

Critical Thinking: The Missing Link in Business Management Education

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Abstract: A pedagogical treatment was developed to teach critical thinking knowledge, skills, and strategies to college students. This treatment was implemented at a Midwestern University for a five-year period. Graduates were surveyed to determine the extent to which the treatment affected their personal, academic, and professional lives. We also identified and quantified evidence of the graduates' satisfaction with the course of study, and, by inference, the curriculum, the College, and the University. Graduates reported that they had transferred the critical thinking knowledge, skills, and strategies they had acquired into their personal, academic, and professional lives. This transfer was validated using qualitative descriptions provided by the graduates of their use of critical thinking. The graduates also reported extremely high rates of satisfaction with the course in general, and its effects on their personal, academic and professional lives.

Key words: critical thinking; transfer of knowledge; domains of knowledge; summative survey; student satisfaction

JEL codes: C10, C12, C91, I23, M00, M10, M19

1. Introduction

Critical thinking is an essential component of education, and it is an important life skill that everyone should acquire (Case, 2005; Giancarlo, Blohm, & Urdan, 2004). Critical thinking has been defined as, "... the use of those cognitive skills or strategies that increase the probability of a desirable outcome" (Halpern, 1998, p. 450). One of the authors defined it as, "The conjunction of knowledge, skills, and strategies that promotes improved problem solving, rational decision making and enhanced creativity" (Reid, 2009, October).

There is ample evidence that this essential knowledge and skill set is not being taught or being acquired (Helsdingen, Bosch, Gog, & Merriënboer, 2010; Marin & Halpern, 2011; Orr et al., 2011a; 2011b; Stupnisky, Renaud, Daniels, Haynes, & Perry, 2008; Willingham, 2007). Devore (2008) reported that, although employers expected that graduates of colleges of business had been taught to think critically, 87% of business school graduates had received no training in these essential business skills. A recent survey of business managers and corporate-suite executives were overwhelmingly unimpressed with the skills acquired by business school graduates (Woods-Bagot, 2012). Leading their list of unacquired skills was problem-solving and critical thinking, along with the inability to work with others. Avrum and Roksa have shown that students in colleges of business administration achieve the

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lowest scores of all students in the Collegiate Learning Assessment (Arum & Roksa, 2011, p. 104). Further, "We find that individual post-college experiences track with performance at the end of college on an evaluation of their higher-order generic skills measured with the Collegiate Learning Assessment" (Arum, Cho, Kim, & Roksa, 2012, abstract).

At the 2010 MBAA International Conference, we reported a quasi-experimental pedagogical investigation involving 55 graduating seniors from a Midwestern college of business administration (Anderson & Reid, 2010, March). Our instructional model was Teaching for Critical Thinking (TCT) developed by Diane Halpern (1998). Within this context, she proposed a "... model for teaching Critical Thinking skills so they will transfer across domains of knowledge ..." consisting of four constituent elements, as shown in Figure 1 (1998, p. 451). The first component of the TCT pedagogical strategy was the dispositional or attitudinal element. The second was instruction in and practice of critical thinking skills. The third component was structure training to facilitate transfer across contexts or domains. Finally, a metacognitive component was used to direct and assess thinking.

Motivation Attention Relevance Confidence Satisfaction	Instruction in CT Skills Self-Awareness Methods of proof Pseudo proofs Problem Solving / Decision Making
Structure Training	Metacognitive Training
In-depth practice to	Knowledge and training
recognize and use Critical	to develop recognition of
Thinking skills in	need to activate Critical
multiple contexts.	Thinking processes

Figure 1 Concept Map of Teaching for Critical Thinking Model

The instructional design model we used was that of Foshay, Silber, and Stelnicki (2003). Borrowing heavily from Merrill (2002; 2007), and from Clark (Clark, Yates, Early, & Moulton, 2006; Kirshner, Sweller, & Clark, 2006), Foshay, Silber, and Stelnicki wrote *Writing Training Materials That Work: How to Train Anyone to Do Anything*. In this book, they describe a five-step model of instructional design that provides a parallel construction to Halpern's model. This model is shown in Table 1 (2003, p. 29).

We used three different assessments to determine the acquisition of CT skills and one for transfer between domains. The primary assessment instrument was the California Critical Thinking Skills Test, which was administered as a pre-test/post-test to the experimental groups and as a post-test to the control group. The CCTST was not used as part of the student's grade for the course

The secondary assessment was a series of 10-question, T/F quizzes provided by Halpern and Rizzio (2003), which were administered in a pre-test/post-test format with each chapter of the text. These quizzes were developed for use in conjunction with Halpern's book *Critical Thinking across the Curriculum*, which was the critical thinking textbook in this treatment (1997a). These T/F quizzes were not used as part of the student's grade for this course.

We also used examinations obtained from Halpern and Riggio to assess chapter-by-chapter learning. The researcher graded these exams and provided them to the instructor. These exams represented five percent of the students' overall grade.

Learners Must Do This to Learn	Trainers Put These Elements in Lessons to Help Learners
1. Select the Information to Attend to:	Attention: Gain & focus learner's attention on the new
Heighten attention and focus it on new knowledge being taught because	knowledge.
that new knowledge is seen as important and capable of being learned	WIIFM: What's In It For Me?
	YCDI: You can do it.
2. Link the New Information to the Existing Knowledge	Recall existing knowledge
Put the new knowledge into an existing framework by recalling	Relate the new knowledge and the old knowledge.
existing/old knowledge related to the new knowledge and linking it to the	
old.	
3. Organize the Information	Structure of Content.
Organize new knowledge in such a way that matches the organization	Objectives.
already in mind for related existing knowledge to make it easier to learn,	Chunking.
cut mental processing time, minimize confusion, and stress only relevant	Text Layout.
information.	Illustrations.
4. Assimilate the New Knowledge into Existing Knowledge	Present New Knowledge.
Integrate the new knowledge into the old knowledge so they combine to	Present Examples.
produce a new unified, expanded and reorganized set of knowledge	
5. Strengthen the New Knowledge in Memory.	Practice.
Strengthen the new knowledge so that it will be remembered and can be	Feedback.
brought to bear in future job and learning situations.	Summary.
	Test.
	On-the-job application.

