

What does the future want
of our young people?

How are we going
to help them?

martin.westwell@flinders.edu.au



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what does the future want?



What Google pay attention to.
Laszlo Bock (SVP, People Operations) and
Kyle Keogh (Director, Sales) host a Hangout.

What does the future want?



What Google pay attention to.
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"how well people learn"

"emergent leadership"

"don't want everyone to be the same"

- shared values
- humility when it comes to learning
- be open to new ideas and that they might be wrong
- "want to have an impact on the world"

"role related knowledge"





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Ideas from abroad: reforming the Australian university admissions system

August 16, 2016 6.07am AEST

What are some alternatives to the ATAR? from www.shutterstock.com

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Following the government's decision to [undertake consultations](#) on how best to reform Australian higher education, one of the key areas up for debate is about how to create an effective university admissions system.

Author



Claire Brown
Associate Director, The Victoria Institute, Victoria University

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Following the government's decision to undertake consultations on how best to reform Australian higher education, one of the key areas up for debate is about how to create an effective university admissions system.

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The value of the ATAR – where high school students receive an overall ranking that is often, although not solely, used as a way to select students for higher education courses – has been called into question. Vice-chancellors have called the model “meaningless” and “too simplistic”. Some have even called for the model to be scrapped entirely.

There has been lots of discussion around whether the current model is working well. What are some alternatives?

Education is notorious for re-inventing the same policy wheels. With that in mind, let's take a look at some of the world's best-performing higher education systems to see what they do differently to give us some inspiration – and possible guidance.



Small snippets of text from various news articles, including headlines and short paragraphs.



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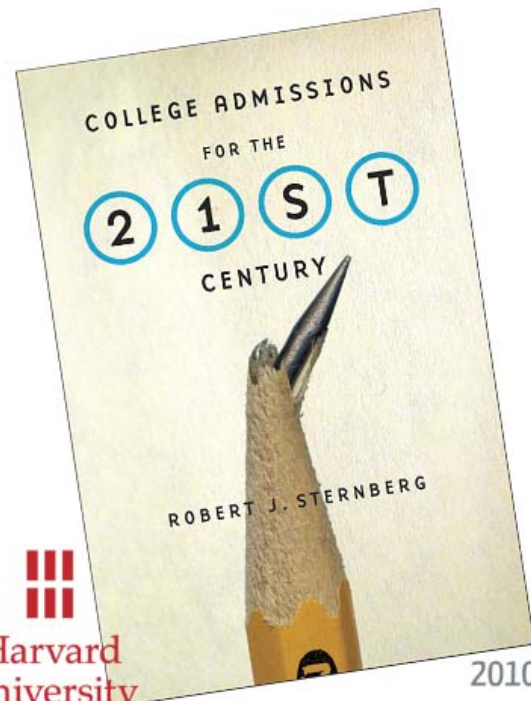


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Harvard University Press

- analytical thinking
- creative thinking
- practical thinking
- thinking with wisdom
- mindful agency

What does the future want?



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Educating Critical Thinkers: The Role of Epistemic Cognition

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Jeffrey A. Greene¹ and Seung B. Yu¹

Abstract

Proliferating information and viewpoints in the 21st century require an educated citizenry with the ability to think critically about complex, controversial issues. Critical thinking requires epistemic cognition: the ability to construct, evaluate, and use knowledge. Epistemic dispositions and beliefs predict many academic outcomes, as well as whether people use their epistemic cognition skills, for example, scrutinizing methods in science and evaluating sources in history. The evidence supporting the importance of epistemic cognition, inside and outside of the classroom, has led to a growing body of intervention research. However, more research can reveal how to best position teachers and students to develop and enact productive epistemic cognition. Promising directions for future research and policy include developing learning environments that promote students' epistemic cognition and subsequent critical thinking, as well as incorporating this work into educator preparation programs.

Keywords

epistemic cognition, critical thinking, learning, teachers

Educating Critical Thinkers: The Role of Epistemic Cognition

"creating, evaluating and using knowledge"

Jeffrey A. Greene¹ and Seung B. Yu¹



Abstract

Proliferating information and viewpoints in the 21st century require an educated citizenry with the ability to understand about complex, controversial issues. Critical thinking requires epistemic cognition: the ability to construct, evaluate, and use knowledge. Epistemic dispositions and beliefs predict many academic outcomes, as well as whether people use cognitive skills, for example, scrutinizing methods in science and evaluating sources in history. The evidence on the importance of epistemic cognition, inside and outside of the classroom, has led to a growing body of interventions. However, more research can reveal how to best position teachers and students to develop and enact productive epistemic cognition. Promising directions for future research and policy include developing learning environments that promote students' epistemic cognition and subsequent critical thinking, as well as incorporating this work into educational programs.

