Thinking Skills and Creativity 6 (2011) 1–13

Contents lists available at ScienceDirect

Thinking Skills and Creativity

journal homepage: http://www.elsevier.com/locate/tsc

# Pedagogy for developing critical thinking in adolescents: Explicit instruction produces greatest gains

Lisa M. Marin[a], Diane F. Halpern[b,*]

[a] Claremont Graduate University, United States
[b] Department of Psychology, Claremont McKenna College, 850 Columbia Avenue, Claremont, CA 91711, United States

ARTICLE INFO

*Article history:*
Received 9 April 2010
Received in revised form 26 July 2010
Accepted 18 August 2010
Available online 16 September 2010

*Keywords:*
Critical thinking
Halpern Critical Thinking Assessment
Explicit instruction
Imbedded instruction
Low-performing schools

ABSTRACT

Although the development and transfer of critical thinking skills are recognized as primary goals for education, there is little empirical evidence to help educators decide how to teach in ways that enhance critical thinking. In two studies, we compared explicit and imbedded instructional modes and assessed critical thinking with the Halpern Critical Thinking Assessment, which uses both constructed response and multiple-choice response formats with everyday situations. Participants were high school students in the United States attending low-performing high schools with large minority enrollment. In both studies, the students receiving explicit instruction showed much larger gains than those in the imbedded instruction group. Grade point average was significantly related to critical thinking scores, but as expected its relationship with critical thinking was much weaker than standardized test scores. These results provide robust evidence that explicit instruction is an effective method for teaching critical thinking skills to high school students.


## 1. Introduction

The development of critical thinking skills is often listed as the most important reason for formal education because the ability to think critically is essential for success in the contemporary world where the rate at which new knowledge is created is rapidly accelerating. Although most educators agree that it is important to teach students the skills of critical thinking, there is much less agreement about the way in which learning to think critically is best achieved, especially for students in high school (e.g., Moseley et al., 2005). There are few empirical studies of the development of critical thinking at the high school level; most of the research has been confined to post-secondary education (Ruggiero, 1998). Given the fact that adolescence and young adulthood are recognized by brain researchers as optimal for the development of higher order cognitive processes (Giedd, Blumenthal, & Jeffries, 1999; Sowell, Thompson, & Holmes, 1999), we focused on critical thinking instruction designed for high school students. We expected to confirm previous findings that the critical thinking skills can be learned and transferred to novel situations when students receive explicit instruction designed to foster transfer (Bangert-Drowns & Bankert, 1990; Cotton, 1991; Dweck, 2002; Halpern, 1998, 2003).

Instruction that compels critical thought can be done either of two ways: either imbedded instruction with critical thinking skills woven into the content matter, or explicit instruction with lessons designed specifically to provide guidance in specific critical thinking skills. Traditionally, practitioners have endorsed the former, challenging students to think beyond subject matter recall and memorization through questioning and discussion, for example. The utility of the imbedded

* Corresponding author. Tel.: +1 626 798 0456; fax: +1 909 621 8419.
*E-mail address:* diane.halpern@cmc.edu (D.F. Halpern).

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doi:10.1016/j.tsc.2010.08.002

approach is clear, especially within a particular discipline; however, the transference of critical thinking procedures from one discipline to another, and to everyday situations, is questionable. Further, exposure to instruction designed to enhance critical thinking is usually limited to those students enrolled in higher level coursework, such as Advanced Placement or Honors classes, which excludes the vast majority of high school students. Research has shown that experience with instruction that includes critical thinking is less common for minority and disadvantaged secondary students (Solorzano & Ornelas, 2004; Warburton & Torff, 2005; Zohar & Dori, 2003).

This study describes an innovative high school program that compared both imbedded (implicit) and explicit methods of critical thinking instruction and the effects of each method on the ability of students to transfer critical thinking to a wide variety of everyday situations. While best practice would surely include both, our purpose was to identify the strategy that was most conducive to transfer.

### *1.1. The need for studies of critical thinking among high school students*

High schools across the U.S. are in a state of crisis; low-performing high schools, in particular, need major reform that is designed around the transfer of learning to out-of-school and other real world contexts (Alliance for Excellent Education, 2009). Critics and reformers alike cite a host of factors that cause young people to exit high school lacking essential skills, with or without a diploma. The Urban Institute study (Orfield, Losen, Wald, & Swanson, 2004) revealed very high dropout rates, exceeding 50% for low-income minority students throughout the nation.

There is abundant evidence that a large proportion of high schools inadequately prepare young people for the real-world demands of work, higher education, and everyday living. Recent reviews of both high school coursework and exit exams by the American Diploma Project (ADP) found that in all states, few students acquire the knowledge or abilities necessary for college or workplace success (ADP, 2004). Foremost among the deficits identified are competencies associated with specific higher level cognitive processes, or simply put, critical thinking. As discussed in the ADP report,

> High school graduates must be able to judge the credibility of sources, evaluate arguments, and distinguish among facts and opinions. . .to evaluate [the media] to help them recognize potential bias. . .help them become savvy media consumers. . .to interpret, synthesize [information] to inform decisions or draw conclusions. (p. 9)

Students themselves recognize the importance of higher order thinking skills in terms of their ability to succeed as young adults. In an on-line survey of over 10,000 high school students across the nation, over 40% responded that they did not feel their school experience provided practical and essential life skills, and over one-third rated their critical thinking preparation as fair-to-poor (National Governor's Association, 2005).

### *1.2. Critical thinking in the public schools*

A chief goal of formal, K-12 education has been to prepare young people for the challenges and uncertainties of the future. Yet, as Browne and Keeley (1997) write:

> As the complexity of the world seems to increase at an accelerating rate, there is a greater tendency to become passive absorbers of information, uncritically accepting what is seen and heard. . .too many of us are not actively making personal choices about what to accept and what to reject. (Preface, p. x)

Kendall and Marzano (2000) analyzed the K-12 national standards and benchmarks in the United States for 12 disciplines and found certain general critical thinking skills common to all content areas, skills assumed to be exercised throughout coursework that comprise the high school curriculum. However, high school teachers face considerable challenges, not the least of which is "covering" the content matter identified by the state standards on which their students will be tested. It has been asserted that much of the mandated high-stakes testing forces teachers to overly concentrate on lower-order thinking skills (ADP, 2004; Darling-Hammond, 2004; Neill, 2003). Plitt (2004) writes that when educating low-performing high school students, adhering to state-mandated curriculum can "shortchange essential skills, such as analytical thinking or the 'habits of mind' that students need for success in college, in the workplace and in their lives as responsible citizens" (p. 745).

Research that supports explicit instruction shows that when key critical thinking skills, such as metacognition (thinking about one's thinking), are overtly taught, using guided instruction in which the student is central and active in the learning experience, those skills are advanced (Kuhn, 2000; Moseley et al., 2005). Bangert-Drowns and Bankert's (1990) meta-analysis of explicit critical thinking instruction found that intensive, practical-skills orientation was most effective.

There is no question that both explicit and imbedded instructional approaches can develop critical thinking; each method has its strengths and its place in education.