Table 1 The Cognitive Training Model

The authors developed a set of assessments to teach and assess the student's use of critical thinking within the domain of business, while also providing structure training within the Halpern model. The business textbook contained many excellent case studies (Hill & Jones, 2009). We chose specific case studies, which emphasized the particular topics congruent with that week's critical thinking treatment. We developed a series of rubrics to be used to assess the student's application of critical thinking to the case study. Since the students taking this course were graduating seniors, they were skilled in analyzing case studies. In these analyses, the students used SWOT analyses, financial analyses, and other business tools, while also applying the critical thinking skills from the chapter in their analyses. These critical thinking case studies also represented five percent of the students' grade.

As a regular part of this course of study, teams of students were assigned major case studies on a particular company. These major case studies were comprehensive, taking the entire semester to complete. Finally, teams of students participated in a computerized business simulation, taking the entire semester to complete. The team case study accounted for forty percent and the team computerized business simulation accounted for fifty percent of the student's grade.

The critical thinking pedagogical treatment developed by the researcher consisted of 11 modules of 1 hour to 1-/12 hours of class time. This consisted of one introductory module, nine book chapters of the Halpern text, and one wrap-up session. Each module, corresponding to a chapter in the Halpern text (1997a), contained the pre-test/post-test, True/False quiz; a computer-aided, multi-media assisted lecture; a discussion of the previous chapter assignment; a new chapter assignment; an examination on the content of the chapter; and a business case study. The pre-test of the T/F quiz was administered within the first five minutes of the class period. A copy of the PowerPoint lecture, the chapter assignment, chapter examination, post-test T/F quiz, and the business case study were emailed to each of the students. Students returned their examination, quiz, and case study by email prior to the following week's class.

The sample was of three sections of a senior level, capstone course in business administration, two of which were experimental and one was the control. The experimental group (n = 34) contained only those students who

completed the treatment, the CCTST pre-test, and the CCTST post-test. Twenty-one (n = 21) students participated in the control class. Students in the control group and in the experimental group prior to receiving training in critical thinking skills achieved a percentile score of 36 in the CCTST, as compared to all other graduating seniors across the country who had taken this test. Students in the experimental group who completed the course in critical thinking, achieved percentile scores of 51, compared with other graduating seniors assessed with the same test of critical thinking skills. These results are shown in Table 2.

CCTST	(Control $(n = 21)$		Experimental $(n = 34)$		
CC1SI	Pre-test	Post-Test	Pre-Test	Post-Test		
Percentile	*	36.2	36.3	50.7		
Total Score	*	14.5	14.6	16.9		
Analysis	*	3.8	4.0	4.4		
Inference	*	6.9	6.8	8.3		
Evaluation	*	3.8	3.6	4.3		
Inductive	*	8.2	8.1	9.4		
Deductive	*	6.3	6.1	7.5		

Table 2	Control v	Experimental	Classes
		-	

These results were analyzed statistically to determine if there were significant differences in the pre-test/post-test scores. The results were also analyzed to determine Cohen's d and the effect size, measured as r^2 . These results are shown in the Table 3.

Parameter	<i>t</i> -Test	Cohen's d	r ²
Total Saara	$T(22) = 2.057$ Significant $\alpha < 0.005$	0.534	22.07%
Total Scole	$1(33) = 3.037$, Significant, $\alpha < 0.003$	Medium	Strong
Porcontilo Sooro	$T(22) = 4.600$ Significant $\alpha < 0.005$	0.789	39.07%
reicentile Score	$1(33) = 4.000$, Significant, $\alpha < 0.003$	Large	V. Strong
Analysis T(33) = 1.521, Not Significant	T(22) = 1.521 Not Significant	0.260	6.55%
	$\Gamma(55) = 1.521$, Not Significant	Small	Medium
Informa	$T(22) = 2.49$ Significant $\alpha < 0.005$	0.598	25.85%
Interence	$1(33) = 3.46$, Significant, $\alpha < 0.003$	Medium	Strong
Evaluation	$T(33) = 2.400$ Significant $\alpha < 0.01$	0.427	15.82%
Evaluation	$1(33) = 2.490$, Significant, $\alpha < 0.01$	Medium	Medium
Inductive	$T(33) = 3.730$ Significant $\alpha < 0.005$	0.640	29.66%
Inductive	$1(55) = 5.750$, Significant, $\alpha < 0.005$	Medium	Strong
Deductive	$T(33) = 2.860$ Significant $\alpha < 0.005$	0.491	19.87%
Deductive	$1(33) = 2.000$, Significant, $\alpha < 0.003$	Medium	Strong

Table 5 Summary of CC151 TTe-Test/10st-Test Statist	able 5 Summa	of CC151 Fre-rest/Post-rest Statistic
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We also analyzed the results of the 10-question, pre-test/post-test quizzes. As part of this analysis, we calculated Cohen's d and r^2 . These results are shown in Table 4.

We concluded in this initial study that critical thinking was taught, was learned, and the skills acquired in the classroom were transferred from the domain of the classroom into the domains of the CCTST and of the business case studies (Anderson & Reid, December 2011, June 2011, October 2011, 2013a, 2013b, 2013c; Reid & Anderson, March 2011, 2012a, 2012b). This treatment was so successful that the educator continued to teach it for four more years. We now report the results of a summative study of the students who took this course and have since graduated.