Keywords

epistemic cognition, critical thinking, learning, teachers

Tweet

Preparing students to be 21st century critical thinkers requires research on epistemic cognition - how to create, evaluate, and use knowledge.

Key Points

- The challenges of the 21st century require students who can think critically in the modern world.
- Educators can teach and promote epistemic cognition and the use of epistemic cognition, which can enable students to think critically in the modern world.

Introduction

The 21st century has brought about unprecedented access to a wide range of information, opinions, and claims about many diverse topics. This information is available from a variety of sources, including the Internet, social media, and news outlets. This information is often complex and controversial, and it is often presented in a way that is designed to be persuasive. This information is often presented in a way that is designed to be persuasive. This information is often presented in a way that is designed to be persuasive.

from an increasingly complex, international, and interconnected world (OECD, 2013; The World Bank, 2011). This rapid increase in information and ease of access to that information has led to many calls for changes in the United States' education system, such as those made in the Center for Best Practices' 2010 NGSS Lead States (2010). These calls share a common goal of preparing today's students to be able to think critically in the modern world. This is a goal that is shared by many other countries as well. In the United States, this goal is reflected in the Common Core State Standards (CCSS) for English Language Arts and Mathematics (CCSS, 2010). In other countries, this goal is reflected in the National Curriculum Framework for School Education (NCERT, 2017). The goal of preparing students to be able to think critically in the modern world is a goal that is shared by many other countries as well. In the United States, this goal is reflected in the Common Core State Standards (CCSS) for English Language Arts and Mathematics (CCSS, 2010). In other countries, this goal is reflected in the National Curriculum Framework for School Education (NCERT, 2017). The goal of preparing students to be able to think critically in the modern world is a goal that is shared by many other countries as well.

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Education Association, 2014). However, critical thinking is not something that the human brain does naturally, and teaching students to think in such ways is challenging (Kahneman, 2011; Sinatra, Kienhues, & Hofer, 2014; Stanovich, 2010). A great deal of evidence reveals how the dispositions, beliefs, and skills that comprise critical thinking require epistemic cognition: How people acquire, construct, understand, and use knowledge both within and beyond the classroom (Greene, Sandoval, & Bråten, in press; Hofer & Bendixen, 2012; King & Kitchener, 1994; Kuhn, Cheney, & Weinstock, 2000). Epistemic cognition is needed whenever people are

"little evidence suggesting that increasing curricular focus on general critical thinking skills will result in additional gains."

Critical Thinking

Critical thinking has been defined as purposeful, reflective, and reasoning about what to do or believe when confronting a problem or issue (Stanovich, 2010). It is a process that involves the use of a variety of skills and dispositions, including the ability to identify and analyze the assumptions, biases, and values that underlie our thinking. It is a process that involves the use of a variety of skills and dispositions, including the ability to identify and analyze the assumptions, biases, and values that underlie our thinking. It is a process that involves the use of a variety of skills and dispositions, including the ability to identify and analyze the assumptions, biases, and values that underlie our thinking.

Two recent meta-analyses of existing research studies about higher education interventions to teach critical thinking skills and dispositions. However, they found little

evidence suggesting that increasing curricular focus on general critical thinking skills will result in additional gains. Instead, more research should be conducted to determine how to teach critical thinking skills within majors or specific disciplines (e.g., science, history, psychology). Likewise, Abrami et al. (2015) found interventions targeting general critical thinking skills and dispositions were only moderately effective, but discipline-specific critical thinking interventions were more promising.

These meta-analyses shed light on a long-standing debate in the field: Whether critical thinking is best taught as a general set of skills and dispositions, a discipline-specific set, or both (Alexander et al., 2011; Ennis, 1987; McPeck, 1981; Willingham, 2007). Advocates for discipline-specific critical thinking instruction argue for significant disciplinary aspects in many of the most pressing contemporary personal challenges (e.g., How will a political candidate's position on taxes affect my income?), policy questions (e.g., To what degree, if any, are humans responsible for climate change?), and workplace demands (e.g., How will increased expansion of the middle class in China affect stock markets in other countries?). Successfully addressing these questions requires deep disciplinary knowledge, as well as understanding how experts in those disciplines engage in analysis, evaluation, and argument (Alexander, 2014; Sandoval, Sodian, Koelscher, & Wong, 2014). It is not enough to tell students to "think critically" about these questions; students must learn the specific skills experts use in these disciplines (Chinn, Mackland, & Samarapungavan, 2011; Sandoval,

2012). Researchers in the field of epistemic cognition have investigated how to optimize students' will and skill for epistemic cognition. Epistemic cognition is a process involving dispositions and skills that determine what we believe, doubt, or disbelieve (Hofer & Bendixen, 2012). In general, when people say that they "know" something, it implies that they believe it to be an available for verification in a particular way, depending on the expertise of the domain. For example, a health expert would be asked or queried about various health experts. The challenges of the modern world make it clear that students need to know more than just what, but also why and how. For example, compared with students who are taught scientific facts and nothing more about higher education interventions to teach critical thinking skills and dispositions. However, they found little (Sandoval et al., 2014).

