based on the belief that one must develop prerequisite basic skills in each area before progressing to more complex, higher-order skills. The cognitive domain is most relevant to the teaching of critical thinking, and it included six categories: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The categories were assumed to be hierarchical, increasing in concreteness and complexity as one moved through the taxonomy. For example, one must develop knowledge (basic concepts, facts) before being able to move to comprehension, where one can use these facts in comparisons, transformations, or new interpretations. This model of critical thinking has long been popular with educators.

Krathwohl (2002) later revised the cognitive taxonomy, altering the language to reflect the active processes that students should be engaged in within each category. He split the cognitive domain into two dimensions: the Knowledge dimension (with categories representing factual, conceptual, procedural, and metacognitive knowledge) and the Cognitive Process dimension (remember, understand, apply, analyze, evaluate, create). The new process dimension, which is most relevant to this discussion of critical thinking, was considered to be less hierarchical, with considerable overlap among many of the categories.

With the development of new technologies, cognitive scientists began to think differently about the way we create and process information. During the industrial revolution, the human body, including the brain, was thought to work much like a steam engine. As computers rose in usage, the information-processing theory of cognition was proposed. Newell and Simon (1961) presented a computer program thought to operate similarly to human cognition, arguing that the human mind solves problems by breaking them down into their component parts and applying systematic strategies to address those problems. The information-processing model is still popular today, but most psychologists have moved past this definition of critical thinking, elaborating specifically on what "systematic strategies" one might use to solve problems.

For example, Norris (1985), in a summary of critical thinking work through the early 80s, defined critical thinking as "rationally deciding what to do or believe" (p. 40). Sternberg (1986), reflecting additional developments in cognitive science, defined critical thinking as "the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts" (p. 3). He proposed a three-part taxonomy of critical thinking, consisting of metacomponents, performance components, and knowledge-acquisition components. Metacomponents are what many researchers, and laypeople, think of when talking about critical thinking: the processes

CRITICAL THINKING IN PRACTICE: A P21 Exemplar Perspective

In tenth grade Modern Global Cultures courses at AIM Academy in Conshohocken, Pennsylvania, educators are charged with helping their students understand how the existence of the institution of slavery was possible in a historical and social context. The challenge in this task is to help students contextualize their modernist vision of a key piece of global history. This requires the leveraging of 21st century critical thinking practices that allow students to reflect on the ramifications and context of this historical happening, while relating these reflections to their current social status quo. Our essential questions have included: How do we engage with students on a deeper level about an issue that has received ample historical attention in their curricular past? How do we guide students to think more deeply about the moral considerations people made in their choice to support the institution of slavery?

Our critical thinking, discussion, and exercise of historical contextualization is rooted in reading of Charles Johnson's seminal work *Middle Passage*. A fictional tale of Rutherford Calhoun, a former slave turned escapee sailor aboard a slave trading ship, Johnson's work presents an entire body of critical thinking dilemmas to its readers. Issues of marriage, the positive treatment of slaves by their owners, and building one's personal legacy are considered, along with more morally reprehensible issues such as cannibalism, abandonment, and plundering of the world's cultural relics. Johnson's work provides a rich critical thinking foundation.

AIM tenth graders engage with Johnson's work in a number of ways including careful readings, discussions, and reflective writings. Quotes from the novel are pulled apart, and students are asked to closely consider each of Johnson's distinct vocabulary selections. Written reflections are created in which students are asked to put themselves in the contextual situation of the characters: What would you do if the enslavement of others or death were your only options? is a common question students are asked to consider. Students are asked to grapple with history in a way that asks them to also grapple with themselves. They are pushed to consider more than just a cleanly defined track of world history, but to dig more deeply into a morally muddy time of the past.

To demonstrate critical thinking skills, students produce a writing portfolio that is used as a major assessment tool. Through these writings, growth is measured in their ability to develop and articulate a personal perspective, their confidence in reason when interpreting historical context, and their examination of implications or consequences of slavery to our modern era. Rubrics are used to guide students toward showcasing their thinking in clear and concise ways. Additionally, rubrics are used in conjunction with the English/Language Arts team to guide student writing expectations. The overarching goal is to help young people shape their vision of the present, and to encourage their demonstration and honing of the inductive, deductive, argumentative, and analytical skills essential for 21st century learning.

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involved in monitoring one's cognition, evaluating a problem, and deciding on a course of action. Performance components are lower-order thought processes, such as reading, visualization, and deductive and inductive reasoning. Knowledge-acquisition components consist of processes that make the acquiring of relevant knowledge easier, such as selective attention. Sternberg also noted that many philosophers and psychologists defining critical thinking had already focused on the core aspects of critical thinking. The issue, then, was with the fringes of the concept. How much of cognition should really be conceptualized as part of critical thinking itself? For example, is knowledge acquisition integral enough to the process of critical thinking that it should be included in the model?

Halpern, in her text, Thought and Knowledge: An Introduction to Critical Thinking (1985, updated 2013), defines critical thinking as "the use of those cognitive skills or strategies that increase the probability of a desirable outcome" (p. 8). She also notes that this thinking should be "purposeful, reasoned, and goal-directed." She also gives her model, which includes explicit critical thinking skills, a disposition for effortful learning, transfer of training, and explicit and overt metacognitive monitoring. Metacognitive monitoring is familiar to us from Dewey's theories, and Halpern's critical thinking skills (e.g., synthesizing of information, reasoning) are also common to multiple other theories. Transfer of training can be understood as the generalizing of critical thinking skills across multiple domains. If you are to be a good critical thinker, you must be able to think critically in many situations, with different requirements put upon you. Disposition for

critical thinking refers to the personality or affective factors that impact one's desire to pursue critical thinking. In other words, if you possess all the necessary skills, yet are unwilling to devote time to researching a topic, you cannot be thought of as a good critical thinker, according to Halpern.

Kahneman's dual system approach to thinking, popularized by his book, Thinking, Fast and Slow (2011), conceptualizes thinking as a dual process. System 1 represents impulsive, reactionary, and emotive thoughts, such as prejudices and "gut reactions." System 2 includes deliberate, reflective, and logical thought, what we would conceptualize as more critical thinking. Other researchers have also theorized thinking as a dual- process model, and this theory has become popular among many social and cognitive psychologists.