Swartz (2003) summarizes three key principles of critical thinking instruction, reflecting the need for both strategies: (a) the more explicit the teaching of thinking is, the greater impact it will have on students. (b) The more classroom instruction incorporates an atmosphere of thoughtfulness the more open students will be to valuing good thinking. (c) The more the teaching of thinking is integrated into content instruction, the more students will think about what they are learning. (p. 208)

In fact, research supports both methods; there is no reason to consider them mutually exclusive, and there is plentiful evidence to expect that together they are especially powerful.

### 1.3. Critical thinking and societal influences

In the world beyond the classroom, high school students are exposed to powerful messages that confound efforts to think critically. The vital need for critical thinking in and beyond formal learning in everyday life, relationships, ethical choices, and in the maintenance and development of participatory democracies grows increasingly apparent (Edwards, 2001; Halpern, 2003; Pithers, 2000). The proliferation of information via the Internet will only be managed effectively by individuals with well-developed thinking skills.

Critical thinking used to be thought of as an intellectual exercise expected only of an educated elite. This practice of relying on a small segment of the population to be the thinkers for society is obsolete (Hay, 2001). Marshak (2003) writes:

> The public school system that we have today was constructed during the first two decades of the 20th century. . .public schools were shaped to fit industrial models of efficient production. One key function for schools was sorting children according to their perceived abilities and encouraging many to drop out and go to work as unskilled laborers. . .public schools built on this industrial model were designed to leave many children behind, so they would drop out and go to work in what we now call low-skill jobs. (p. 1)

In addition to the academic inferiority of the schools that frequently serve large minority populations, economically distressed and/or minority families often lack the knowledge or connections with institutions that can facilitate entry into college or a vocational training program, including potential funding sources and career options (Neill, 2003; Stanton-Salazar, 1997). This lack of social capital or access to social structures in order to achieve a certain end significantly impacts their future prospects. Stanton-Salazar also points out how these students are further disadvantaged when their school experience does not include the development of critical thinking skills like problem solving, decision making, reasoning through argument, and identifying ways in which they may avoid subtle coercion into a lifestyle that is counterproductive to setting long-term goals.

High school students who do not entertain a future that includes post secondary education exit the K-12 pipeline prior to graduation at a much higher rate than their privileged fellow students. A recent study by the Urban Institute (Orfield, Losen, Wald, & Swanson, 2004) revealed that the national high school drop-out rate is far greater than the states' self-reported rates. In California, the numbers are particularly high, especially among African-American and Latino students; only 57% of African-Americans and just 60% of Latinos graduated in 2002, compared with 78% of White students and 84% of Asians. The ramifications of such large numbers of drop-outs for the individual, their families, and society are deeply disturbing as are the suggestions that students are being forced out by schools seeking higher accountability test scores (Harvard University, 2005).

### 1.4. Teaching for critical thinking

Although there are many approaches to teaching students to exercise critical thought, two distinct philosophies exist regarding how instruction is best situated. Some scholars and practitioners endorse the imbedded approach in which the course structure and teacher advance higher-order thinking without direct instruction in the language and exercise of critical thinking skills (Case, 2002). Others advocate explicit instruction, where specific skills are taught; these are general cognitive abilities that intersect various academic and real-life situations. There is substantial research to support both methods (Cotton, 1991) but little is known about their comparative effectiveness. The former has the obvious advantage of not requiring an additional course in the high school curriculum; however, a disadvantage is that imbedded instruction is teacher-dependent and may or may not be practiced in the classroom (Presseisen, 1989).

This is a difficult issue since little attention has been given to critical thinking instruction for educators and may not be a central concern in an educational climate that focuses on content-matter mastery (Paul, Elder, & Bartell, 1997). Even in courses in which critical thinking has long been associated, such as the sciences, it is often the case that thinking about content in a reflective manner does not occur.

Despite the acknowledged importance of developing students' higher order thinking skills, many teachers believe that instruction that stimulates such abilities is appropriate only for a certain sector of the student population, specifically high achieving learners. In this view, low achieving students are overly challenged and thus frustrated by teaching that includes activities focused on higher order thinking (Zohar & Dori, 2003). These negative expectations fuel the cycle of underachievement, failure, and exclusion from participation in productive and meaningful occupations (Drew, 1996).

A vast number of institutions of higher learning throughout the country have undergraduate course requirements in critical thinking, particularly in what is called "the freshman experience" (Kurfiss, 1988, p. 19). But similar classes appear to be rare to non-existent at the secondary level. Coursework in the instruction of critical thinking (explicit or otherwise) designed for the practicing or future teacher are similarly hard to locate. A study in which 101 education faculty and 39 subject-matter faculty in California teacher education programs were interviewed and observed during teaching found a lack of instructor understanding, practice, and teaching of critical thinking and recommended substantive change to address the issue (Paul, Elder, & Bartell, 1997). A majority of the participants (89%) claimed that critical thinking was a primary goal

in their instruction, yet only 19% could clearly articulate a meaning for critical thinking. Less than 10% were actually using instructional methods that foster critical thinking. Despite the outcomes and recommendations of the study, little evidence of subsequent change in teacher preparation programs is available in the literature.

Focusing on the secondary level, Thomas (1999) conducted a partial replication of Paul et al.'s (1997) study, interviewing 40 randomly selected Los Angeles area high school teachers about their understanding and practice of critical thinking and observing 33 teachers, some of whom were randomly selected and some purposively identified as outstanding instructors in the area of critical thinking. Results from the study confirmed the findings of the larger study of teacher education programs throughout the state of California. It was found that a large percentage of teachers in the study lacked the vocabulary with which to discuss critical thinking standards, to provide appropriate instruction, and were unable to identify thinking skills. Most of the teachers who demonstrated exemplary practice in critical thinking in high school instruction had not received critical thinking instruction training in their teacher preparation programs. Additionally, the study revealed a difference in the critical thinking instruction between high and low achieving students, with students in honors or AP classes having greater access to exemplary teachers whose encouragement of critical thinking is reflected in their teaching.

### *1.5. Studies of explicit instruction in critical thinking*

Throughout the literature on the teaching and learning of higher-order thinking, two facts are clear: to learn critical thinking, both high and low achieving students benefit from explicit instruction and repeated practice. The former is about identifying content and skills, design, and delivery; the latter is dependent upon context and requires deliberate effort. As several scholars have noted, critical thinking is not easy; it is challenging, it is hard, but it is not exclusive to "smart people" (Dweck, 2002; Halpern, 2003; Kuhn, 2000).

In a meta-analysis of explicit instruction of critical thinking skills, researchers found average effect sizes of 0.4 for programs in which concepts or skills were explicitly labeled and discussed, and students were guided throughout the practice of critical thinking skills (Bangert-Drowns & Bankert, 1990). Those studies selected for inclusion in the meta-analysis used pre-test and post-test scores for each group (repeated measures) to calculate effect sizes. Programs that were intensive and continuously emphasized specific skills had an effect size of 0.5. The least effective programs focused on logic instruction or those that targeted performance on measures of intelligence. Teaching critical thinking skills that were practical were found to be more effective, and duration of instruction had no correlation with efficacy.