Abrami et al. (2015) - 341 effect sizes

and Epistemic Cognition

Epistemic dispositions and beliefs can activate, or deactivate, the epistemic cognition skills needed for critical thinking (Kane & Kitchener, 1994; Kuhn et al., 2000). These skills

"The most effective strategies for promoting critical thinking involve teachers creating a supportive environment where small student-peer groups actively construct and critique arguments about problems specific to the discipline."

Constructivist pedagogy requires that teachers engage in often unfamiliar practices, such as allowing students opportunities to take the lead in exploring and solving problems, as well as depending on students to help their peers (Bendixen, in press; Brownlee, Schray, Walker, & Ryan, in press; Murphy

Classroom Instruction Interventions

Traditional classroom instruction (e.g., predominantly teacher-focused, lecture-based) does not change maladaptive epistemic beliefs or skills, whereas constructivist classrooms do (Bendixen, in press; Conley, Pintch, Vekiri, & Harrison, 2004; Muis & Duffy, 2013). **Constructivist classrooms differ from traditional ones by being student- and learning-focused, using pedagogies that allow students to practice and receive feedback in class. The most effective instructional strategies for promoting both epistemic cognition and critical thinking involve teachers creating a supportive environment where small student-peer groups actively construct and critique arguments about problems specific to the discipline (Muis,**

indicate their... in constructivist... teachers must guide students to construct and... Teachers... unlikely to have been... programs. Nonetheless... with proper training, teachers can effectively diagnose which... epistemic cognition and critical thinking on their own (Abrams... eration programs is still all too rare (Smylie & Chinn, 2012)... unlikely to be met unless educators are taught how to foster... effective epistemic cognition as a part of pre-service training, and supported in doing so, through professional development and in-service support (Murphy et al., 2014).

Teacher Preparation

Teachers' own epistemic beliefs predict their likelihood of endorsing critical thinking as a desired instructional outcome, and their likelihood of using pedagogies that promote critical thinking. Also, teachers' epistemic beliefs predict their students' success at solving complex problems (Brownlee et al., in press). Unfortunately, more research is needed on how to integrate epistemic cognition into teacher preparation programs. However, given the resource challenges of providing in-service teachers with sufficient professional development and support to engage in constructivist teaching, it is likely the more effective, efficient route is to

In classrooms where the teachers explicitly focus on the arguments and justifications for particular ideas in their discipline (i.e., emphasizing not just the *what* but also the *why* and *how*), students are more likely to engage in effective critical thinking.

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specific
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Murphy et al., 2014; Sinatra & Chinn, 2012). In classrooms where the teachers explicitly focus on the arguments and justifications for particular ideas in their discipline (i.e., emphasizing not just the *what* but also the *why* and *how*), students are more likely to engage in effective epistemic cognition (Murphy et al., 2014). For example, when middle school students receive proper support, they can engage in sophisticated epistemic cognition, such as creating effective criteria

Strategies for Teaching Students to Think Critically: A Meta-Analysis

Philip C. Abrami, Robert M. Bernard, Eugene Borokhovski,
David I. Waddington, C. Anne Wade,
and Tonje Persson
Concordia University, Canada

Critical thinking (CT) is purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanations of the considerations on which that judgment is based. This article summarizes the available empirical evidence on the impact of instruction on the development and enhancement of critical thinking skills and dispositions and student achievement. The review includes 341 effects sizes drawn from quasi- or true-experimental studies that used standardized measures of CT as outcome variables. The weighted random effects mean effect size (g^+) was 0.30 ($p < .001$). The collection was heterogeneous ($p < .001$). Results demonstrate that there are effective strategies for teaching CT skills, both generic and content specific, and CT dispositions, at all educational levels and across all disciplinary areas. Notably, the opportunity for dialogue, the exposure of students to authentic or situated problems and examples, and mentoring had positive effects on CT skills.