The purpose of the research reported in this study was three-fold. First, we wanted to determine quantitatively

the extent the knowledge, skills, and strategies taught in the treatment were transferred into the personal, academic, and professional lives of the graduates. Second, we wanted to determine the effects of the treatment on the satisfaction of the graduates. Finally, we wanted to determine the feelings and sensibilities of graduates reflecting on the critical thinking treatment and its effects upon them.

Module	<i>t</i> -Test	Cohen's d	r ²
1 Introduction	$T(28) = 2.72$ Significant $\alpha < 0.005$	0.435	16.25%
	$\Gamma(38) = 2.72$, Significant, $\alpha < 0.003$	Medium	Strong
2 Momente & Knowledge	$T(20) = 1.807$ Significant $\alpha < 0.05$	0.324	9.81%
2 – Memory & Knowledge	$1(50) = 1.807$, Significant, $\alpha < 0.05$	Small	Medium
3 Thought & Language	T(38) = 2.673 Significant $a < 0.005$	0.428	15.82%
5 – Thought & Language	$1(38) = 2.075$, Significant, $\alpha < 0.005$	Medium	Strong
1 - Deductive Ressoning	$T(36) = 5.03$ Significant $\alpha < 0.005$	0.827	41.30%
4 – Deductive Reasoning	$1(30) = 5.05$, Significant, $\alpha < 0.005$	Large	V. Strong
5 – Analyzing Arguments	$T(37) = 3.224$ Significant $\alpha < 0.005$	0.523	21.93%
5 Anaryzing Arguments	1(57) = 5.224, Significant, $u < 0.005$	Medium	Strong
6 – Thinking as Hypothesis Testing	$T(36) = 3.526$ Significant $\alpha < 0.005$	0.580	25.67%
o Thinking as Hypothesis Testing	1(50) 5.520, Significant, u < 0.005	Medium	Strong
7 – Likelihood and Uncertainty	$T(32) = 3.736$ Significant $\alpha < 0.005$	0.650	30.37%
/ Encennood and encertainty	1(52) 5.750, 51gminouni, a < 0.005	Medium	Strong
8 – Problem Solving	$T(30) = 4.403$ Significant $\alpha < 0.005$	0.790	39.25%
o Troblem Solving	1(50) 1.105, 51gmineant, a < 0.005	Large	V. Strong
9 – Decision Making	$T(27) = 1.996$ Significant $\alpha < 0.05$	0.377	12.86%
> Deelsion Making	1(27) 1.990, Significant, a < 0.05	Medium	Medium
Overall Score	$T(312) = 9.360$ Significant $\alpha < 0.005$	0.535	22.28%
	1(512) 9.500, Significant, a < 0.005	Medium	Strong

Table 4	Summary of	Chapter Pr	e-Test/Post-Tes	t Quiz Statistics
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2. Transfer of Knowledge: Literature Review

For a course of study to be effective, the skills, techniques, and philosophy must be transferred from the classroom and into the lives of the graduates. The problems of transfer have vexed educators and scholars. Gelder opines:

One of the biggest challenges in learning new skills, particularly general skills such as critical thinking, is the problem of transfer. In a nutshell, the problem is that an insight or skill picked up in one situation is not, or cannot be, applied in another situation. A transfer of acquired knowledge and skills certainly does occur to some extent; otherwise, education would be an exceedingly laborious business. The problem is that it happens much less than one might naively expect. (2005, p. 3)

As all teachers have known since the beginning of instruction, if the lessons learned are not applied by the student, then the instruction did not pass the test of utility in the real world (Sophocles, 450 BCE). Halpern and Hakel assert the goal of education is transfer of knowledge from the classroom into the real world.

The purpose of formal education is transfer. We teach students how to write, use mathematics, and think because we believe that they will use these skills when they are not in school. We need to always remember that we are teaching toward sometime in the future when we will not be present—and preparing students for unpredictable real world "test" that we will not be giving-instead of preparing them for traditional midterm and final exams. (2003, p. 38)

The failure to transfer the knowledge, skills, and strategies from the classroom into the real world is expressed most eloquently by Halpern. "If we fail to address the fact that too many students leave our classrooms unable to transfer principles and understanding to new domains of knowledge, we will create a work force for tomorrow that is superbly prepared only for yesterday's problems" (1997b, p. 26). To determine whether a course of study was effective, the graduates must be surveyed to determine the extent, type, and conditions under which they use the instruction they received, and in which aspects of their lives they employ it.

However, it is widely recognized that self-assessments are characteristically flawed. Kruger, and Dunning, and other authors have demonstrated that those in the lowest quintile on a variety of tests of skills, knowledge and capabilities consistently estimate their abilities and their scores to be in the fourth quintile (Dunning, Heath, & Suls, 2004; Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008; Kruger & Dunning, 1999, 2002). Those who score in the fifth quintile consistently rate their performance in the fourth quintile. However, once they know they are overestimating the capabilities of others and underestimating their own, top performers can determine their absolute scores with reasonable accuracy.

Other research has shown that training in critical thinking, of which metacognition is a part, improves the capacities of persons responding to surveys such as ours. In 1999, Kruger and Dunning trained underachieving students to evaluate their own performance, increasing their personal metacognition. These students improved their ability to differentiate their correct answers from their incorrect answers, concurrently improving their performance (Kruger & Dunning, 1999). Subsequently, they demonstrated similar performance improvements using different tests and controls (Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008). Finally, Helsdingen, Bosch, Gog, and Merriënboer reported that soldiers trained in critical thinking demonstrated improved command and control decision-making, employing these skills in a variety of situations. They concluded that participants demonstrated deeper understanding of problems enabling them to solve new problems different from those in the training courses (2010).