In 1990, the American Psychological Association commissioned a panel of 46 experts to decide upon a definition of critical thinking. The panel's report, commonly referred to as the Delphi report (Facione, 1990), discusses critical thinking from two dimensions—cognitive skills and dispositions. The cognitive skill dimension includes the sub-skills of interpretation, analysis, evaluation, inference, explanation, and self-regulation, and the dispositional dimension includes the affective characteristics that are necessary for the cognitive sub-skills to thrive. Although the dispositional dimension was debated, with 30% of contributors arguing that it should not be included in conceptualizations of critical thinking, the cognitive skills dimension was widely agreed upon.

Reflective, analytical, evaluative, and deliberate skills and characteristics are common themes across these definitions, conceptualizations, and theories. They've evolved over time, moving far past Dewey's description of simple self-reflection to complex, multi-faceted definitions and models of cognition.

ASSESSMENTS

The assessment of critical thinking has been of interest to many fields, including the military, business, and education. It could even be argued that intelligence tests were early measures of critical thinking, as early tests attempted to measure problem-solving ability, logical thinking, and other forms of cognition that later came to be defined as critical thinking. Indeed, intelligence tests and even standardized tests such as the SAT or ACT are often used as proxies to assess thinking skills. However, many researchers argue that these tests miss vital aspects of critical thinking, such as judgment, reasoning, or decision making (Stanovich, 2009).

But how best to assess critical thinking in educational contexts? Ku (2009) points out that multiple- choice, survey-style inventories are likely not the most effective way to measure critical thinking. She argues for a more comprehensive test involving both multiple- choice and short- answer questions. Researchers generally agree that assessments should be based on simulations that approximate real-world problems and issues and that reflect "authentic" problems, contexts, and performances (Bonk & Smith, 1998; Halpern, 1998).

However, many critical thinking assessments still use multiple- choice formats. For example, the Collegiate Assessment of Academic Proficiency (CAAP) test includes a critical thinking module, which consists of multiple- choice questions designed to assess students' analysis, evaluation, and clarification skills in response to given passages. The Delphi report (Facione, 1990) also outlined strategies to develop a critical-thinking measure, stressing the need for content and construct validity, as well as reliability and fairness. Facione, Facione, and Blohm (2007) then followed these guidelines in the development of the California Critical Thinking Skills Test, a measure designed to assess numerous processes associated with critical thinking, measuring skills such as deduction, evaluation, inference, as well as overall reasoning.

The Halpern Critical Thinking Assessment, based on Halpern's own critical thinking model (Halpern, 1998), has also been developed to assess critical thinking skills. In the 1998 paper, Halpern proposes a model of critical thinking, as well as recommendations for the instruction in and assessment of critical thinking skills. The HCTA is designed with both open-ended (short answer) and forced response (multiple choice or ranking) questions. The prompts are based on everyday scenarios, and the test has been validated on a wide range of samples, from high school seniors to working adults.

One of the oldest assessments is the Cornell Critical Thinking Test (CCTT) (Ennis, Millman, & Tomko, 2005), based on a definition of critical thinking as cognition that assists in "deciding what to believe or do" (p. 1). Similar to the Halpern Assessment, the Cornell Test embeds critical thinking questions in a real-world scenario, with the difference that the CCTT has a consistent scenario that runs throughout the assessment. Items address five aspects of critical thinking: assumptions, credibility, deduction, induction, and observation. The CCTT is among the most widely used critical thinking assessments (Abrami et al., 2008).

The Council for Aid to Education launched a measure in 2002 as part of an effort to measure undergraduate learning through performance tasks. The measure consists of some multiple-choice questions, but the most

well-developed section is the writing task, in which students are asked to respond critically to a prompt, after analyzing a collection of associated documents. There have been a number of criticisms related to the validity of the measure. A report conducted by the Fund for the Improvement of Postsecondary Education examined these concerns and found that when the results were averaged across the population of an entire college, the test seemed to have better predictive power and be more reliable than when evaluating individual results. This measure was originally developed for college populations but has been adapted to measure students at the high-school level as well.

INTERVENTIONS

There are a wide variety of interventions that can be used to teach critical thinking. Whether it is integrated with a subject matter or taught separately from specific disciplines, whether the teacher implementing the intervention has been trained to educate for critical thinking or not, there are many factors that go into each intervention. In general, research on the effectiveness of these interventions is mixed. However, when critical thinking skills are taught specifically to transfer to other domains, improvements are more pronounced (Halpern, 2013). The research suggests that these conflicting results are not a result of an inability to

CRITICAL THINKING IN PRACTICE: A P21 Member Perspective

Imagine the panic and sense of powerlessness of not knowing if a fire alarm sounded at a school - a reality for 14 deaf students at Mission Heights Junior College in New Zealand. Noting this issue, three 10th grade students made it the area of concern in their Community Problem Solving project. Using the six-step creative problem solving process modeled by major government and business think-tanks, these students researched, analyzed the situation, applied critical thinking and then implemented an action plan whereby each of the deaf students was provided with a portable vibrating alarm designed and programmed by the team. The device has been submitted for a patent after much interest was generated within multiple agencies. This is one example of the critical thinking applied in Future Problem Solving Program International, a 501 (c) (3) non-profit program which provides essential skills for today's students.

Developed in 1974 by Dr. E. Paul Torrance, Future Problem Solving continues to expand to new regions of the world offering learners of many ages a variety of opportunities to learn and apply critical thinking and creative problem solving skills required for success throughout life. Picture students as young as primary school researching and analyzing the topic of Space Junk and completing a 12-page written booklet utilizing the six-step creative problem solving process to assess the given futuristic situation, identify an underlying problem, brainstorm a variety of solutions, analyze the options, and develop a well-conceived plan of action. STEM-based topics are enhanced by the program's emphasis on both oral and written communication skills as students collaborate and submit written or oral work in each of the various components offered.

Isaksen, Dorval, & Treffinger (2011) proposed that effective problem solving involves both generating options (creative thinking) and focusing options (critical thinking). Creative thinking, critical thinking, problem-solving, and developing what Torrance described as "the long look at the future" continue to be described as fundamental goals across educational systems. The development of individual skills, as well as team collaboration, enable students with varied learning and problem solving styles to engage in Future Problem Solving in personally rewarding ways.