Research tells us that effective critical thinking instruction is structured in a manner that engages students during a period in which a particular skill is introduced, requires deliberate practice, and provides students with the opportunity to transfer their knowledge. Initially, the benefits of the application of the skill should be explained (Baker & Brown, 1984) as should its use in other contexts (Feuerstein, 1980; Perkins & Salomon, 1989). Student prior knowledge should be tapped during the introductory phase (Ausubel, 1960; Mayer, 1983). The importance of metacognition should be stressed and both internal and external metacognitive reflection should be encouraged (Beyer, 2001; Costa, 2001; Halpern, 2003; Staib, 2003). Instructors should model reflective thinking during this period (Costa & Kallick, 2000).

Simulating real-world experiences and providing opportunities to discuss challenges in those scenarios can enhance learning thinking skills. In her review of the literature, Staib (2003) found that student real-life role-play, the use of case studies, group discussion and student-instructor interaction are among the most effective means of developing critical thinking skills. Sternberg (2001) recommends using real-life issues when teaching problem-solving skills in order to increase the likelihood that those skills will be transfer outside of the classroom. Our instructional program for teaching critical thinking for transfer used the four-part model described by Halpern (1998): (a) a dispositional or attitudinal component that consisted of modeling critical thinking and actively encouraging thoughtful responding; (b) instruction in and practice with critical thinking skills; (c) structure training activities designed to facilitate transfer across contexts, which was accomplished by deliberately noting how specific thinking skills apply with very different topics; and (d) a metacognitive component, which included having students discuss the process of thinking.

### *1.6. Research questions*

Central to this study was the hypothesis that the skills of critical thought can be learned, practiced, and transferred via explicit instruction (Halpern, 2003); it was also acknowledged that deliberate and repeated practice is required (Van Gelder, Bissett, & Cumming, 2004). Although we anticipated that both strategies of instruction would show gains, we believed that among high school students with marginal prior experience in using critical thinking strategies, explicit instruction would more effectively prepare students to transfer their learning to everyday situations because of the use of more varied examples, which means that students need to focus on the structure of a problem or issue without regards to the content manner. Explicit instruction that uses examples of each thinking skill with information from many different domains is an application of the cognitive principle known as encoding variability. Varied conditions during learning make the learning more effortful, but they also produce more durable learning that is more likely to transfer to novel settings (Bransford, Brown, & Cocking, 1999).

We were also interested in the appropriateness of the Halpern Critical Thinking Assessment for high school students. The Halpern Critical Thinking Assessment uses believable examples with an open-ended response, followed by questions in a forced-choice format that probe for the reasoning behind an answer. If, for example, the thinking skill of understanding

and recognizing the distinction between correlation and cause were being assessed, it would be tested with examples taken from medical research (e.g., coffee drinkers reported more headaches), social policy analysis (e.g., welfare mothers who received job training were more likely to be employed after one year than welfare mothers who did not receive job training), and numerous other everyday scenarios. Such materials are ecologically valid in that they are representative of the many examples that could be found in newspapers and casual discussions. The open-ended portion of the question allows test-takers to demonstrate whether or not they spontaneously use the skill. Specific probes in the form of alternatives for the forced-choice questions follow the open-ended responses. These probes allow test takers to demonstrate their understanding of the concepts, such as whether they are able to recognize the problem of determining cause when they are provided with hints. A psychometric analysis of the Halpern Critical Thinking Assessment in both Chinese and English language versions was recently published by Ku (2010). Ku lauded the multi-response format and its use of authentic and believable contexts. The Halpern Critical Thinking Assessment has been used in other studies of critical thinking (e.g., Ku & Ho, 2010). The Spanish language translation of the Halpern Critical Thinking Assessment has also been used successfully in Spain (Nieto & Saiz, 2008).

We expected that the Halpern Critical Thinking Assessment would be an appropriate metric for high school students as it focuses on practical, everyday situations that young people across multiple income levels and ethnic backgrounds are likely to find familiar. Equally important, the Halpern Critical Thinking Assessment requires a constructed response for each scenario, which provides an added measure of thinking ability that assesses more than the ability to recognize a correct response.

In an effort to better understand critical thinking among high school students, we also investigated correlations between academic covariates and critical thinking scores. We expected to find positive relationships between higher level coursework and critical thinking scores. Two studies were conducted in public high schools, using complementary research designs.

## 2. Study 1: random assignment with voluntary participation

### 2.1. Method

#### 2.1.1. Study design

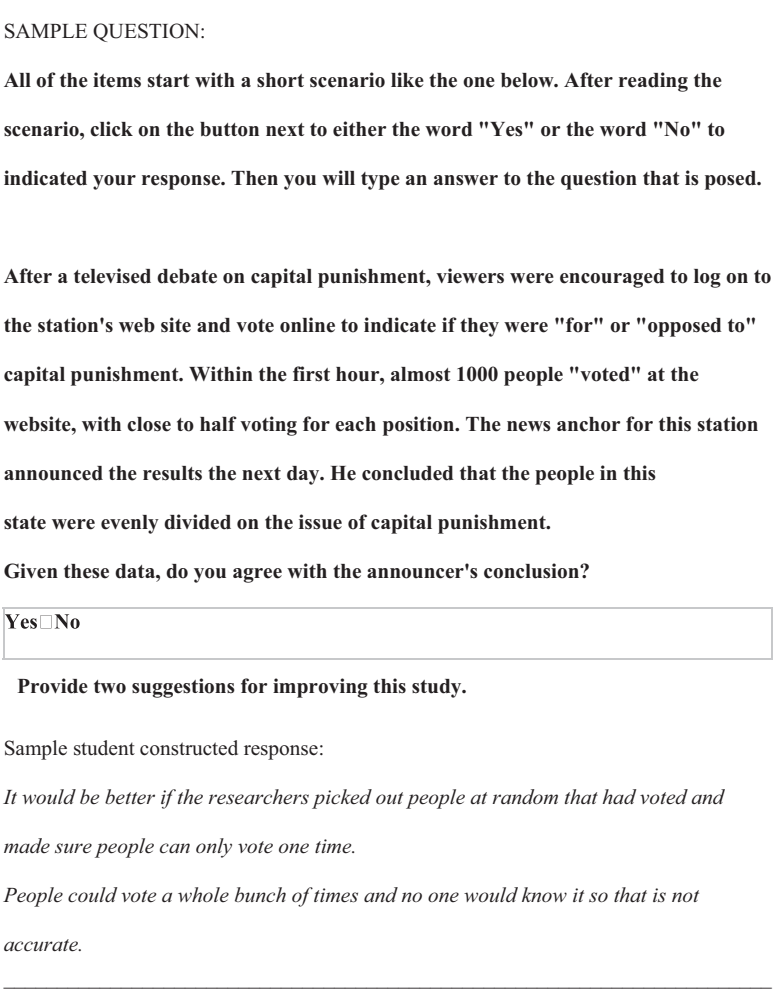
The first study consisted of two learning groups and a wait-listed group. One learning group participated in a Web-based Critical Thinking Workshop that provided explicit instruction in specific critical thinking skills: the development of argument analysis, distinguishing between correlation and cause and effect, identification of stereotypes as well as the influence of mental models, and understanding the long-term consequences of decisions. The second group received instruction in basic principles of cognition and cognitive development via an Introduction to Psychology Workshop in which the critical thinking skills were imbedded; that is, the course was designed to engage students in the use of the same critical thinking skills without direct instruction in thinking skills. The wait-listed group participated in all preliminary tests and provided additional covariate data, but as the group name implies, they did not receive any coursework that was deliberately designed to enhance critical thinking.