Those authors related these miscalculations in both relative and absolute scores to the individual's metacognition of their actual abilities. By improving the participants' skills and their metacognitive awareness, the students recognized their limitations and improved their ability to estimate their relative and absolute scores. Since one of the outcomes of the critical thinking pedagogical treatment for students is improved metacognition, then we would like to believe that the self-evaluations reported by the graduates were close approximations of their actual status. However, since we cannot be sure, we sought confirmation.

Facione (1990b) conducted a Delphi study, in which 46 experts determined the cognitive skills, dispositional dimensions, and assessments that could be used to measure critical thinking. The results generated by this panel led to the development of the California Critical Thinking Skills Test (Facione, Facione, Blohm, & Gittens, 2008; Facione, 1990a), the California Critical Thinking Disposition Inventory (Facione, 1992), the Holistic Critical Thinking Scoring Rubric (Facione, 1994), and the California Measure of Mental Motivation (Giancarlo & Facione, 2000) among others. In that Delphi study, the panelists agreed on four different methods that could be used to assess a person's critical thinking skills.

In theory there are several ways persons can be judged to be more or less proficient in a given CT skill or at the integrated use of related CT skills.... A third way is to query persons and receive their descriptions of the procedures and judgments they are using as they exercise that skill, would use if they were to perform that skill, or did use when they performed that skill (p. 31).

In our survey, we included a qualitative component to each of the specific questions. Further, our survey contained three additional questions requesting the graduates' opinions of the strengths, weaknesses, and potential modifications to the course. One use of these answers is strictly qualitative, i.e., to obtain new insights or explore

alternate avenues. We used the graduates' descriptions of the procedures and judgments they used when answering the survey questions as assessments of their acquisition and use of the knowledge, skills, and strategies taught in the critical thinking treatment, the third of Facione's assessment methods. We have included such descriptions submitted by the graduates to confirm the transfer of critical thinking from the classroom into their personal, academic, and personal lives and to confirm their perceived levels of satisfaction with the pedagogical treatment.

3. Method

Valid contact information was obtained for 71 graduates. These graduates became the population for this study. Of these, twenty-nine responded, a 41% return. These respondents were our sample.

We developed a survey to provide both quantitative and qualitative information concerning the pedagogical treatment. We used two questions used for screening purposes. Eleven of our questions were quantitative, based on a 7-point Likert scale. On this scale, 1 was the worst/least/lowest possible score, 7 the best/most/highest possible score, and 4 was defined as neutral. We used this scale to calculate the effects of transfer from the classroom into the lives of the graduates. This relationship is shown in Figure 2.

1	2	3	4	5	6	7
Worst	Worse	Bad	Neutral	Good	Better	Best
		-	-	-	-	-

Figure 2 Seven-point Likert Scale

We also included qualitative components in these eleven questions, in which respondents were asked to provide their opinions on the subject posed by the question. In addition, three questions were qualitative, asking for the graduate's opinions on the best and worst parts of the critical thinking treatment, as well as any suggestions for changing, improving, or modifying the treatment.

We tabulated the surveys in a spreadsheet, and performed statistical analyses to obtain the median and standard deviation. We calculated Cohen's d to determine the effect size. Since the mean of the survey question was defined by the Likert scale, we performed a Z-test on the responses to determine quantitatively the transfer and use of critical thinking knowledge, skills, and strategies by graduates in their personal, educational, and professional lives.

A panel of three experts from two different colleges studied the graduates' responses independently. The three experts then compared their findings to determine whether they were opinions, reasoned judgments or facts. The opinions provided, although interesting, were not useable as supporting premises for the graduates' responses. The three educators then studied the graduates' reasoned judgments to ascertain the validity of the premises and of the conclusions drawn from them. If they were judged to be valid arguments, they were used to substantiate the graduate's responses to this survey. If they were judged to be invalid, they were also discarded.

As an intrinsic aspect of analyzing the data, we created graphs of the respondent's numerical responses. We observed that these graphs were abnormal, in that they were highly skewed. We initiated further studies of this graphical data, attempting to interpret and to further our understanding of the respondents' reasoning that led to these distortions. Although two statistical measurements used to analyze such data include the mean and standard deviation, these statistics apply to Gaussian distributions and do not necessarily apply to highly skewed data.

Therefore, we developed two additional procedures to analyze these data. We began by reconsidering our Likert scale. We assigned a different yet equivalent set of numerical values to the Likert scale responses, assigning a value of 0 to the Neutral response. We redefined Good as +1, Better as +2, and Best as +3, with Bad, Worse and

Worst as -1, -2, and -3, respectively.

Using this alternate Likert scale, we summed the numbers of the positive responses and of the negative responses. We then calculated the ratio between these two values. This ratio represented the numerical proportion of respondents who expressed satisfaction or dissatisfaction with the results of this training as it applied to their personal, academic or professional life. We refer to this calculated ratio as the Breadth of Satisfaction.

In a similar manner, we multiplied the number of respondents falling into each of the numerical categories by the value of that category to compute a weighted value. We summed the weighted values of the positive and of the negative values. We then calculated the ratio of the weighted positive values to the weighted negative values. This ratio of weighted values corresponded to the intensity of the respondents' satisfaction or dissatisfaction with the results of this training as it applied to their personal, academic or professional life. We referred to this ratio as the Depth of Satisfaction.

We also reconsidered the statistical mean of these numerical responses. By design, the mean for each question was 4. Any mean value greater than 4 would be a positive response, as a value less than 4 would be negative. The difference between the actual mean and the defined mean is a measure of the overall strength of the respondent's responses. We referred to this value as Strength.