Data collected from FPSPI alumni shares the overall impact of FPSPI participation on their personal and professional lives. Over 93% reported that they continue to use the Future Problem Solving process daily and that they found these skills the same ones desired by their employers. The skills most mentioned include analysis, critical thinking, collaborative ability, problem solving skills, research, and time management.

Critical thinking and problem solving impacts personal growth beyond the high school years, confirming the importance of the FPSPI motto: Teaching students how to think, not what to think!

Learn more at www.fpspi.org

Isaksen, S. G., Dorval, K. B., & Treffinger, D. J. (2011). Creative approaches to problem solving. (3rd ed.). Thousand Oaks, CA: Sage Books.

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teach critical thinking, but rather a discrepancy in how the interventions were conducted.

Abrami et al. (2008) conducted a meta-analysis of 117 studies that examined critical thinking interventions and found mixed results. Although a surprising number of the analyzed studies had positive results, meaning the critical thinking intervention worked, they were not all positive. Many studies demonstrated no change, and others even showed a negative effect. Upon closer examination, they found that the type of intervention, as well as the pedagogic grounding of the intervention, both contributed significantly to the explanation of the variance in effect size. They found that a mixed-method type of intervention, where critical thinking skills are taught alongside a course, had the greatest impact on critical thinking. The smallest effects were seen when critical thinking was not explicitly stated in the course objective. In terms of pedagogy, the interventions had the greatest effect when the teachers were specifically trained before the intervention, or when they were closely observed.

In a meta-analysis conducted by the Thinking Skills Review Group (Higgins et al., 2004), 191 studies of critical thinking interventions were initially selected and later narrowed to 23 studies that fit the researchers' criteria of both quantitative and qualitative data. The authors found a majority of positive studies, with no studies showing negative impacts on students who received critical thinking instruction. Interestingly, their results also indicated that low-performing students showed particular benefits with critical thinking instruction, especially when the instruction involved metacognitive strategies. There is also some evidence that these thinking skills were transferable to other domains, which is necessary in Halpern's view of critical thinking. Fong, Krantz and Nisbett (1986) also showed that critical thinking skills could be generalized across situations. In their study, participants were trained in abstract mathematical concepts (the law of large numbers) and later tested to see if their instruction helped participants improve in statistical reasoning. They found that these improvements persisted even when participants were later tested outside of their learning environment (by phone survey in their own home). Kosonen and Winnie (1995) extended this line of research, again showing that instruction of statistical reasoning improves participants reasoning about everyday problems.

Explicit instruction appears to be a key component to teaching critical thinking skills successfully. Marin and Halpern (2011) found evidence that students who were explicitly taught critical thinking skills (i.e., the students knew they were taking a critical thinking course) performed better than students who were simply taking a course with the skills embedded within it. When the two sets of students were tested after the course, the students who explicitly learned critical thinking skills performed significantly better than those who did not receive the instruction explicitly. Bangert-Drowns and Bankert (1990) conducted a meta-analysis of studies that explicitly taught critical thinking skills, and found that in pre-test post-test designs, studies that used explicit instruction showed an average effect size of 0.4. Helsdingen, Van den Bosch, Van Gog, & van Merriënboer (2010) found similar results: When two groups were given realistic, complex, decision-making scenarios to solve, the group given explicit critical thinking instruction performed better on the task. The researchers also found that these effects seemed to generalize to aspects not tested by the original instruction sets.

CRITICAL THINKING IN PRACTICE: A P21 Member Perspective

We often get the question about whether Board certification makes a difference in student achievement. The answer is clear: More than a decade of research validates that students of Board-certified teachers learn more than students in other classrooms. This has been proven across K-12; in reading, math and science; and in urban, rural and suburban schools. The impact is even greater for minority and low-income students.[1]

Most recently, in March 2015, research by Dr. Dan Goldhaber and James Cowan in Washington state estimated that students of Board-certified teachers gained one-and-a-half months' worth of learning in middle school math, based on state standardized tests.[2] The researchers stated, "Board certification appears to be among the teacher credentials most consistently associated with student learning gains."[3]

That finding echoed numerous studies reviewed by the National Research Council in a report commissioned by Congress in 2008, which concluded: "The evidence is clear that National Board Certification distinguishes more effective teachers from less effective teachers with respect to student achievement."

However, the focus on student achievement may obscure a more important point also evident in the research: Board-certified teachers have the proven ability to instill critical thinking skills and the habits of mind that are so important for students' success in college and beyond. Studies in 2000 and 2005 found that students of Board-certified teachers have stronger writing abilities, are better able to comprehend and integrate complex classroom materials, better understand concepts, and are more capable of abstract thinking than students of non-certified teachers.[4,5]

Increasingly, states and districts are looking to leverage Board-certified teachers as instructional change agents. As the Mississippi Department of Education prepares to implement its Third Grade Gate policy requiring third-graders to meet minimum literacy benchmarks before being promoted to the fourth grade, it is deploying Board-certified teachers statewide. In addition to working with K-3 students during the school year and in special summer sessions, they will work alongside teacher colleagues, spreading instructional best practices.

The impact of Board certification in spurring deeper learning and critical thinking is perhaps best expressed by students. In a recent blog, Ray Salazar, a Board-certified high school English teacher working in Chicago's South Side, shared a quote from a student who had gone on to succeed in college. The student said, "Before your class, I knew what I did right. But I never knew what I did wrong." Salazar attributes this to "the confidence-building approach I've gained by teaching AP English Language: When a student's writing does not work, we focus on whatever does work, but then the student must decide what to do next."

When Salazar asked another student how college was going, he replied: "Everything in my writing life is fine." Finally, in the clipped eloquence of Twitter, a third student boasted: "Guess who's the only one in class who can explain ethos, pathos, and logos?" Now there's a sentiment that brings the research to life, and is critical to creating a future workforce and citizenry capable of digging deeper, solving complex problems and fostering greater understanding.

Dr. Ronald Thorpe

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[1] Cavalluzzo, L., Barrow, L., Henderson, S. et al. (2015). From Large Urban to Small Rural Schools: An Empirical Study of National Board Certification and Teaching Effectiveness. CNA Analysis and Solutions; Goldhaber, D., & Anthony, E. (2007). Can teacher quality be effectively assessed? The Review of Economics and Statistics 89(1), 134-150.

[2] Cowan, J., & Goldhaber, D. (2015). National Board Certification and Teacher Effectiveness: Evidence from Washington. The Center for Data & Research, University of Washington Bothell.