#### 2.1.2. Measurements

A baseline score of critical thinking ability was obtained from all participants using the Halpern Critical Thinking Assessment (Halpern, 2010). A sample question for the Halpern Critical Thinking Assessment is shown in Fig. 1. We omitted questions pertaining to understanding likelihood and uncertainty for this study because we did not include instruction on these topics. The students who completed the learning sessions took the Halpern Critical Thinking Assessment a second time as a posttest. All participants also took two self-report questionnaires; one was designed to assess conscientiousness (a subscale on the personality inventory known as "The Big Five"; Costa & McCrae, 1992) and an individual's inclinations towards critical thought ("Need for Cognition"; Cacioppo, Petty, & Kao, 1984) and the Comprehensive Ability Battery for Verbal, Numerical, and Spatial skills (Hakstian & Cattell, 1975). Demographic information for the participants came from school records, which included gender, ethnicity, language spoken at home, overall high school Grade Point Average (GPA), course level in English, science, and math, scores from the California High School Exit Exam (CAHSEE) in English and math, and scores on the California Standards tests (CST) in English and math (Figs. 2 and 3).

#### 2.1.3. Participants

The first study was conducted in a mid-sized, comprehensive high school in Southern California. The high school enrollment is over 3500 students. It is officially classified as a low-income school. The base Academic Performance Index (API) score in 2005 was 620 and placed this school in the second decile, among the lowest in the state. The API is a measurement used in California for accountability to the state and is a component of the federal measure of Academic Yearly Progress (AYP). In the period during which the study was conducted, over one-half (58%) of the students were classified as low-income. Fifty-one percent received free or reduced lunches. The ethnic composition of the school was and continues to be predominantly Hispanic/Latino. All participation was voluntary and required parental consent. Participants received incentives to participate in the form of vouchers that could be spent at a nearby mall, tickets to the prom, and coupons that could be spent at a popular coffee house. All students who were interested in participating were included in the first study if they met the following criteria: no suspensions in the prior year, no excessive absences, and fluency in English. Only one student who


SAMPLE QUESTION:

**All of the items start with a short scenario like the one below. After reading the scenario, click on the button next to either the word "Yes" or the word "No" to indicated your response. Then you will type an answer to the question that is posed.**

**After a televised debate on capital punishment, viewers were encouraged to log on to the station's web site and vote online to indicate if they were "for" or "opposed to" capital punishment. Within the first hour, almost 1000 people "voted" at the website, with close to half voting for each position. The news anchor for this station announced the results the next day. He concluded that the people in this state were evenly divided on the issue of capital punishment.**

**Given these data, do you agree with the announcer's conclusion?**

**Yes □No**

**Provide two suggestions for improving this study.**

Sample student constructed response:

*It would be better if the researchers picked out people at random that had voted and made sure people can only vote one time.*

*People could vote a whole bunch of times and no one would know it so that is not accurate.*

**Fig. 1.** The Halpern Critical Thinking Assessment—Sample question.

applied failed to meet these criteria for inclusion. The students in our sample were 69% Hispanic, 16% African-American, and 15% White; and in gender breakdown, 35% male and 65% female. Fifty-three percent indicated that the language used in their homes is English. All student participants were “proficient in English” but many of the parents were not, thus all materials were available in Spanish.

### *2.2. Procedure*

Participants were randomly assigned to one of three groups: (a) the group receiving explicit instruction in critical thinking ($n = 28$), (b) the group receiving critical thinking instruction imbedded in a course on Introduction to Psychology ($n = 18$), and (c) the wait list control ($n = 24$). Eleven students were in a second explicit instruction group that participated with a parent. Those 11 students were included in the analyses of covariate data with pre-test critical thinking scores, but not in the comparisons of pre-to-post test scores after instruction. Learning conditions were significantly different for those students who worked with a parent, preventing their post-test scores from being included in statistical analyses with the student-only learning groups.

### *2.3. The sessions*

There were six sessions during the course of the project, including one for the pre-test Halpern Critical Thinking Assessment and administration of the CAB-Verbal, Numerical, and Spatial assessments, four learning sessions, and the post-test Halpern Critical Thinking Assessment. Each student group met twice weekly for 2.5 h for three weeks with one instructor, two student research assistants, as well as the computer lab manager/instructor at the high school who helped with technical issues.

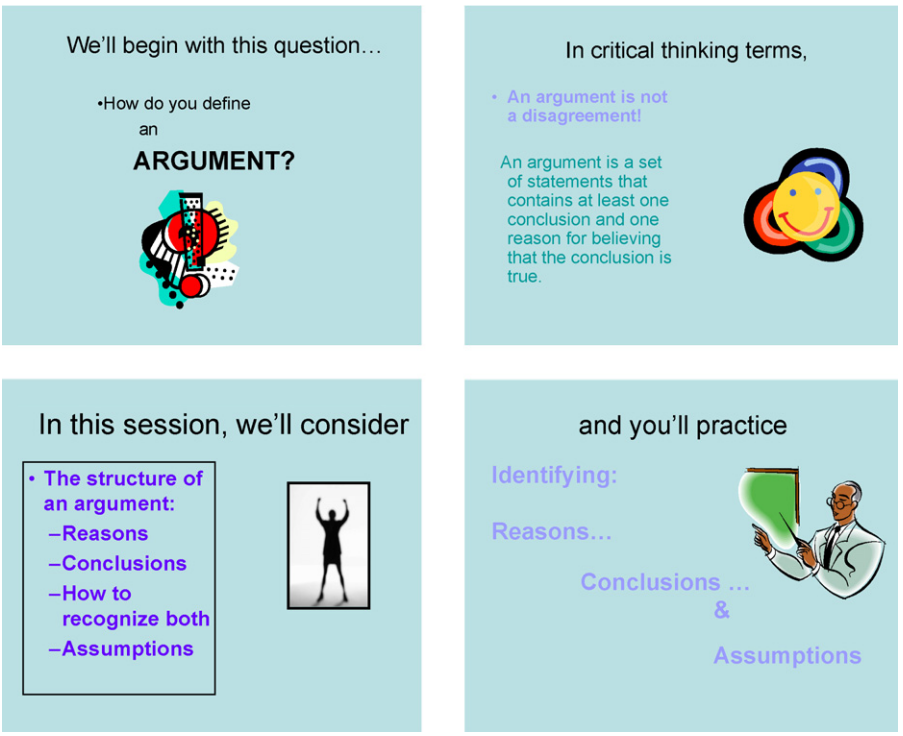



**Fig. 2.** Excerpt from Session One, ***Analyzing Arguments***, a direct instruction preview to the on-line tutorial.

### *2.4. The web-based critical thinking workshop*

An online tutorial using topics of interest to high school students was created for this study. These topics included video gaming, music videos, sports, dieting, and legal scenarios. The online materials required active responding on the part of the learner. Additional classroom materials corresponding to each online tutorial were developed for in-class instruction. These were used by the teacher to introduce, discuss, and close each session. Each session covered specific topics in critical thinking: (a) Tutorial Session One: Analyzing Arguments; (b) Tutorial Session Two: Causal Claims and Correlation; (c) Tutorial Session Three: Mental Models, Stereotypes and Confirmation Bias; and (d) Tutorial Session Four: Making Sound Decisions

### *2.5. Imbedded instruction: an introduction to psychology*

The group receiving imbedded instruction participated in a four-session course in the selected topics of psychology. The sessions were similar in pedagogical components (i.e., in-class learning and online tutorials) and duration as the explicit treatment group. Critical thinking skills were imbedded in this curriculum; the instructor engaged students in activities that required them to analyze data for validity, interpret graphs, observe correlation, identify cause and effect, consider problems and solutions, and to exercise metacognition. The sessions covered the following topics: principles of behavior and conditioning, cognitive development, theories of intelligence, and self-efficacy.