However, these three values were difficult to compare or assess. Therefore, we developed an interval scale to produce a consistent set of values that we could sum and average to provide an overall satisfaction score. We used this Graduate Satisfaction Score as a measure of the satisfaction or dissatisfaction with the results of the critical thinking training as it applied to the personal, academic or professional life of the respondents. We then assigned a word to represent each level of respondents' satisfaction.

These relationships are shown in Table 5. For instance, a strength score of 1.4 would be assigned a scale value of 3. A breadth score of 3.5 would achieve a score of 2, while a depth score of 4.9 would rate a score of 3. The average of these scores is 2.7, which is a Graduate Satisfaction (GS) score of 2, designated as Satisfied.

Scale	1	2	3	4	5
Strength	< 1	1-1.25	1.26-1.5	1.60-1.75	≥ 1.75
Breadth	< 2	2-3.9	4-5.9	6-10	≥ 10
Depth	< 2	2-3.9	4-5.9	6-10	≥ 10
GS Score	< 2	2-2.9	3-3.9	4-4.9	≥ 5
GS Term	Moderate	Satisfied	Very	Extremely	Elated

Table 5 Relationship of Scale Value to Strength, Breadth, Depth and Graduate Satisfaction Score

4. Results and Discussion

4.1 Pre-graduation vs. Post-graduation Questions

We asked four questions to explore the opinions of the graduates when they were students as different from their opinions now that they are graduates and working professionals. In the first pair, we explored their overall opinion of the critical thinking treatment itself. In the second pair of questions, we explored their opinions regarding their perceived need to learn to think critically.

4.1.1 Questions 1 and 3: Opinion of the Critical Thinking Treatment

First, we asked the graduates, "At the time you took the unit of instruction in critical thinking, what was your opinion of the critical thinking component in general?" Their mean scores as students were 5.00 with a standard

deviation of 1.49, a statistically significant result (Z = 3.55, p = 0.0005). The effectiveness of the pedagogical treatment was measured by computing Cohen's d, which was found to be 0.67, a medium-strong effect size.

In the third question, we asked, "Since the time you took the unit of instruction in critical thinking, what is your opinion of critical thinking module in general?" The mean scores for this question was 5.46 with a standard deviation of 1.60, which is significant, Z = 4.85, p < 0.00003. The effectiveness of the pedagogical treatment was measured by computing Cohen's d, which was found to be 0.92, a large effect size.

There was a difference in the means of the responses to the pre-course Question 3 and the post-course Question 5. When this difference was subjected to further statistical analysis, we found it was significant (Z = 1.71, p = 0.045). We interpreted the results as revealing that, upon retrospection, the graduates' opinions of the critical thinking treatment had improved significantly in comparison with their opinions of the treatment at the time they were taking this course.



The graphical representations of the respondents' answers are shown in Figure 3.

Figure 3 Opinions of the Critical Thinking Treatment

The distribution of responses to Question 3 is generally Gaussian. The Strength value and the Breadth and Depth ratios are in the range of Satisfied to Very Satisfied responses. The Graduate Satisfaction of 2.67 is in the Satisfied range.

In contrast, the distribution of responses to Question 5 is skewed in the positive direction. The Strength value and the Breadth and Depth ratios are in the range of Very Satisfied to Extremely Satisfied. The Graduate Satisfaction of 3.67 is in the Very Satisfied range. The Graduate Satisfaction score in Question 5 is 1 point higher than that in Question 3. Since we have already demonstrated that the Z-values of Question 1 and 3 are statistically different, we can conclude that the Graduate Satisfaction scores are also significantly different.

4.1.2 Questions 2 and 4: Opinion of Their Need to Learn to Think Critically

In the second question, we asked the graduates, "At the time you took the unit of instruction in critical thinking, what was your opinion of your need to learn critical thinking skills and techniques?" The mean score for this question was 4.75 with a standard deviation of 1.69. This result was statistically significant, Z = 2.35, p = 0.019.

Cohen's d was 0.44, a medium effect size.

In the fourth question, we asked, "Since the time you took the unit of instruction in critical thinking, what is your opinion of your need to learn critical thinking skills and techniques?" The mean score for this question was 5.68 with a standard deviation of 1.52. This result was statistically significant, Z = 5.86, p < 0.00003. Cohen's d was 1.11, an extremely large effect size.

Again, we subjected the means of questions 2 and 4 to further statistical analyses. We found that the means were significantly different (Z = 3.24, p = 0.005). Therefore, we concluded with confidence, that upon reflection, the graduates were significantly more cognizant of their need to learn to think critically than they were as ignorant undergraduates confident of their own capabilities while not looking forward to the prospects of additional work in a class.



The graphical representations of the respondents' answers are shown in Figure 4.

Figure 4 Opinions of the Need to Learn Critical Thinking

The distribution of responses to Question 2 is skewed along the positive axis. The Strength value and the Breadth and Depth ratios are in the range of Moderate to Very Satisfied responses. The Graduate Satisfaction of 2.33 is in the Satisfied range.

In contrast, the distribution of responses to Question 4 is highly skewed in the positive direction. The Strength value and the Breadth and Depth ratios are in the range of Extremely Satisfied to Elated. The Graduate Satisfaction of 4.67 is in the Extremely Satisfied range. The Graduate Satisfaction score in Question 4 is 1-1/3 points higher than that in Question 2. Since we have already demonstrated that the Z-values of Question 2 and 4 are statistically different, we can conclude that the Graduate Satisfaction scores are also significantly different.

4.1.3 Qualitative Confirmation of Pre-Post Graduation Responses

We evaluated the responses of the graduates to confirm their use of critical thinking processes and procedures.

(1) One graduate used four premises to support their logical argument: "Everyone needs to learn critical thinking skills. Our younger generations have no clue of how to think for themselves. They don't know how to communicate. How you respond when you are face to face with someone is critical. I'm currently going into

Nursing; this field requires a person to use critical thinking."