[3] National Board for Professional Standards press release, March 19, 2015. Accessed online at: http://www.nbpts.org/newsroom/two-new-studies-add-evidence-base-board-certified-teachers-impact-student-achievement.

[4] T. W. Smith, et al., An Examination of the Relationship Between Depth of Student Learning and National Board Certification Status (Boon, N.C.: Office of Research on Teaching at Appalachian State University, 2005).

[5] L. Bond, et al., The Certification System of the National Board for Professional Teaching Standards: A Construct Validity Study (Greensboro, N.C.: Department of Education Research Methodology and Center of Educational Research and Evaluation, University of North Carolina, September 2000).

CONCLUSIONS AND RECOMMENDATIONS

Conclusion: Over time, conceptualizations of critical thinking have become more complex and multi-faceted, but common features of most definitions include reflective, analytical, and evaluative skills, generally being used to help solve problems and reach conclusions.

> **Recommendation:** When considering critical thinking interventions, educators should consider the definition of critical thinking upon which the program is based to ensure that view of critical thinking matches their school's definition and goals in this area.

Conclusion: Explicit attention to the fostering of critical thinking skills and sub-skills, as well as dispositions, should be made an instructional goal at all levels of the K-12 curriculum.

> **Recommendation:** Critical thinking skills should be an integral part of education at the elementary-school level.

> **Recommendation:** In middle schools and high schools, instruction on various aspects and applications of critical thinking should be integrated into instruction across the curricula. Specific courses in critical thinking should be made available to all students.

> **Recommendation:** At the post-secondary level, all academic courses should be considered part of an institution's critical thinking strategy.

Conclusion: Teaching and modeling critical thinking skills explicitly is a necessary and important job for teachers.

> **Recommendation:** Teaching critical thinking is most effective if the instructor models dispositions and the proper use of critical thinking sub-skills in the process of their instruction.

Conclusion: Assessment of critical thinking skills and sub-skills, when possible, should be performance-based.

> **Recommendation:** Performance-based assessment is believed to be a more valid (but not necessarily more reliable) measure of the critical thinking construct. If a performance-based assessment is not possible, critical thinking is often best assessed within the context of real-world scenarios.

TABLE 1: What do we need to do?

Education Level	Intervention	Assessment	Evaluation
P-12 Classroom	Determine extent to which critical thinking is being developed and modeled in the classroom environment; embed critical thinking into the classroom culture	Promote critical thinking within curriculum and instruction; focus on how it can be used in school, everyday life, and issues important to the community	Include dimensions of critical thinking within assignments (such as evaluating real-world materials from the subject matter); Develop and/or use formative, curriculum-based assessments of critical thinking; regularly assess student's growth and report the results to parents
School	Embed critical thinking within the underlying culture of the school and make sure learning spaces encourage critical thinking; determine how well overall school environment encourages critical thinking and take steps to address gaps	Develop common vision, plan and strategy for incorporating critical thinking into teaching and learning; build staff capacity and support innovative teaching practices, such as selecting key components of critical thinking (e.g., logic, recognizing manipulation, evaluating sources) to emphasize school wide	Develop an assessment plan that incorporates the evaluation of critical thinking development as a regular part of the evaluation and reporting process. Encourage formative assessment of critical thinking in a variety of ways, such as within student assignments, in testing, and in project evaluation
Out-of-School	Evaluate the extent to which programs, activities, services, spaces and culture support critical thinking; redesign learning/activity environment as needed	Incorporate critical thinking into programs, activities and services; support building staff capacity through professional development and professional learning communities	Encourage measurement of students' growth in critical thinking as integral part of desired program outcomes
School District	Determine how resources are used to promote critical thinking in learning spaces and culture; allocate resources as needed	Provide professional development and resources to schools to build capacity to incorporate critical thinking into teaching and learning	Support the incorporation of critical thinking into the district's assessment system and encourage the assessment of critical thinking in schools
State	Promote the inclusion of critical thinking outcomes in schools and districts; support teaching practices and learning environments that promote critical thinking	Develop curricula promoting critical thinking; provide districts with curricular and instructional resources, including professional development	Promote the assessment of critical thinking as a necessary student outcome for success; ensure assessments used show discriminant validity from standard achievement or intellectual tests
National	Promote the inclusion of critical thinking outcomes in schools and districts; support teaching practices and learning environments that promote critical thinking	Develop curricula promoting critical thinking; provide districts with curricular and instructional resources, including professional development	Promote the assessment of critical thinking as a necessary student outcome for success; ensure assessments used show discriminant validity from standard achievement or intellectual tests

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Marin, L. M., & Halpern, D. F. (2011). Pedagogy for developing critical thinking in adolescents: Explicit instruction produces greatest gains. *Thinking Skills and Creativity*, 6(1), 1-13.

Newell, A., & Simon, H.A. (1961). Computer simulation of human thinking. *Science*, 134(3495), 2011-2017.

Norris, S. P. (1985). Synthesis of research on critical thinking. *Educational leadership*, 42(8), 40-45.

Stanovich, K. E. (2009). *What intelligence tests miss: The psychology of rational thought*. New Haven, CT: Yale University Press.

Sternberg, R. J. (1986). *Critical thinking: Its nature, measurement, and improvement*. Washington, DC: National Institute of Education. Retrieved from http://eric.ed.gov/PDFS/ED272882.pdf

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times: Learning for life in our times*. San Francisco: John Wiley & Sons.

Wagner, T. (2008). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need—and what we can do about it*. New York: Basic Books.

ANNOTATED BIBLIOGRAPHY

Critical thinking is included in the P21 Framework for 21st Century Learning as one of the Learning and Innovation Skills (www.P21.org/Framework). Also known as the "4Cs," they include creativity, critical thinking, collaboration, and communication.

Critical thinking has been studied by educational scholars for many years, and is still gaining ground in terms of its perceived importance by teachers, scholars, and administrators alike. In this annotated bibliography, an emphasis was placed on resources that are likely to be found online or in most university and many public libraries, that are especially comprehensive, are accessible to the lay reader to the extent possible, and collectively represent the major figures in the field.

The communication bibliography was compiled by Anna Dilley, Ronald Beghetto, James Kaufman, and Jonathan Plucker at the University of Connecticut's Neag School of Education. They appreciate the helpful feedback and recommendations provided by the P21 Staff.