KEYWORDS: critical thinking, instructional practices, learning processes/strategies

Toward the mid- to late 1920s, John Dewey became significantly more pessimistic in his outlook. Discouraged by the intellectual vacuity and corruption of the Harding and Coolidge administrations and by a faith-based free market approach to social and economic problems, Dewey (1925) underlined, again and

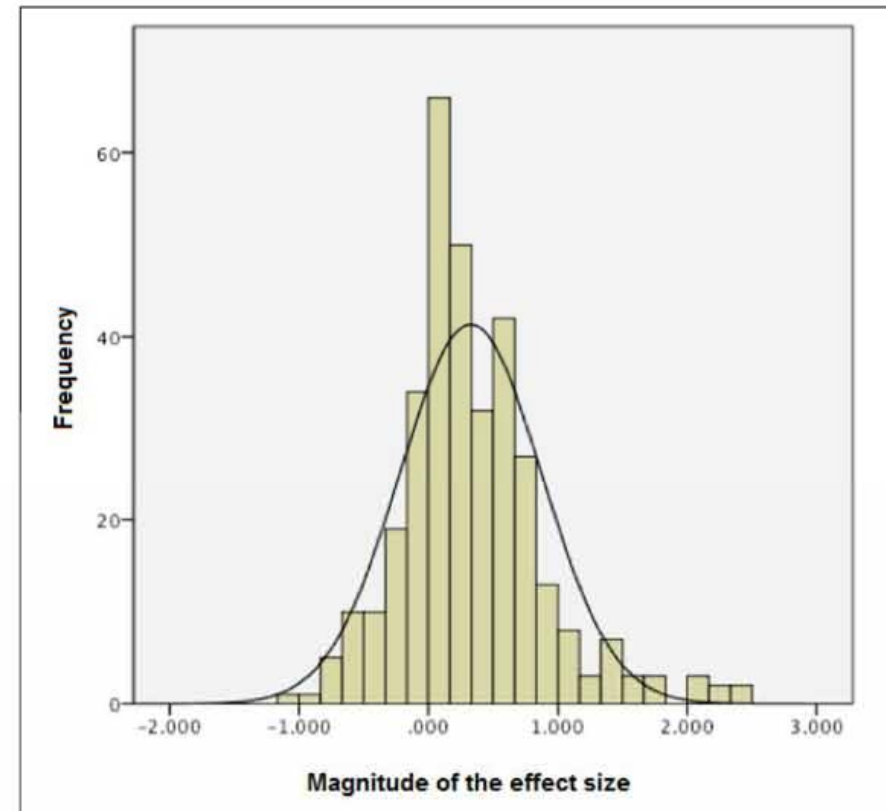
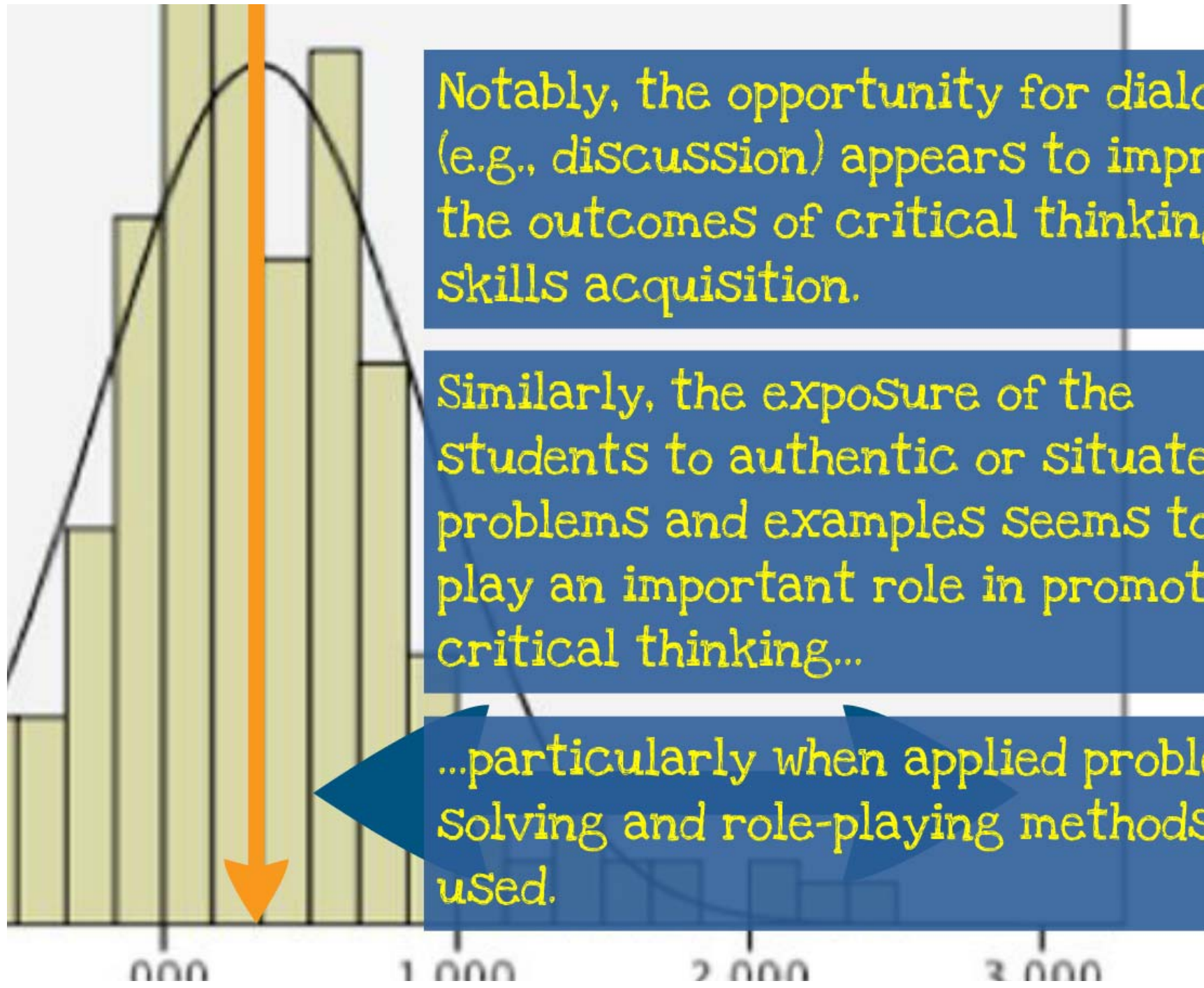