(2) A second graduate used three premises to support their argument: "I really needed to change the way I thought about life in general. This course helped change my life. I returned to school, finished my degree, and now currently working in the medical field that I tried to go into 20 years ago. My critical thinking skills have helped develop me into a wiser person."

(3) A third also used deductive reasoning to conclude, "The critical thinking course required much effort on my part. But, as I progress through the material, I realized how useful it was, and would make me a smarter decision maker."

(4) The fourth provided a logical argument to disprove his/her previously held conviction: "Before I took (the) critical thinking course, I was a firm believer that common sense was something that just could not be taught. After taking the course, I am a firm believer that it can be taught by using good old fashion logic and critical thinking."

(5) A fifth graduate used personal anecdotes to formulate premises supporting the conclusion of his argument. "Everyone needs to learn critical thinking skills. Our younger generations have no clue of how to think for themselves. They don't know how to communicate on almost every level except texting and FacebookTM. That's not real communication. How you respond when you are face to face with someone is critical.

(6) A sixth graduate used two premises to support the conclusion of his argument. "... being able to use critical thinking and apply it to life situations helps me with my personal life as well as my professional life. It's more like using logical judgment."

(7) A seventh graduate postulated the reasoned judgment, "The course added an in-depth look at some areas and made some ideas more logical as you identify the problem and solutions."

In our expert opinion, these arguments, analogies, or statements are representative of or congruent with the knowledge, skills, or strategies the graduates learned in the critical thinking treatment.

4.2 Academic/Education Question

4.2.1 Question 5: Graduates' Use of Critical Thinking in Other Courses

In this question, we asked the graduates, "Since the time you took the unit of instruction in critical thinking, have you used critical thinking skills and techniques in other classes or courses of study?" The mean score for this question was 5.30 with a standard deviation of 1.48, which is significant, Z = 3.94, p = .00003. Cohen's d was .88, a large effect size. We deduced that the critical thinking treatment was extremely beneficial, otherwise the students would not be using it in other classes. We concluded, with an extremely high degree of confidence, that the students had used critical thinking in subsequent classes and that transfer had occurred.

4.2.2 Qualitative Confirmation of Educational Question Responses

Again, we confirmed the graduates' critical thinking with their own words.

(1) One used the following logical argument: "I utilized this instruction through my two years at (university) and graduated Summa Cum Laude, with a 4.0 GPA."

(2) A second used deductive reasoning to support a logical argument: "I wish I could say every class required it, but one class that helped was Economics."

(3) A third provided similar reasoning to support this logical argument: "One class that used some more thought to solve problems is Statistics."

(4) A fourth logically argued, "... any student can benefit from the critical thinking techniques found in this course. I recommend the instruction of critical thinking to all students wishing to become better decision makers."

In our expert opinion, these arguments, analogies, or statements are representative of or congruent with the





The graphical representations of the respondents' answers are shown in Figure 5.

Figure 5 Use of Critical Thinking in Academic Pursuits

The distribution of responses to Question 5 is skewed along the positive axis. The Strength value and the Breadth and Depth ratios are in the range of Satisfied to Extremely Satisfied responses. The Graduate Satisfaction of 3.0 is in the Very Satisfied range.

These responses are unusual in that the Depth ratio is twice that of the Breadth ratio. In most questions, the Depth and Breadth ratios are similar. As can be observed in the graphical representation, the intensity of the positive responses is very high. That is many respondents were in the +2 to +3 ranges. At the same time, the negative responses were only in the -1 range. That is, those who responded in the positive were very enthusiastic, while those who responded negatively were only moderately displeased.

4.3 Profession/Career Question

4.3.1 Question 6: Graduates' Use of Critical Thinking in Their Career or Profession

We asked the important question, "Since the time you took the unit of instruction in critical thinking, have you used critical thinking skills and techniques at work?" The mean score for this question was 5.21 with a standard

deviation of 1.55, which is significant, Z = 4.15, p < 0.00003. Cohen's d, was 0.78, a large effect size. We deduced that the critical thinking treatment was extremely beneficial, otherwise the graduates would not be using it in their work. We concluded with an extremely high degree of confidence that the graduates transferred the critical thinking knowledge, skills, and strategies from the pedagogical treatment into their professions or careers.

4.3.2 Qualitative Confirmation of Profession/Career Question Responses

We confirmed that graduates were using critical thinking from their own words.

(1) One used three premises to support their conclusion: "To my surprise forecasting and inventory control and things of that nature requires a lot of critical thinking skills."

(2) A second used multiple premises to conclude, "It helps deciding many factors such as staffing needs, budgets, purchasing, and many more aspects of my job."

(3) A third used problem-solving skills to conclude, "Yes (I use CT at work), I sometimes have to do projections in our Fixed Asset System, and the software lets me do a trial and error approach to different 'what if' scenarios."

(4) A fourth used disconfirming evidence to logically argue, "The best part of the critical thinking was being able to go through a process to solve problems that required more thought than just assuming the right answer."

In our expert opinion, these arguments, analogies, or statements are representative of or congruent with the knowledge, skills, or strategies the graduates learned in the critical thinking treatment.



The graphical representations of the respondents' answers are shown in Figure 6.

Figure 6 Use of Critical Thinking in Professional Activities

The distribution of responses to Question 5 is skewed along the positive axis. The Strength value is Satisfied and the Breadth and Depth ratios are in the range of Extremely Satisfied responses. The Graduate Satisfaction of 3.33 is in the Very Satisfied range.

4.4 Personal Questions

In the next five questions, we asked how the critical thinking treatment had affected the graduates at a personal level. Three of the questions involved the graduate's interactions with others; two required their introspection to determine reasons for changes they observed in their interpersonal activities.