### *2.6. Results*

Cronbach's alpha reliability coefficients were calculated for the post-test scores on the Halpern Critical Thinking Assessment, which had 20 everyday scenarios on a variety of topics, each followed by questions that first require a constructed (open-ended) response then forced choice items (i.e., multiple choice or multiple rating); for constructed response and forced choice questions combined, $\alpha = .82$. For constructed response questions only, $\alpha = 0.81$; for forced choice questions alone, $\alpha = 0.79$; indicating satisfactory internal consistency for the critical thinking measure. (The Halpern Critical Thinking Assessment has 25 everyday scenarios, but the 5 scenarios that concerned likelihood and uncertainty were not included in this study because it was not part of the experimental curriculum designed for this study.)

Pre- and post-test scores from the Halpern Critical Thinking Assessment for each of the three groups are presented in Table 1. Both the explicit instruction and imbedded instruction group showed significant gains in critical thinking, ($t(16) = 4.59$, $p < .001$) and ($t(15) = 2.18$, $p < .05$) respectively, but the explicit instruction group showed much greater gains ($d = .70$) than the imbedded instruction group ($d = .30$).

Welcome to Session One:

Analyzing Arguments – Deciding What to Believe

**Free Offer-** 

**Does this Sound Familiar?**

They are everywhere—in magazines, in your classroom, on every radio and television news program, and even at family gatherings. What are they? They are **persuasive appeals**—attempts to persuade you to buy a particular product, vote for a certain candidate, give money to a charity, or side with a friend during a disagreement. Persuasive appeals are part of almost every communication. They can be used to fool you, so you must be able to use your thinking skills to decide what to believe or do.

How can you use reason to decide what to believe or what to do when you are bombarded by persuasive appeals? Critical thinkers use the skills of **argument analysis**. For many experts in the field, argument analysis is at the heart of critical thinking.

But, first things first. What is an argument and how is it used as a technique of persuasion?

Contents:



**Fig. 3.** Screen shot from the on-line tutorial.

**Table 1**
Mean, standard deviation, minimum and maximum scores for the Halpern Critical Thinking Assessment Year 1 Study*.

| | Pretest | | Posttest | |
|---|---|---|---|---|
| Critical Thinking Instruction | Mean | Range | Mean (SD) | Range |
| Explicit, all Students ($n = 28$) | 87.9 (16.4) | 53–119 | 99.8(18.7) | 60–127 |
| Imbedded ($n = 16$) | 86.9 (15.2) | 65–119 | 90.9(16.5) | 62–115 |
| Wait-list Control ($n = 24$) | 82.5 (15.9) | 49–109 | | |

* The likelihood and uncertainty subscale of the Halpern Critical Thinking Assessment was not used in this study.

Pretest scores on the Halpern Critical Thinking Assessment were significantly correlated with academic measures, although there were large differences in the size of the correlations, GPA ($r = 0.34$, $p = 0.006$), CST math ($r = .39$, $p = 0.004$), CST in English/Language Arts ($r = 0.60$, $p < 0.001$), CAHSEE Math ($r = 0.56$, $p < 0.001$), and CAHSEE English Language Arts ($r = 0.57$, $p < 0.001$).

### 2.7. Course levels

Additional analyses indicated that students who were enrolled in below grade level math courses scored significantly lower on the pre-test of critical thinking skills than those at or above grade level, ($t(61) = 4.46$, $p < .001$);($d = -1.33$). A similar analysis using grade level of English courses failed to obtain significance. Students who were enrolled in a science course scored significantly higher on the Halpern Critical Thinking Assessment than those who were not enrolled in a science course, ($t(60) = 3.11$, $p < .001$), ($d = 0.80$). The two dispositional assessments, "Conscientiousness" and "Need for Cognition," had low correlations with scores on the Halpern Critical Thinking Assessment ($r = 0.20$, $p = .051$) ($r = 0.20$, $p = 0.051$), respectively.

Participants completed the Comprehensive Ability Battery, consisting of short timed tests (5–7 min), which measure Verbal, Numerical, and Spatial abilities (CAB V, N, S; Hakstian & Cattell, 1982). These data are shown in Table 2. Significant correlations between performance on the assessment of critical thinking were found for all three cognitive ability tests: CABV and Halpern Critical Thinking Assessment ($r = 0.54$, $p < 0.001$); CAB-N and Halpern Critical Thinking Assessment ($r = 0.26$, $p = 0.044$), CAB-S and Halpern Critical Thinking Assessment ($r = 0.28$, $p = 0.029$).

### 2.8. Discussion: study 1

Results from the Year 1 study in which high school students from a very low performing school were taught critical thinking skills with explicit instruction or with embedded instruction showed that although students taught with either method showed gains on a critical thinking assessment relative to a wait-list control group, the gains were much larger for the explicit instruction group. Despite this positive outcome, there were methodological limitations in this study that limit its generalizability. The students who participated attended classes after their regular school day or on Saturdays, so they (or their parents) were likely different from students who did not choose to participate. The issue of whether results can be generalized from any voluntary intervention to the general population of students is always questionable when educational researchers do not use random selection from the population, and even though the groups were not significantly different on any of pre-instruction measures, differences in response to educational interventions could be subtle and possibly due to undetected differences in academic motivation.

Another problem is the small number of students in each group. Although we offered incentives for participating (e.g., movie tickets, "cash cards" for use at a local mall), the number of students who applied and who met our inclusion criteria (no suspensions in the prior year, no excessive absences, and good command of English) was small. On the other hand, the experimental design that we used allowed us to obtain parental permission to access the students' school records, which included their grades and scores on multiple standardized tests. To remedy the problems in the first study that used random assignment of students who elected to participate, we ran a similar program at another very low performing high school, but this time the interventions were incorporated into the regular classroom curriculum, which allowed us to randomly assign entire classes to different conditions. Although this research design allowed us to incorporate the critical thinking instruction into entire classes, thereby eliminating the problem of voluntary participation, there were other limitations. This design corrected the problem of self-selection biases and increased the number of students who participated, but because

**Table 2**
CAB-Verbal, numerical, spatial scores: means, standard deviations, and correlations with Halpern Critical Thinking Assessment Halpern Critical Thinking Assessment Study 1.

| Test | Mean (SD) | Correlations with Halpern Critical Thinking Assessment |
|---|---|---|
| Verbal | 11.9 (3.8) | 0.54** |
| Numerical | 8.6 (3.8) | 0.26 |
| Spatial | 37.0 (14.4) | 0.28* |

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

we did not need parental permission for this program, we did not have access to the students' grades or standardized test scores, which are confidential and can only be accessed with parental consent.