FIGURE 1. Distribution of unweighted effect sizes for generic critical thinking skills ($k = 341$, $\bar{X} = 0.33$, $SD = 0.55$).

will outline below, variations in educational level, subject matter, and treatment duration did not generate significant differences in outcome. As a result, there are likely no confounds with these variables that could compromise subsequent substantive analyses.

Educational level. Table 3A shows the 341 effects broken down by educational



Notably, the opportunity for dialogue (e.g., discussion) appears to improve the outcomes of critical thinking skills acquisition.

Similarly, the exposure of the students to authentic or situated problems and examples seems to play an important role in promoting critical thinking...

...particularly when applied problem solving and role-playing methods are used.

Same Content - critical thinking

- best developed within learning areas
- student-student dialogue
- authentic problem solving
- (can't be separated from disposition)

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Philip C. Abrami, Robert M. Bernard, Eugene Boruckivski, David I. Waddington, C. Anne Wade, and Tuyen Person
 Concordia University, Canada

Critical thinking (CT) is purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanation of the conclusions on which that judgment is based. This article summarizes the available evidence on which that judgment is based. This article summarizes the available evidence on which that judgment is based. This article summarizes the available evidence on which that judgment is based. This article summarizes the available evidence on which that judgment is based.

Keywords: critical thinking, instructional practices, learning processes, strategies

Toward the end of the 1920s, John Dewey became significantly more pessimistic in his outlook. Discouraged by the intellectual vacuity and corruption of the Harding and Coolidge administrations and by a 1918-based free market approach to social and economic problems, Dewey (1925) redefined, again and again, the importance of critique. The final chapter of *Experience and Nature*, which is recognized as one of Dewey's most important philosophical works, is dedicated to an explicit and passionate defense of the power of critique in all aspects of our lives. Intelligence, said Dewey, was "critical method applied to goals of belief, appreciation and conduct, no in treatment that and more secure guide" and was "the only and support of all reasonable hopes" (p. 437). Critical thinking (thereafter, in this article, abbreviated CT), for Dewey, was something all citizens needed to engage in on a regular basis, and the role of the philosopher

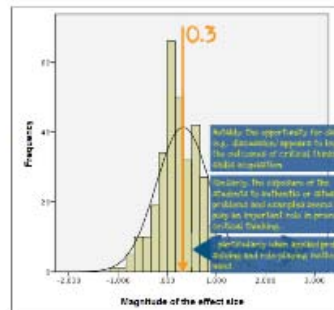


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will outline below, varies in educational level, subject matter, and treatment duration did not generate significant differences in outcome. As a result, there are likely no confounds with these variables that could compromise subsequent substantive analyses.

Educational level. Table 2A shows the 361 effects broken down by educational level. There are no significant differences among the levels, suggesting that a skills-based approach to CT improvement can achieve same level of success at all grade levels. Furthermore, with the exception of the last category (i.e., graduate and adult students) the average effect size of CT instruction is significantly greater than zero.

Subject matter. No significant differences among different broad types of subject matter were observed as shown in Table 3B. In fact, the confidence intervals for STEM and non-STEM overlap almost perfectly, with a $p < 0.51$ for the former

group of effective strategies. There are some caveats attached to this finding, but we will postpone discussion of those until our "Outstanding Questions" section.