4.4.1 Personal 1: Daily Life

When we asked graduates, "Since the time you took the unit of instruction in critical thinking at the University, have you used critical thinking skills and techniques in your daily life?" their responses were overwhelming in the affirmative. The mean score for this question was 5.75 with a standard deviation of 1.11, which was statistically significant, Z = 8.35, p << 0.00001. Cohen's d was 1.58, an extraordinarily large effect size. This extraordinarily positive result indicates that the graduates were transferring the knowledge, skills, and strategies acquired in the classroom into their daily lives. Further, the fact that they are using these skills is an extremely positive indicator of the need for such training. If these skills were not needed, the graduates would not be using them.

The graphical representations of the respondents' answers are shown in Figure 7.



Figure 7 Use of Critical Thinking in Daily Life

The distribution of responses to Question 7 is the most skewed of all the graphs in this study. The Strength value and the Breadth and Depth ratios are in the range of Elated responses, the highest possible scores in this analysis. The Graduate Satisfaction of 5 is in the Elated range and is the highest in this survey.

Again, these responses are unusual in that the Depth ratio is twice that of the Breadth ratio. In most questions, the Depth and Breadth ratios are similar. As can be observed in the graphical representation, the intensity of the positive responses is very high. That is many respondents were in the +2 to +3 ranges. At the same time, the negative response was in the -1 range. That is, those who responded in the positive were very enthusiastic, while the one who responded negatively were only moderately displeased.

4.4.2 Personal 2: Interactions with Others

In the next question, we asked, "Has the unit of instruction in critical thinking you took while at the University affected the way you interact with others?" Again, the responses were enthusiastic, with the mean score of 5.29 with a standard deviation of 1.56. This result was statistically significant, Z = 4.36, p < .00003. Cohen's d was .82, a large effect size. We concluded with a high degree of confidence that the critical thinking knowledge, skills, and strategies very positively affected the graduates' inter-personal relationships.

The graphical representations of the respondents' answers are shown in Figure 8.



Figure 8 Critical Thinking Affects on Personal Interactions

The distribution of responses to Question 7 is skewed along the positive axis. The Strength value and the Breadth and Depth ratios are in the range of Very Satisfied responses. The Graduate Satisfaction of 3.67 is in the Very Satisfied range.

4.4.3 Personal 3: Perceptions of the World

In the next question, we asked, "Has taking a unit of instruction in critical thinking you took while at the

University affected your perceptions of the world around you?" The mean score for this question was 5.50 with a standard deviation of 1.53, which was statistically significant, Z = 5.20, p < .00003. Cohen's d was .98, a very large effect size. This extremely positive result indicates that the graduates not only were transferring the knowledge, skills, and strategies acquired in the classroom into their daily lives, but also using it in their personal perception of the world around them. This is an extremely positive indicator of the need for such training. Graduates have modified their worldview, using critical thinking skills at the most basic human level.



The graphical representations of the respondents' answers are shown in Figure 9.

Figure 9 Critical Thinking Affects on Perceptions of the World

The distribution of responses to Question 7 is skewed along the positive axis. The Strength value is in the Very Satisfied range, while the Breadth and Depth ratios are in the range of Extremely Satisfied responses. The Graduate Satisfaction of 3.67 is in the Very Satisfied range.

4.4.4 Personal 4: Perceptions of Oneself

In the penultimate question, we asked each of the graduates, "Has taking a unit of instruction in critical thinking you took while at the University affected your perceptions of yourself?" The mean score for this question was 4.89 with a standard deviation of 1.83, which is significant, Z = 2.58, p = .008. Cohen's d was .49, a medium effect size. Although positive, this result was more reserved than the responses of the graduates in the previous three questions.

The graphical representations of the respondents' answers are shown in Figure 10.

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Figure 10 Critical Thinking Affects on Perceptions of the Oneself

The distribution of responses to Question 7 is skewed along the positive axis. The Strength value and the Breadth and Depth ratios are in the range of Moderate to Satisfied responses. The Graduate Satisfaction of 1.67 is in the Moderate range.

4.4.5 Personal 5: Personal Changes

In the final question, we asked the graduates, "Has the unit of instruction in critical thinking you took while at the University changed you in any way?" These results were similar to those of the previous question. The mean score for this question was 4.93 with a standard deviation of 1.68. This result was statistically significant, Z = 2.93, p = 0.002. Cohen's d was 0.55, a medium effect size. Although we concluded that the positive results indicated the graduates were aware of changes in their perspective, at least in part attributing them to their perceptions of self, we were concerned with the differences in the scores of the first three of the personal questions as compared with the last two questions.

The graphical representations of the respondents' answers are shown in Figure 11.

The distribution of responses to Question 7 is skewed along the positive axis. The Strength value and the Breadth and Depth ratios are in the range of Moderate to Very Satisfied responses. The Graduate Satisfaction of 2.00 is in the Satisfied range.

We tested the means of these five questions to determine if they were statistically different. We found that the mean of Personal 1 was significantly different from Personal 4 (Z = 4.09, p < 0.00003) and significantly different from Personal 5 (Z = 3.91, p = .00005). Similarly, Personal 3 was significantly different from Personal 4 (Z = 2.10, p = 0.017), and also from Personal 5 (Z = 1.98, p = .034).

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Figure 11 Critical Thinking Affects on Perceptions of Personal Change

These results confirmed our observations, but did not help us to determine the reasons for the cognitive dissonance the graduates are reporting. Is it possible that the graduates are very satisfied with their external interactions, including their daily lives, perceptions and interactions, while less satisfied with the changes in themselves? Do they view their own changes as a necessary price to be paid for changes in other aspects of their lives? Is this just an expression of modesty, false modesty, or reticence to admit to being pleased with the changes they have experienced? Perhaps the changes that the graduates have experienced have been sufficiently slow and gradual, that they did not realize that they had changed or that their perceptions had changed. As such, intimations that they have been changed by the critical thinking treatment may not be as satisfying as their changes in external relations. They might even be ashamed, viewing their changes as a necessary price to be paid for changes in other aspects of their lives. Regardless, this is an interesting phenomenon, which deserves to be studied.