GLOSSARY

Critical thinking – The process of analyzing, synthesizing, conceptualizing, applying, and/or evaluating information from various sources.

Decision making – The cognitive process of choosing between alternatives, based on the values of the decision maker, that may or may not lead to a behavioral outcome.

Heuristics – A "shortcut" method of problem solving, used to speed decision making when necessary.

Information literacy – The ability to locate and use appropriately information necessary to a problem at hand.

Metacognition – "Thinking about thinking", including knowledge of one's cognition, and the regulation of cognitive processes.

Higher-order thinking – Based on learning taxonomies (such as Bloom's Taxonomy), this term refers to a number of thinking skills, including critical thinking, that are believed to be more cognitively taxing.

BROAD OVERVIEWS

Abrami, P.C., Bernard, R.M., Borokhovski, E., Wade, A., Surkes, M.A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research*, 78(4), 1102-1134.
This meta-analysis based on 117 studies looks at the major ways that critical thinking is measured and taught in an attempt to find the instructional strategies that are most effective. They found that the strategy of teaching critical thinking skills explicitly as a component of a specific content course where application of CT to the content happened immediately thereafter was more effective than teaching CT as a stand-alone course or as a skill embedded implicitly or indirectly into a content course. They also found that the best teachers of CT received direct preparation for teaching CT skills or thorough observation of their teaching of CT.

Beyer, B.K. (1987). What research says about teaching thinking skills. In A. Costa (Ed.), *Developing minds: A resources for teaching thinking*. Alexandria, VA: ASCD.
Beyer summarizes major work in an attempt to apply research theory to the practice of teaching thinking skills. Beyer organizes the strategies presented into what works best when introducing a thinking skill (modeling and metacognitive reflection), what to do to encourage practice of thinking skills (scaffold support, cued practice, and feedback), and how to encourage transfer of thinking skills (generalizing and abstracting principles for application in new contexts).

Cotton, K. (1991). *Teaching thinking skills*. Northwest Regional Educational Laboratory, School Improvement Program.
Cotton explores existing literature on thinking skills education, including controversies related to the teaching of thinking skills, definitions of terminology related to thinking skills, and research findings in the field.

Cuypers, S. E., & Haji, I. (2006). Education for critical thinking: Can it be non-indoctrinative? *Educational Philosophy and Theory*, 38(6), 723-743.

The authors discuss the importance of teaching critical thinking in schools, and the conundrum of teaching to young critical thinking to young children. Namely, that it is sometimes necessary to indoctrinate the material before it is possible for the children to learn it, as they do not yet have the cognitive capacity for critical thinking. They then argue for creating what they call "proto-critical thinkers", who will with some assistance develop into autonomous critical thinkers.

Dewey, J. (1910). *How we think*. Boston: D.C. Heath.
In this partly psychological and partly philosophical work, Dewey argues that thinking is natural to humans but it can be encouraged to develop more effectively. In order to do this, we need to expose students to experiences that present confusion or a dilemma. These experiences, in turn, will stimulate thinking as students become curious and creative in how they reason through dilemmas. From Dewey's perspective, curiosity, if cultivated, will lead to more consistent reflective thought--the heart of effective reasoning.

Dunn, D.S., Halonen, J.S., & Smith, R.A. (Eds). (2008). *Teaching critical thinking in psychology: A handbook of best practices*. Oxford, UK: Wiley-Blackwell.
Empirical support for a variety of teaching practices that help to teach critical thinking skills, specifically, within the discipline of psychology

Francione, P.A. (1990). *Executive Summary- Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction* (The Delphi Report). Retrieved from the Duke Trinity College of Arts & Sciences website: http://assessment.aas.duke.edu/documents/Delphi_Report.pdf.
The American Philosophical Association commissioned this panel of 46 critical thinking scholars and experts to develop a consensus definition for critical thinking. Consensus was reached on defining the skills of critical thinking (including interpretation, analysis, evaluation, inference, explanation, and self-regulation) and the affective dispositions of a good critical thinker. The report acknowledged the debate, however, as to whether the dispositions of a good critical thinker were inherent to the definition of critical thinking ability. This commission drew a clear line between critical thinking as a distinct, albeit similar, higher order thinking skill from problem-solving, decision-making, and creativity.

Flores, K. L., Matkin, G. S., Burbach, M. E., Quinn, C. E., & Harding, H. (2012). Deficient critical thinking skills among college graduates: implications for leadership. *Educational Philosophy and Theory*, 44(2), 212-230.
The authors first develop a general construct that defines critical thinking, in order to discuss its role in leadership, constructivism, and education. They then challenge higher education to make more of an effort to teach critical thinking skills to undergraduates.

Ku, K.Y.L. (2009). Assessing students' critical thinking performance: Urging for measurements using multi-response format. *Thinking Skills and Creativity*, 4, 70-76.
A review of different methods for assessing critical thinking. It argues against assessments based solely on multiple-choice question formats due to their inability to assess the dispositions of the test-taker. A combination of multiple-choice and open-ended questions are required, it is argued, in order to assess a student's reasoning and capacity to spontaneously apply critical thinking skills when appropriate.

Lieberman, M.D. (2013). *Social: Why our brains are wired to connect*. New York, NY: Crown Publishing.
An in-depth explanation of the social brain theory. It is argued that the brain has an evolutionarily natural tendency towards thinking socially. Based on extensive neuroscientific studies, Lieberman suggests that our cognitive capacity for analytical thought is less powerful and less instinctual than our capacity for social thought.

Leu, D. J., Jr. & Kinzer, C. K. (2000). The convergence of literacy instruction and networked technologies for information and communication. *Reading Research Quarterly*, 35, 108-127.
Leu & Kinzer describe the 21st century forces that are changing the nature of literacy as we move towards more digital ways of reading and consuming information. They introduce the concept of literacy instruction as becoming increasingly deictic, or ever-evolving and thus hard to definitively pinpoint. This deictic nature of the internet will necessitate the teaching of adaptability and higher-order thinking skills in order to be deemed literate in the 21st century.

Paul, R. W., & Binker, A. J. A., Eds. (1990). *Critical thinking: What every person needs to survive in a rapidly changing world*. Rohnert Park, CA: Center for Critical Thinking and Moral Critique.
An extensive set of essays arguing on behalf of teaching critical thinking and presenting models for how to teach it effectively.