Looking more specifically at the question of possible instructional strategies, it is clear that two general types of instructional interventions are especially helpful in the development of generic CT skills. Namely, the approaches for dialogue (i.e., discussion) appear to improve the outcomes of CT skills acquisition, especially where the teacher poses questions, when there are both whole-class teacher-led discussions and teacher-led group discussions. Similarly, the exposure of students to authentic or situated problems and complex issues to play an important role in promoting CT, particularly when applied within solving and role-playing methods are used.

In addition, as Table 3 indicates, it also appears as though dialogue and authentic instruction are effective in combination, particularly when mastery is added to the mix. As our findings demonstrate, studies that featured all three types of interventions (A + D + M) generated significantly larger effect sizes than either (A + D) or (A or D) alone. This is particularly interesting in light of the fact that non-responding studies were especially rare (mostly when studies are in flight). It appears as though mastery may serve as a catalytic capacity to augment other strategies in a powerful way but is not especially useful in isolation.

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Third, and finally, Pellegrino (2007) conducted a study to attack high school students in the experimental condition were taught American History through various historically engaging or "historical thinking" activities. Typically, students were asked to present their views on a historical period in question and offer their interpretations of what developments had shaped in that time. Responses were then aligned with various aspects of historical reconstruction and were asked to judge

Teaching Critical Thinking

for reasons, the relative reliability of source versus need to identify conflicting viewpoints. The teacher tried to elicit concrete theories to learners' personal opinions and knowledge in class discussions. Activities were designed to allow both the teacher and the students to recognize and appreciate various perspectives of historical content in its complexity, context and independent inquiry. The first and second objectives, and help their understanding of the dynamics of historical events. There was several role-play games and series of discussions involved. The major difference between the experimental and control used knowledge on the discussion of American history (CT) with a response of 0.33, and the intervention resulted in the effect size of $r = 0.33$.

In all three studies, no one thing effect sizes resulting from a combination of all elements of our three category scheme. Furthermore, it is clear from the descriptions that all three examples are compelling, longer duration studies in which a robust methodological intervention achieved impressive results, and the results of the meta-analysis clearly point toward a need for further research, exploration and refinement of these variables to successful strategies.

Outstanding Questions

Before concluding, we feel that it is worthwhile to consider three significant objections that could be leveled against the analysis so far. First, that this review likely contains a systematic bias of teaching CT in which successful instruction is simply a matter of adopting the correct instructional practices, second, that our conclusion that CT can be taught is subject to some significant caveats. As we will explain, the first objection is mitigated by the nature of our analysis, whereas the second objection deserves serious consideration.

The first objection holds that while we were strands of critical thought, there is a prevailing misapprehension of the teaching process that makes it seem as though good teaching is nothing more than applying the "magic recipe" of teacher behaviors that will produce the desired product. One could further argue that this reality is present in our own approach, which has attempted to determine which types of instructional interventions yield the most promising results in terms of generating favorable results on standardized tests that purport to measure CT.

The first part of the objection has some substance and appears a bit of farmed thinking that has been influential. One can see a particularly clear and vibrant notion of it in Skinner's (1958, 1959) educational reform efforts, and a more modern version is present within the process-product research tradition (Hargis & Necker, 1988). Furthermore, it is probable that many of the studies analyzed in this meta-analysis reflect this view to some extent. The very fact that these studies took the approach they did (in many cases, incidentally when domain mastery followed by a standardized test) arguably indicates that they tacitly favor a process-product view of teaching.

However, as we indicated in our section on the contextual definition of CT, the mere fact that this analysis produces results that secondarily take a complete approach to CT does not imply that we endorse such a view. We regard teaching (and, more specifically, teaching CT) as a complex and multifaceted process, in which there is no magic recipe for the "production of learner success." There are,

APPENDIX C (continued)

C.1: Illustrative examples of codes for Category 2 (Dialogue)

Code "1": dialogue slightly present (Crawford, 1976)

The primary concern of the research was the evaluation of transferability of CT skills acquired in language art classes to analyses of social studies problems. The experimental group instruction focused on reasoning, analyses, and students' ability to defend choices. Although the latter seemed to involve some dialogue, it was not made clear by the description of the procedure how much discussion argumentation and group work was involved.

Code "2": dialogue moderately present (D. L. Watson, Hagihara, & Tenney, 1999)

In the experimental condition, students met in small groups to discuss good and poor answers to their assignments. Discussion was the major instructional strategy, but discussion did not take place in all student activities, and so the code "2" was assigned.