## 3. Study 2: random assignment of classes to conditions

### 3.1. Method

In the year following Study 1, a research design with two treatment groups, explicit and implicit instruction of critical thinking skills, and a no-treatment group, was conducted at another high school. Both high schools were in the Inland Empire of California, which is an area in San Bernardino County, directly east of Los Angeles. The base API score for the second high school was 646 and like the first school, it ranked very low in the state—in this case, the lower 3rd decile. These schools are considered "similar schools" due to the comparable student demographics and testing data.

### 3.2. Participants

One hundred and eight students completed a 6-week version of the program. Instruction occurred during school hours in regularly scheduled classes taken by juniors and seniors (mean age: 16.9 years). Unlike the Year 1 study, none of the groups included parents. Seventy two percent of those who completed the study were female, 28% were male. The excess number of females is probably a reflection of the fact that fewer boys in low-performing school graduate from high school and thus there would be fewer boys than girls in 12th grade and because we did not use shop or auto repair classes, which tend to have largely male enrollments. Approximately 58% were Hispanic, with the remaining 42% divided among Caucasian/White (10%), African-American/Black (7%), Asian/pacific Islander (4%), Biracial/multiracial 6%, with the remainder classified as Other or missing data.

### 3.3. Procedure

Five classes participated in this study, with two assigned at random to receive the explicit instruction (Critical Thinking Curriculum, final $n = 40$), two assigned at random to receive the Imbedded instruction (Introduction to Psychology, final $n = 38$), and one class assigned at random to serve as a control group receiving no treatment (final $n = 30$). All participants took the same battery of Comprehensive Ability Tests as were administered in Study 1, and all participants took the Halpern Critical Thinking Assessment. Students in the two treatment groups also took the Halpern Critical Thinking Assessment as a post-test at the end of instruction. In order to fit the same instructional program as the Year 1 study into standard class period, instruction for the Year 2 study occurred twice a week for six weeks, so it extended over a longer period of time.

### 3.4. Results

Cronbach's alpha reliability coefficients were calculated for the pretest scores on the Halpern Critical Thinking Assessment. We used the pretest scores for determining reliabilities because it included students in the no-treatment control condition and thus increased our sample size. For the constructed response and forced choice items combined, $\alpha = .80$; for constructed response only, $\alpha = .77$; for forced choice only, $\alpha = .75$. Although these values are slightly lower than those in the Year 1 study, possibly because the participants were more heterogeneous, they are within a generally acceptable range for internal consistency. There is also some heterogeneity in the critical thinking assessment as it assesses performance for verbal reasoning, argument analysis, hypothesis testing, and decision-making, which yields a lower score for reliability than if only one of these areas were being assessed.

Means and standard deviations for the Halpern Critical Thinking Assessment are shown in Tables 3 and 4. Pretest scores were not significantly different among students in the three groups. Following the six-week program, the post-test results showed significant gains among the students who received explicit instruction via the Web-Based Critical Thinking Workshop ($t(39) = 3.71$, $p < 0.005$), ($d = 1.15$), but unlike the results from Study 1, the pretest–posttest increase in critical thinking scores failed to obtain statistical significance for the students in the imbedded instruction classes. Accordingly, the post-instruction difference in scores on the Halpern Critical Thinking Assessment were significantly higher for students who received explicit instruction as compared to those who received the imbedded instruction, ($t(76) = 3.3$, $p < .005$), ($d = .45$).

**Table 3**
Mean, standard deviation, minimum and maximum scores for the Halpern Critical Thinking Assessment Year 2 Study*.

| | Pretest | | Posttest | |
|---|---|---|---|---|
| | Mean (SD) | Range | Mean (SD) | Range |
| Explicit ($n = 40$) | 70.4 (12.8) | 44–92 | 83.8 (10.3) | 63–105 |
| Imbedded ($n = 38$) | 71.8 (16.4) | 53–103 | 77.7(16.4) | 54–100 |
| None ($n = 30$) | 79.2 (16.1) | 49–101 | | |

* The likelihood and uncertainty subscale of the Halpern Critical Thinking Assessment was not used in this study.

**Table 4**
CAB-Verbal, numerical, spatial scores: means, standard deviations, and correlations with Halpern Critical Thinking Assessment for Study 2.

| Test | Mean (SD) | Correlations with Halpern Critical Thinking Assessment |
|---|---|---|
| Verbal | 12.4 (3.8) | 0.39** |
| Numerical | 10.1 (7.3) | 0.36* |
| Spatial | 43.0 (15.1) | 0.02 |

* Significant at the 0.05 level (2-tailed).
** Significant at the 0.01 level (2-tailed).

### 3.5. Discussion: study 2

In Study 2, intact high school classes were assigned at random to receive either explicit instruction in critical thinking (2 classes), imbedded instruction in critical thinking with the critical thinking skills incorporated in introductory psychology lessons (2 classes) or as a control that did not receive specific instruction in critical thinking (1 class). This design had the advantage over the research design used in Study 1 in that it did not rely upon volunteers to serve as participants. But, it had disadvantages as well in that the researchers did not have access to confidential student records because they did not need to obtain informed consent for standard instruction in the curriculum. In addition, there are the usual problems associated with using intact classrooms, including the possibility that students in different classes differ in subtle ways from class to class, which could affect results even when the entire class is assigned at random to a condition. Alone, neither of these designs provide sufficient assurance of the generalizability of the findings, but taken together, especially with good replications, researchers can have more confidence in the findings. The main finding, which shows that students in the explicit instruction improved relative to their own pretest scores and relative to the imbedded instruction group, is strong. Relationships between the comprehensive abilities battery of tests and scores on the critical thinking assessment were essentially the same as those found in Study 1.

## 4. General discussion

The two studies that emerged from this project were motivated by the common belief that critical thinking instruction should be a central part of the general education of all high school students. As young people prepare to graduate and meet the challenges of increasing independence in the workplace and/or college, developing an awareness of the various issues explicitly addressed in the Web-Based tutorial provides a basis for better decision-making during the critical years ahead. Despite the fact that the need for critical thinking instruction at the high school level is widely known and supported in theory, in reality very little specific curriculum for explicit critical thinking instruction for secondary students is available.

The need to engage students in critical thinking is expounded in nearly all subject matter content standards documents, pre- and in-service teaching instruction, and educational reform discussions, but there are few studies to help educators decide between the relative merits of imbedded and explicit methods of instruction. The results of our studies support the hypothesis that explicit instruction in thinking skills is more effective than imbedded instruction for the transfer of those skills to everyday situations such as those presented in the Halpern Critical Thinking Assessment. This is consistent with prior studies at the post-secondary level and provides evidence that short-term, intensive, explicit instruction is a viable means for developing critical thinking skills that transfer to scenarios that individuals are likely to encounter in daily life (Moseley et al., 2005).

Our findings are especially encouraging as they indicate that helping students learn critical thinking skills can be done without a comprehensive restructuring of the high school curriculum. A program such as the one described here could be offered as a supplemental after-school course or provided during the school day without seriously disrupting a school's already tightly packed curriculum.