Perkins, D.N., & Salomon, G. (1989). *Are cognitive skills context bound? Educational Researcher*, 18(1), 16-25.
Bridging the gap between the specialist and generalists camps when it comes to the question of transfer in teaching thinking skills, Perkins and Salomon argue that specialized content knowledge and understanding of general thinking strategies are both necessary components of effective reasoning.

Perry, W.G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart, and Winston.
Using research conducted over the course of fifteen years at Harvard, Perry establishes a scheme of nine stages that students progress through as they develop critical thinking skills. He groups these into four areas. The first area, dualism, refers to a stage where students believe that all questions have correct answers, and they are dependent on authority figures to provide or confirm those answers. The second area, multiplicity, indicates a recognition of multiple answers but a belief that all answers are relative, and students struggle to choose an answer leading them to rely on authority figures as guides. In the third area, contextual relativism, students begin to see evidence as the authority which leads them to choose one idea over another. Finally, in commitment within relativism, students can recognize that the best answer to a problem depends on the perspective from which the question is being raised.

Pithers, R.T, & Soden, R. (2000). Critical thinking in education: A review. *Educational Research*, 42(3), 237-249.
A literature review which considers both the teaching practices which inhibit and those which promote effective learning of critical thinking. Effective methods presented include inquiry and problem-based learning strategies along with the use of metacognition.

Stanovich, K. E. (2009). *What intelligence tests miss: The psychology of rational thought*. New Haven, CT: Yale University Press.
Argues that current, dominant IQ tests fail to assess reasoning, judgment, and decision-making even though it is possible to do so.

Weiner, J. (2011). Is there a difference between critical thinking and information literacy? A systematic review 2000-2009. *Journal of Information Literacy*, 5(2), 81-92.
By analyzing 16,946 articles from education, library science, and health science journals published between 2000-2009, Weiner found that the definitions of critical thinking and information literacy are strikingly similar and map well onto Bloom's taxonomy. The major difference is that critical thinking is seen as a more private, internal, or mental function whereas information literacy is seen as more public since it involves a person acting with computers in order to carry out the thinking functions.

CONCEPTUAL MODELS

Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. New York: David McKay Company.
Commonly known as "Bloom's Taxonomy," this seminal work divided the educational objectives that teachers set for their students into three areas: cognitive, affective, and psychomotor. In the cognitive model, Bloom and his colleagues presented an argument that students needed to master lower level thinking skills, such as memory of knowledge and comprehension before they could attempt higher order, critical thinking skills such as application, analysis, evaluation, and synthesis.

Bruner, J. S., Goodnow, J. J., Austin, G. A. (1956). *A study of thinking*. Malden, MA: John Wiley & Sons.
The major contribution of this work is the development of the idea of "concept attainment" as integral to the development of thinking and reasoning skills. Similar to the process of inductive thinking, concept attainment is the process by which students categorize objects and ideas by identifying attributes that allow them to separate objects into examples and non-examples. Thus, the practice of comparing and contrasting is at the heart of Bruner, Goodnow, and Austin's argument for how students can construct their own understanding of concepts which helps them to improve their ability to inference as part critical thinking skills.

Craik, Kenneth J. W. (1943). *The nature of explanation*. Cambridge: Cambridge University Press.
This pioneering work first proposed the notion that our working memory crafts mental models in order to reason and predict future events. Johnson-Laird (1983) relied heavily on this theory in his more expansive discussion of the skills of reasoning and thinking.

Ennis, R. H. (1962). A conception of critical thinking. *Harvard Educational Review*, 32(1), 81-111.
Presents a model for teaching critical thinking skills based on the premise that critical thinking is essentially the process of correctly assessing statements.

Halpern, D.F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist*, 53(4), 449-455.
An introduction to the Halpern Critical Thinking Assessment. This model proposes a four part approach which includes preparing students for the dispositions needed for CT work, direct instruction in CT skills, teaching for transfer including considering the structure of arguments and problems, and instruction in meta-cognitive elements for self-reflection.

Halpern, D.F. (2014). *Thought and knowledge: An introduction to critical thinking (5th ed)*. NY: Psychology Press.
Rooted in her four part model for teaching critical thinking skills (1998), Halpern presents a textbook approach for how to deconstruct and develop reasoning, decision making, analysis of arguments, using probabilities, problem-solving, and creativity.

Johnson-Laird, P.N. (1983). *Mental models: Towards a cognitive science of language, inference, and consciousness*. Cambridge, MA: Harvard University Press.
Building off of Kenneth Craik's (1943) proposition that we create models in our working memory which we use to reason, this is a seminal work from the perspective of information processing theory. This book describes reasoning as a process dependent upon constructing models in the mind which we then manipulates as we seek to make meaning of experiences and language. It argues against the idea that our mind simply applies rules of logic, deductively, in order to think. Our ability to construct these models, Johnson-Laird argues, depends on input from our senses, our long-term memory, and our assumptions.

Krathwohl, David R. (2002). "A revision of Bloom's taxonomy: An overview." *Theory Into Practice*, 41(4), 212-218.
In an attempt to bring greater clarity to the understanding and use of the original taxonomy of educational objectives put forth by Bloom et al. in 1956, Krathwohl modified the language of Bloom's taxonomy from nouns to verbs to reflect the active process in which students would be engaged should they be challenged to think at these different levels. Krathwohl also changed the order of the last two levels and reframed synthesis as the act of creating new ideas. Thus his new structure includes: remembering, understanding, applying, analyzing, evaluating, and creating.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment*. New York: Cambridge University Press.
The article first presented Kahneman's dual system approach to thinking which has now become well-known through his book Thinking, Fast and Slow (2011). The dual system model posits that human thinking operates in different ways depending on the system being invoked. System 1 is intuitive and makes quick judgments that are often susceptible to logical fallacies. System 2 is deliberate, reflective, and more logical but requires greater time and effort.

Leu, D.J., Jr., Kinzer, C.K., Coiro, J., Cammack, D. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. In R.B. Ruddell & N. Unrau (Eds.), *Theoretical Models and Processes of Reading*, Fifth Edition (1568-1611). Newark, DE: International Reading Association.
Leu et al. propose a definition for New Literacies which establishes higher order thinking skills as intrinsic to literacy. They argue that the internet requires students to apply critical thinking processes in order to locate, evaluate, synthesize, and then communicate what the information and ideas have come to understand.