Code "3": dialogue strongly present (Parkinson & Ekachai, 2002)

The intervention consisted of using the "Socratic Dialogue" method in an introductory public relations course. The Socratic approach was modeled on an introductory law course where students were asked to brief the cases described in the readings and then individual students were called on in class to describe the case and answer questions about it. These questions included identification of objectives, audiences, research, legal restrictions, and public relations tactics. The questions and comments from the instructor were intended to help the students see principles that underlay the public relations problems or solutions described in the cases read.

C.2: Illustrative examples of codes for Category 3 (Authentic or Anchored Instruction)

Code "0": authentic instruction not present (Schulhauser, 1990)

Fourth-grade students in the treatment group were divided into literary discussion groups consisting of six students each. Groups read a text book every 3 weeks over a period of 4 months and met twice weekly with their teacher to discuss the book content. There was no evidence of anchored or authentic instruction. The focus of the intervention was on individual study, discussions, and teacher explanations.

Code "1": authentic instruction slightly present (Zohar, Weinberger, & Tamir, 1994)

CT-oriented activities in the study included meta-cognitive discussions of the particular reasoning skills and how to use them. The main premise was that the same CT skills should be transferable and may be applied in many occasions and contexts, including various applied problems in biology.

Code "2": authentic instruction moderately present (Faryniarz, 1989)

In this study, the experimental group of community college students studied the topic of ecosystems using three simulator modules. These simulations addressed real-life problems of lake pollution analysis, wastewater quality management, and population dynamics.

Code "3": authentic instruction strongly present (Hill, 2000)

There was a high degree of solving applied problems. Educational psychology students tackled difficult and contentious issues in educational psychology based on real-life scenarios and begin to understand that the aim of inquiry is to further understand and create meaning in a world of conflicting perspectives and interpretations.

(continued)

levels of dialogue

1. reasoning and analysis to defend a choice/decision
2. discussion of good and poor answers
3. "socratic dialogue"

levels of authentic learning

0. read book; discuss content
1. discussion of reasoning skills and how to use them
2. simulations
3. contentious real life scenarios

levels of dialogue

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beware programs!

- reduction in level
- loss of the principle
- general critical thinking

APPENDIX C (continued)

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CT-oriented activities in the study included meta-cognitive discussions of the particular reasoning skills and how to use them. The main premise was that the same CT skills should be transferable and may be applied in many occasions and contexts, including various types of problems.

Code "2": authentic instruction moderately present (L. B. Resnik, 2002)

In this study, students were engaged in a series of problem-solving activities related to environmental issues. The problems included lake pollution analysis, wastewater quality management, and population dynamics.

Code "3": authentic instruction strongly present (L. B. Resnik, 2002)

There was a high level of student engagement and participation in the study. The students tackled a complex scenario and began to understand that the aim of inquiry is to further understand and create meaning in a world of conflicting perspectives and interpretations.

**"Laszlo Bock
assessment"**

**21st century
assessment**

(continued)

levels of dialogue

1. reasoning and analysis to defend a choice/decision
2. discussion of good and poor answers
3. "Socratic dialogue"

levels of authentic learning

0. read book; discuss content
1. discussion of reasoning skills and how to use them
2. simulations
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Same content - critical thinking

- best developed within learning areas
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Given that thinking (CT) is a powerful, self-regulatory judgment that results in interpretation, analysis, evaluation, and selection, as well as explanation of the content matter on which that judgment is based. This article summarizes the available empirical evidence on the effectiveness of instructional strategies and methods to teach CT skills to students in secondary and tertiary education. The review included 341 effects from 100 studies on 14,000 students. The weighted random-effects mean effect size (ES) was 0.30 ($p < .001$). The confidence interval (CI) was 0.27 to 0.33. The confidence interval (CI) was 0.27 to 0.33.

Keywords: critical thinking, instructional practices, learning processes, strategies.

Toward the end of his 1926 book Dewey became significantly more pessimistic in his outlook. Discouraged by the intellectual poverty and confusion of the Harding and Coolidge administrations and by a DRR-based free market approach to social and economic problems, Dewey (1927) redefined, again and again, the importance of critical thinking. The final chapter of *Experience and Nature*, which is recognized as one of Dewey's most important philosophical works, is dedicated to an exposition and passionate defense of the power of critique in all aspects of our lives. In fact, Dewey saw "critical method" applied in "a wide range of human activities, and it is the method that is the most secure ground" and was "the way and support of all reasonable hopes" (437). Critical thinking (hereafter, in this article, abbreviated CT), for Dewey, was something all citizens needed to engage in on a regular basis, and the role of the philosopher

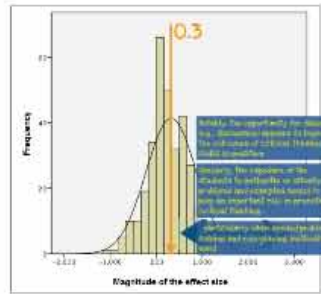


FIGURE 8. Distribution of weighted effect sizes for empirical critical thinking skills. $M = .30$, $SE = 0.03$, $CI = 0.27$ to 0.33 .

will continue below, remains in educational level, subject matter, and treatment duration did not generate significant differences in outcomes. As a result, there are likely no confounding with these variables that could compromise subsequent substantive analyses.