Student scores on the pretest Halpern Critical Thinking Assessment were significantly correlated to academic achievement, although the strength of the relationships was highly variable. High school GPA was the smallest contributor to predictions of scores on the critical thinking assessment, a finding that suggests that GPA is less associated with critical thinking ability than nonacademic factors. Indeed, substantial research indicates that GPA is linked to student assets that include family support, student persistence, homework completion, and attendance (Search Institute, 2003). The California high school exit exam is based on the belief that too many students are graduating from high school with acceptable or high GPAs and few of the cognitive skills needed for success in the workforce or college.

The predictive power of the CST English Language Arts scores for higher performance on the pretest Halpern Critical Thinking Assessment provides substantial evidence that literacy is significantly linked to critical thinking ability. A student's reading comprehension and facility with language and writing conventions as measured by both the CST and the CAHSEE appears to be closely connected with his or her ability to demonstrate, develop, and apply critical thinking skills. This finding further suggests that the CST and the CAHSEE may be providing some evidence of a student's higher order thinking. Both of these standardized tests were designed to foster higher order thinking skills. They require students to make inferences from reading passages and to critique arguments, which are core topics in critical thinking instruction. This is an important finding because one common criticism of criterion-referenced tests is that they do not measure important, non-content

related abilities. Establishing the ways in which standardized testing may or may not assess the ability to think critically is an extremely crucial issue for future study as these tests have considerable, and seemingly growing, influence in both the academic outcomes of students and their schools.

The significant relationship between enrollment in science courses and scores on the Halpern Critical Thinking Assessment may be appreciated in view of the goals of science education, which include many of the competencies associated with critical thinking. Scientific literacy, as described by the National Academy of Sciences (1999), is a set of observational and interpretative skills that can form the foundation for personal decision making, civic and cultural participation, and for making and evaluating arguments based on evidence. When applied in the study and practice of the sciences, the construction of a factual knowledge base is essential, but even more empowering is the ability to access, analyze, synthesize, and evaluate information. In a broad sense, the individual who attains and practices scientific literacy makes constructive conclusions about evidence and applies them in their lives (National Academy of Sciences, 1999). These mirror the goals of critical thinking instruction, both for academics and everyday life. The results showing a clear positive relationship between science course taking and critical thinking are powerful reminders of the need to promote scientific literacy among all students.

The success of the explicit instructional portion of this project provides evidence that intervention targeting specific critical thinking skills that transfer to everyday situations is feasible for high school students whose exposure to explicit strategies had been marginal at best. The use of an easily accessible, Web-based program has promise as a supplement to the high school curriculum. The sequenced, focused character of the explicit instruction minimizes disruption of the school day; as an extracurricular event, it can be used with after-school or Saturday programs with which to engage students and parents.

The successful use of the Halpern Critical Thinking Assessment in this study warrants close examination of the potential for its administration throughout secondary schools in addition to its use in post-secondary education, as should long-term follow up of explicit programs of instruction. There are multiple reasons to encourage the explicit instruction of critical thinking skills in high school (and by extension post-secondary education). In one study, a large sample of adults ($n = 356$) took a test of critical thinking skills that was similar in content to the one use in these studies. In addition, they were asked about common everyday events such as how many times in the last year they rented a movie and did not watch it, bought clothes they never wore, had unprotected sex, and other similar behaviors that are generally indicative of poor thinking (Bruin, Parker, & Fischoff, 2007). The researchers found that adults who scored higher on the critical thinking assessment reported fewer negative life events than those who had lower scores. In other words, learning how to apply critical thinking skills was correlated with positive outcomes in real life.

Every study has limitations, and the two discussed here are no exceptions. The students in this study came from very low performing high schools. It is possible that students from higher performing schools would should smaller gains. We also do not have posttest data from students in the control condition, so some portion of the gain could be attributed to practice effects, although this is unlikely because the students in the imbedded condition took both pretests and posttests and did not show gains.

## 5. Conclusion

Our studies reflect the benefits of an explicit mode of teaching critical thinking—making specific strategies abundantly clear to students who are in the incipient stage of developing such skills. We anticipate that future use of this program will yield further support for the explicit instruction of critical thinking skills. The importance of thinking skills for high school success as well as success in the workplace, post-secondary education, and everyday life makes the necessity of supplementary methods of instruction clear. Without compromising the need for subject matter competency, explicit instruction in critical thinking skills is a viable means by which to educate students in ways with which to negotiate the complexities of modern life, both within the boundaries of school and beyond. The program that has been developed, evaluated, and presented in this paper provides empirical evidence that such instruction is feasible and effective and that such instruction can bridge the considerable divide that separates those who are more advantaged from those whose life histories compromise their exposure to the skills associated with critical thought.

## Acknowledgements

We sincerely thank the Jacob Foundation for their generous support of this research.

## References

Alliance for Excellent Education. (2009). *Whole-school reform: Transforming the nation's low-performing high schools*. Retrieved from. http://www.all4ed.org/files/PolicyBriefWholeSchoolReform.pdf

American Diploma Project (ADP). (2004). *Do graduation tests measure up? A closer look at state high school exit exams*. Achieve, Inc. Retrieved from. http://www.achieve.org/dstore.nsf

Ausubel, D. P. (1960). The use of advance organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology, 51*, 267–272.

Baker, L., & Brown, A. L. (1984). Metacognitive skills and reading. In P. D. Pearson, R. Barr, M. L. Kamil, & P. Mosenthal (Eds.), *The handbook of reading research* (pp. 353–394). New York: Longman.