Lieberman, M.D. (2012). Education and the social brain. *Trends in Neuroscience and Education*, 1, 3-9.
A neuroscience perspective on the Social Brain theory argues that the mentalizing network of the brain (that which thinks about the thoughts, feelings, and perspectives of others) need not be considered as competing with the brain's regions which support analytical thought. By harnessing the brain's natural tendencies towards social thinking, it is argued, overall learning and the ability to think analytically can be enhanced.

Newell, A.; & Simon, H.A. (1961). Computer simulation of human thinking. *Science*, 134(3495), 2011-2017.
Argues that a computer program (the General Problem Solver) can simulate human thinking. This originated the theory of an information-processing model of human thinking. This model proposes the idea that humans think

and solve problems by breaking problems into discrete steps and applying a small number of general heuristics in order to think through a situation.

Paul, R.W., & Elder, L. (2001). *The miniature guide to critical thinking: Concepts & tools*. Tomales, CA: The Foundation for Critical Thinking.
Presents a succinct definition for the attributes and dispositions of critical thinking and good critical thinkers.

Salomon, G, & Perkins, D.N. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. *Educational Psychologist*, 24(2), 113-142.
Building off of their middle-ground position that thinking requires both general understanding of thinking strategies and specialized content knowledge (Perkins & Salomon, 1989), Salomon and Perkins present a model for how transfer occurs in learning thinking skills. So-called "low road" transfer happens when experiences trigger a behavior to occur in a slightly new context that has become automatic through repeated practice. So-called "high road" transfer, on the other hand, occurs when we deliberately abstract principles of past experiences in order to apply them in new situations.

Simon, H. A., & Reed, S. K. (1976). Modeling strategy shifts in a problem-solving task. *Cognitive Psychology*, 8(1), 86-97.
In this study, the authors used a computer model to investigate the effects of giving a hint, or of repeating the problem after a successful solution was found.

ten Dam, G., Volman, M. (2004). Critical thinking as a citizenship competence: Teaching strategies. *Learning and Instruction*, 14, 359-379.
Fundamentally an argument on behalf of teaching critical thinking as a means to learning effective citizenship skills, this article also considers effective strategies for teaching critical thinking. Active, problem-based learning from a social-constructivist perspective is promoted as a particularly effective strategy.

Tomasello, M. (2014). *A natural history of human thinking*. Cambridge, MA: Harvard University Press.
An evolutionary and neuroscientific approach to explaining humans' natural tendencies towards and capacities for thinking. Tomasello's shared intentionality hypothesis argues that cooperative social thinking is a uniquely human trait and evolved in order to support humans' ability to live peacefully and productively in large communities. Perspective-taking, inferences, and metacognition are all linked to the cognitively complex processes that evolved in conjunction with humans cooperative lifestyles.

EMPIRICAL STUDIES

Anderson, T., & Soden, R. (2001). Peer interaction and the learning of critical thinking skills. *Psychology Learning and Teaching*, 1(1), 37-40.
The authors discuss the use of peer interaction to enhance student's learning of critical thinking skills. They found that peer interaction is effective in assisting students' learning of critical thinking skills, as long as the interaction is conducted over multiple repeating sessions, and student's conflicting views are made explicit.

Butler, H. A., Dwyer, C. P., Hogan, M. J., Franco, A., Rivas, S. F., Saiz, C., & Almeida, L. S. (2012). The Halpern Critical Thinking Assessment and real-world outcomes: Cross-national applications. *Thinking Skills and Creativity*, 7(2), 112-121.
This study supports the efficacy of the Halpern Critical Thinking Assessment (Halpern, 1998) by studying how well HCTA scores predicted a person's ability to think critically in real-world application. It found that HCTA scores are equally good at predicting community college students', state university students', and community adults' abilities to think critically.

Dewberry, C., Juanchich, M., & Narendran, S. (2013). Decision-making competence in everyday life: The roles of general cognitive styles, decision-making styles and personality. *Personality and Individual Differences*, 55(7), 783-788.
The authors investigate what factors influence differences in individual's decision-making competence. The factors considered are personality factors, as measured by a Big-5 personality inventory, and cognitive styles. The authors found that cognitive style alone did not predict decision-making ability, but personality did and also personality combined with cognitive style predicted decision-making competence.

Huff, M. T. (2000). A comparison study of live instruction versus interactive television for teaching MSW students. *Research on Social Work Practice*, 10(4), 400-416.

Huff compared student outcomes in critical thinking between a live instruction environment, and a distance learning environment. They found no significant difference between the two instructional methods in terms of critical thinking skills.

Marin, L.M., & Halpern, D.F. (2011). Pedagogy for developing critical thinking in adolescents: Explicit instruction produces greatest gains. *Thinking Skills and Creativity*, 6, 1-13.
Using the Halpern Critical Thinking Assessment, which includes both multiple-choice and open-ended responses, this study investigated the efficacy of explicit vs. imbedded strategies for teaching critical thinking skills. It was found that explicit instruction led to much greater gains.

Shim, W., & Walczak, K. (2012). The impact of faculty teaching practices on the development of students' critical thinking skills. *International Journal of Teaching and Learning in Higher Education*, 24(1), 16-30.
The authors examined the relationships between faculty teaching practices and students self-reported and directly measured critical thinking. They found that asking challenging questions was associated with increases in both measured, and self-reported critical thinking levels. They also found that presentations, as well as group discussions decreased both measures of critical thinking. This was inconsistent with previous literature.

West, R. F., Toplak, M. E., & Stanovich, K. E. (2008). Heuristics and biases as measures of critical thinking: Associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology*, 100(4), 930.
The authors correlate the avoidance of heuristics and biases, with a more traditional measure of critical thinking (logical reasoning in the face of information that conflicts with prior beliefs). This correlation was not due to simply both being measures of general cognitive ability, as the relationship remained strong when the variance due to cognitive ability was removed.

INTERVENTIONS

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage-1 meta-analysis. *Review of Educational Research*, 78(4), 1102-1134.
The authors conducted a meta-analysis of 117 interventions aimed to improve students' critical thinking skills. They found 161 effects, with an average effect size of 0.341. Overall, their recommendation was for educators to take steps in ensuring critical thinking objectives are clear in their courses.