Educational level. Table 24 shows the 341 effects broken down by educational level. There are no significant differences among the levels, suggesting that a traditional approach to CT instruction can address some level of success at all grade levels. Furthermore, with the exception of the last category (i.e., graduate and adult students) the average effect size of CT instruction is significantly greater than zero.

Subject matter. No significant differences among different broad topics of subject matter were observed as shown in Table 26. In fact, the confidence intervals for STEM and non-STEM overlap almost perfectly, with a z -test of 0.31 for the favor

of effective strategies. There are some caveats attached to this finding, but we will postpone discussion of these until our "Outstanding Questions" section.

Looking more specifically at the question of possible instructional strategies, it is clear that two general types of instructional interventions are especially helpful in the development of general CT skills. Specifically, the effectiveness for teaching of (a) *direct instruction* to improve the acquisition of CT skills is moderate, especially when the teaching focus is on *analysis*, *evaluation*, and *selection*. In addition, the effectiveness for teaching of (b) *problem-based learning* is moderate, especially when the teaching focus is on *analysis*, *evaluation*, and *selection*. In addition, the effectiveness for teaching of (c) *problem-based learning* is moderate, especially when the teaching focus is on *analysis*, *evaluation*, and *selection*.

In addition, as Table 4 is shown, it also appears that high challenge and authentic instruction are effective in combination, particularly when instruction is added to the mix. As our findings demonstrate, studies that featured all three types of interventions (A + B + M) generated significantly larger effect sizes than either A + B or A + M. This is particularly interesting in light of the fact that non-STEM students especially strongly benefit when analyzed on its own. In light of this, it appears that high challenge may serve as a catalyst, thereby augmenting other strategies in a powerful way but is not especially useful in isolation.

With respect to the effectiveness of these interventions in which all three elements of the three strategy where the strategy present (i.e., high challenge, high challenge, and high challenge), the effectiveness of structured high-challenge instruction based on direct instruction in CT skills of analysis, evaluation, and selection. Learners were required to articulate their thoughts and then to compare of course content and were encouraged to think critically about the course content and especially about questions and feedback comments from both their peers and the instructor. In this study, all three major instructional interventions were coded equally (1) in terms of the experimental condition. The effect on CT skills (as measured by the CCTS) in comparison with the control students, whose high-challenge discussions were restricted and scripted, was $g = 0.33$.

Second, in a study conducted by Arief (1997), the high prevalence in the experimental condition of these three strategies (i.e., Dewey—coded 1, authentic instruction—coded 1, and Montessori—coded 2) resulted in the effect size of $g = 0.038$. In this study, undergraduate psychology students received an intervention intended to promote identity development. The intervention framed an outcome as success in the area of exploration and critical problem solving with respect to making personal life choices (authenticity) with guidance offered by the teacher, both individually (Montessori) and in whole-class discussions (Dewey).

Third, and finally, Paloutzian (1977) conducted a study in which high challenge and authentic instruction were used together. The high challenge instruction was implemented as a "structured learning" activities. Typically, students were asked to prepare a paper on a topic that was chosen and then they were asked to write a paper on that topic. The high challenge instruction was implemented as a "structured learning" activities. Typically, students were asked to prepare a paper on a topic that was chosen and then they were asked to write a paper on that topic.

Thinking Critical Thinking

The review, the relative quality of the review process was to identify and analyze the evidence. The review team in this review, however, is not a "critical thinking" review, but a review of the evidence on the effectiveness of instructional practices to teach the skills and methods to recognize and appreciate various purposes of critical thinking in a variety of contexts (e.g., workplace, school). The 144 studies included in this review were selected on the basis of the following criteria: (a) the review team had to be able to identify the studies that were relevant to the review, (b) the review team had to be able to identify the studies that were relevant to the review, (c) the review team had to be able to identify the studies that were relevant to the review, and (d) the review team had to be able to identify the studies that were relevant to the review.

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However, as we indicated in our review on the conceptual definition of CT, the review team did not use a specific definition of CT and therefore we were unable to take a specific approach to CT that we typically do in our review. We used teaching (and, more specifically, teaching CT) as a criterion and a valid outcome, in which this is the only exception for the "production of better reasons." There are

What does the future want of our young people?

How are we going to help them?



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CELEBRATING
50 years
OF INSPIRING
ACHIEVEMENT