Bangert-Drowns, R., & Bankert, E. (1990). Meta-analysis of effects of explicit instruction for critical thinking. In *Paper presented at the annual meeting of the American Educational Research Association* Boston, MA.
Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school.*. Washington, DC: National Academy Press.
Beyer, B. (2001). What research says about teaching thinking skills. In A. Costa (Ed.), *In developing minds: A resource book for teaching thinking*. Alexandria, VA: Association for Supervision and Curriculum Development.
Browne, M. N., & Keeley, S. (1997). *Asking the right questions: A guide to critical thinking* (5th ed.). Mahwah, NJ: Prentice Hall.
Cacioppo, J. T., Petty, R., & Kao, C. H. (1984). The efficient assessment of Need for Cognition. *Journal of Personality Assessment*, *48*, 306–307.
Case, R. (2002). Partnering to promote critical thinking. *School Libraries in Canada*, *22*(1), 11–13.
Costa, A. (2001). *Developing minds: A resource book for teaching thinking*. Alexandria, VA: Association for Supervision and Curriculum Development.
Costa, A., & Kallick, B. (2000). Using questions to challenge students' intellect. In A. L. Costa, & B. Kallick (Eds.), *Activating and engaging habits of mind* (pp. 34–45). Alexandria, VA: Association for Supervision and Curriculum Development.
Costa, P. T., & McCrae, R. R. (1992). *NEO PI-R Professional manual*. Odessa, FL: Psychological Assessment Resources, Inc.
Cotton, K. (1991). *Close-up #11: Teaching thinking skills*. Retrieved from Northwest Regional Educational Laboratory's School Improvement Research Series Web site. http://www.nwrel.org/scpd/sirs/6/cu11.html
Darling-Hammond, L. (2004). Standards, accountability, and school reform. *Teachers College Record*, *106*(6), 1047–1085.
de Bruin, W. B., Parker, A. M., & Fischhoff, B. (2007). Individual differences in adults decision-making competence. *Journal of Personality and Social Psychology*, *92*, 938–956.
Drew, D. (1996). *Aptitude revisited: Rethinking math and science education for America's next century*. Baltimore, MD: The Johns Hopkins University Press.
Dweck, C. S. (2002). Beliefs that make smart people dumb. In R. J. Sternberg (Ed.), *Why smart people can be so stupid*. New Haven, CT: Yale University Press.
Edwards, J. (2001). Learning and thinking in the workplace. In A. Costa (Ed.), *Developing minds: A resource book for teaching thinking.*. Alexandria, VA: ASCD.
Feuerstein, R. (1980). *Instrumental enrichment: An intervention programme for cognitive modifiability*. Baltimore, MD: University Press.
Giedd, N., Blumenthal, J., Jeffries, N., et al. (1999). Brain development during childhood and adolescence; a longitudinal MRI stud. *Nature Neuroscience*, *2*(10), 86l–93l.
Hakstian, A. R., & Cattell, R. B. (1975). *The comprehensive ability battery*. Champaign, IL: Institute for Personality and Ability Testing.
Hakstian, A. R., & Cattell, R. B. (1982). *Manual for the comprehensive Ability Battery (CAB)*. Champaign, IL: Institute for Personality and Ability Testing.
Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Dispositions, skills, structure training, and metacognitive monitoring. *American Psychologist*, *53*, 449–455, doi:0003-066X/98/$2.00.
Halpern, D. F. (2003). *Thought and knowledge: An introduction to critical thinking* (4th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
Halpern, D. F. (2010). *Halpern Critical Thinking Assessment*. Schuhfried (Vienna Test System). http://www.schuhfried.at
Harvard University. (2005). *The Civil Rights project: Confronting the graduation rate crisis in California*. Retrieved from. http://www.civilrightsproject.harvard.edu/
Hay, L. (2001). Thinking skills for the information age. In A. L. Costa (Ed.), *Developing minds: A resource book for teaching thinking*. Alexandria, VA: Association for Supervision and Curriculum Development.
Kendall, J. S., & Marzano, R. J. (2000). Retrieved from http://www.mcrel.org/standards-benchmarks/docs/process-lifeskills.asp#thinking.
Ku, K. Y. L. (2010). Assessing students' critical thinking performance: Urging for measurements using multi-response format. *Thinking Skills and Creativity*, *4*, 70–76, doi:10. 1016/j.tsc.2009.02.001.
Ku, K. Y. L., & Ho, I. T. (2010). Dispositional factors predicting Chinese students' critical thinking performance. *Personality and Individual Differences*, *48*, 54–58, doi:10.1016/j.paid.2009.08.015.
Kurfiss, J. (1988). *Critical thinking: Theory, research, practice, and possibilities. ASHE-ERIC Higher Education Report No. 2*. Washington, DC: Association for the Study of Higher Education.
Kuhn, D. (2000). Metacognitive development. *Current Directions in Psychological Science*, *9*, 178–181.
Marshak, D. (2003). No child left behind: A foolish race into the past. *Phi Delta Kappan*, *85*(3), 229–231.
Mayer, R. E. (1983). *Thinking, problem solving, cognition*. New York: Freeman.
Moseley, D., Baumfield, V., Elliott, J., Gregson, M., Higgins, S., Miller, J., & Newton, D. P. (2005). *Frameworks for thinking: A handbook for teaching and learning*. Cambridge: Cambridge University Press.
National Academy of Sciences. (1999). In M. Kipke (Ed.), *Forum on adolescence*. Washington, DC: National Academy Press.
National Governor's Association. (2005). *Rate your future survey: A summary of the results from the National Governor's Association*. Retrieved from. http://www.nga.org/portal/site/nga/menuitem.9123e83a1f6786440ddcbeeb501010a0/?vgnextoid=2d7ef891bc025010VgnVCM1000001a01010aRCRD
Neill, M. (2003). The dangers of testing. *Educational Leadership*, *60*(5), 43–46.
Nieto, A. M., & Saiz, C. (2008). Evaluation of Halpern's "Structural Component" for improving critical thinking. *The Spanish Journal of Psychology*, *11*, 266–274.
Orfield, G., Losen, D., Wald, J., & Swanson, C. (2004). *Losing our future: How minority youth are being left behind by the graduation rate crisis*. Cambridge, MA: The Civil Rights Project at Harvard University. Contributors: Advocates for Children of New York, The Civil Society Institute.
Paul, R., Elder, L., & Bartell, T. (1997). *California teacher preparation for instruction in critical thinking: Research findings and policy recommendations*. ERIC Document #437 379.
Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context bound? *Educational Researcher*, *19*(1), 16–25.
Pithers, R. T. (2000). Critical thinking in education: A review. *Educational Research*, *42*(3), 237–249.
Plitt, B. (2004). Teacher dilemmas in a time of standards and testing. *Phi Delta Kappan*, *85*(10), 745–748.
Presseisen, B. (1989). *Teaching thinking: A focus for schooling*. ERIC Doc.# 377 172.
Ruggiero, V. (1998). *Beyond feelings: A guide to critical thinking*. Mountain View, CA: Mayfield Publishing Company.
Search Institute. (2003). Boosting student achievement. New research on the power of developmental assets. *Insights and Evidence*, *1*(1), 2.
Solorzano, D., & Ornelas, A. (2004, February–March). A critical race analysis of Latina/o and African American advanced placement enrollment in public high schools. *The High School Journal*, *87*(3), 15–26.
Sowell, E. R., Thompson, P. M., Holmes, C. J., et al. (1999). In vivo evidence for post adolescent brain maturation in frontal and striatal regions. *Nature Neuroscience*, *2*(10), 859–861.
Staib, S. (2003). Teaching and measuring critical thinking. *Journal of Nursing Education*, *42*(11), 498–508.
Stanton-Salazar, R. D. (1997). A social capital framework for understanding the socialization of racial minority children and youths. *Harvard Educational Review*, *67*(1), 1–39.
Sternberg, R. (2001). Teaching problem solving as a way of life. In A. Costa (Ed.), *Developing minds: A resource book for teaching thinking*. Alexandria, VA: ASCD.
Swartz, R. (2003). Infusing critical and creative thinking into instruction in high school classrooms. In D. Fasko (Ed.), *Critical thinking and reasoning*. Cresskill, NJ: Hampton Press.
Thomas, P. (1999). *Critical thinking instruction in selected greater Los Angeles area high schools*. Unpublished doctoral dissertation, School of Education and Behavioral Studies, Azusa Pacific University, Azusa, CA.
Van Gelder, T., Bissett, M., & Cumming, G. (2004). Cultivating expertise in informal reasoning. *Canadian Journal of Experimental Psychology*, *58*(2), 142–152.
Warburton, E. C., & Torff, B. (2005). The effect of perceived learner advantages on teachers' beliefs about critical-thinking activities. *Journal of Teacher Education*, *56*, 24–33.
Zohar, A., & Dori, Y. (2003). Higher order thinking skills and low-achieving students: Are they mutually exclusive? *Journal of the Learning Sciences*, *12*(2), 145–182.