Elliott, B., Oty, K., McArthur, J., & Clark, B. (2001). The effect of an interdisciplinary algebra/science course on students' problem solving skills, critical thinking skills and attitudes towards mathematics. I*nternational Journal of Mathematical Education in Science and Technology*, 32(6), 811-816.
The authors examined whether an interdisciplinary course in science and algebra would have a significant impact on students problem-solving skills, critical thinking skills, or attitudes about mathematics. They found that problem solving skills were the same across the two groups (one in the interdisciplinary course, one in a college algebra course), but that students in the interdisciplinary course had slight gains in critical thinking, and significantly more positive attitudes towards mathematics at the end of the course.

Freseman, R. D. (1990). *Improving higher order thinking of middle school geography students by teaching skills directly*. Retrieved from ERIC. (ED320842)
Freseman developed a program to teach thinking skills to middle school students studying geography. They noticed an increase in higher-order thinking ability as the program progressed, as well as student enthusiasm.

Hudgins, B. B., & Edelman, S. (1988). Children's self-directed critical thinking. *The Journal of Educational Research*, 81(5), 262-273.
An experiment was conducted to evaluate the effectiveness of teaching children "self-directed critical thinking". Two groups of children were presented with a problem which they solved in a one-on-one interview format. Half of the children were then put in small groups and taught "self-directed critical thinking" skills. All the children were then given a problem that was comparable, but not identical, to the first. The children who had been instructed scored significantly higher than the children in the control group on a number of measures of critical thinking.

MacKnight, C. B. (2000). Teaching critical thinking through online discussions. *Educause Quarterly*, 23(4), 38-41.
MacKnight offers suggestions for fostering critical thinking in online discourse including Socratic questioning, and the effective use of computer mediated communication.

WHERE TO FIND ADDITIONAL RESEARCH

Thinking Skills and Creativity (http://www.journals.elsevier.com/thinking-skills-and-creativity)

Cognitive Psychology (http://www.journals.elsevier.com/cognitive-psychology/)

The Critical Thinking Community (http://www.criticalthinking.org/)

P21 MEMBERS ORGANIZATIONS

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ENA

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Fisher-Price

Ford Motor Company Fund

Future Problem Solving Program International

Gale Cengage Learning

The Goddard School

Intel Corporation

Learning.com

LEGO Education

National Board for Professional Teaching Standards

National Education Association

PBS

Pearson

People to People International

Playworld, Inc.

Project Management Institute Educational Foundation

VIF International Education

The Walt Disney Company

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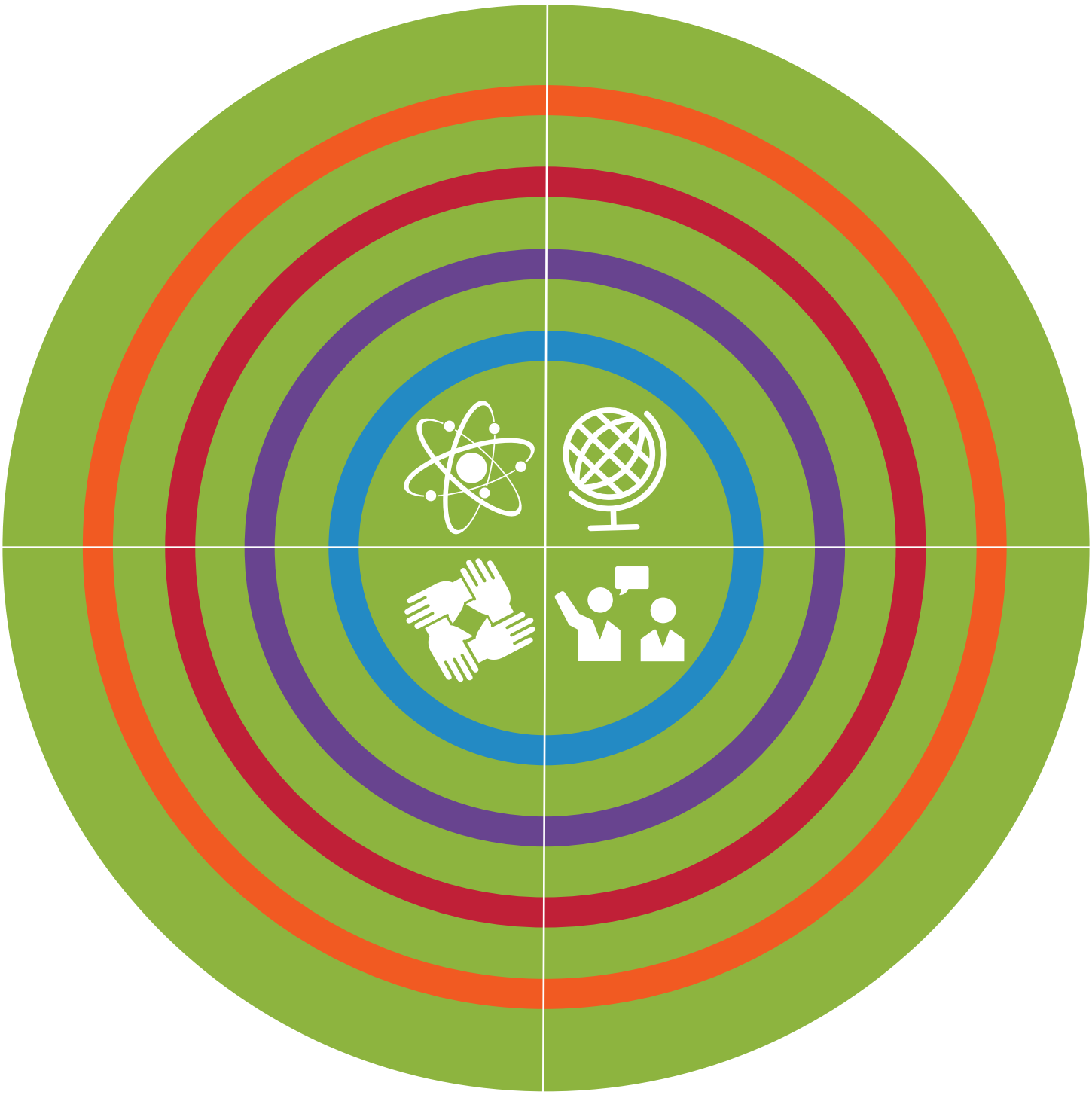

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