4.4.6 Qualitative Confirmation of Personal Question Responses

Again, we confirmed the graduates' understanding and use of critical thinking, based on their statements.

(1) One used a creative solution: "It helps me look outside the box for other answers/solutions to decisions I need to make."

(2) A second used inductive and deductive reasoning, as follows: "I see the world differently. Instead of going for the surface, I tend to go deeper and look to the core."

(3) A third used the combination of language skills and argument to make decisions: "It usually only takes me a moment to recognize when someone lacks the ability to respond with a logical reply."

(4) A fourth was most perceptive, arguing, "I am not saying that I am not naïve anymore, but I know I am a lot

less naïve now."

(5) A fifth reflected on the use of creative skills to develop new perspectives: "I try to analyze a situation from a different point of view when necessary."

(6) The sixth created a deduction comparing before and after states: "I have always been known as a person who thinks a lot what to do before I do things, but after I took this course it had help me a lot. I not only think before I do things, but now I think everything in a different perspective."

(7) The seventh graduate used deductive reasoning as well as pseudo-arguments, as follows: "The best part of the critical thinking treatment was breaking apart ideas that were held to be 'truth' and finding out there are holes in that belief and possibly no validity to them."

In our expert opinion, these arguments, analogies, or statements are representative of or congruent with the knowledge, skills, or strategies the graduates learned in the critical thinking treatment.

4.5 Aggregate of Responses

Finally, the values of all the responses for all the questions were aggregated, and analyzed in the same manner were the responses from individual questions. The mean score for the aggregate sum of all the questions was 5.22 with a standard deviation of 1.57. This result was statistically significant, Z = 12.05, p << .00001. Cohen's d was .77, a large effect size. We concluded that the aggregated total of all the responses from all of the graduates demonstrated transfer of the critical thinking knowledge, skills, and strategies from the pedagogical treatment into every aspect of their lives.

The results of this quantitative survey are shown in Table 6, Statistics for Quantitative Questions.

	Mean	S.D.	Z-Score	Cohen's d
Q1	4.93	1.47	Z = 3.28 Significant, p = 0.0005	0.63 Medium
Q2	4.67	1.66	Z = 2.08 Significant, p = 0.019	0.40 Medium
Q3	5.41	1.52	Z = 4.57 Significant, p < 0.00003	0.88 Large
Q4	5.63	1.52	Z = 5.56 Significant, p < 0.00003	1.07 Huge
Education	5.32	1.52	Z = 3.78 Significant, p = 0.00007	0.87 Large
Work	5.26	1.56	Z = 4.20 Significant, p < 0.00003	0.81 Large
Personal 1	5.78	1.12	Z = 8.24 Significant, p << 0.00001	1.59 Huge
Personal 2	5.26	1.58	Z = 4.13 Significant, p < 0.00003	0.80 Large
Personal 3	5.48	1.55	Z = 4.96 Significant, p < 0.00003	0.95 Large
Personal 4	4.85	1.85	Z = 2.38 Significant, p = 0.008	0.46 Medium
Personal 5	4.93	1.71	Z = 2.82 Significant, p = 0.002	0.54 Medium
Aggregate	5.18	1.59	Z = 12.81 Significant, p << 0.00001	0.74 Large

Table 6 Statistics for Quantitative Questions

The graphical representations of the respondents' answers are shown in Figure 12.



Figure 12	Aggregate o	f Responses
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The distribution of responses to Question 7 is skewed along the positive axis. The Strength value is in the range of Satisfied, the Breadth Ratio is in the Very Satisfied range, and Depth ratio is in the range of Extremely Satisfied responses. The Graduate Satisfaction of 3 is in the Very Satisfied range.

5. Conclusion

5.1 Use of Critical Thinking Skills

Our study has shown that the pedagogical treatment was extremely successful in transferring the knowledge, skills, and strategies of critical thinking from the classroom into a variety of environments. Graduates report statistically significant transfers of critical thinking from the classroom and into their personal lives, their jobs, and their education. The graduates described their use of critical thinking in their personal, academic, and professional lives. These descriptions and reasoning were congruent with the critical thinking model taught in the pedagogical treatment. Their descriptions of the knowledge, skills, and strategies they were using in their personal, academic, and professional lives confirmed that they were using what they had learned, thereby acting as an appropriate assessment of their abilities and capabilities.

5.1.1 Argument 1

It might be argued that the qualitative responses simply reflect the quantitative results, in that the respondents could be aware of the desired responses the survey was seeking. However, there was no evidence of bias inherent in

the results, while there is ample evidence that the graduates were well considered in their responses. First, the graduates clearly differentiated between their opinions of the critical thinking treatment before they had taken it and now, several years later. The difference between the means of the pairs of pre-post graduation was statistically significantly for both pairs of questions. This is evidence that the graduates took the time and effort to consider their states of mind, and they responded accordingly.

5.1.2 Argument 2

This line of reasoning is further supported by the observations of the graduates. It must be remembered that these graduates had taken this course one to four years prior to this survey. If the knowledge, skills, or techniques taught in a course of study are not used by the student, then they are quickly forgotten. Yet, here we have practicing professionals, often several years removed from school, asserting that they are using critical thinking, and supporting their responses with words, phrases and examples that are almost out of a textbook.

5.1.3 Argument 3

Further, we see a statistically significant differentiation between the graduates' responses regarding their interactions with others in Personal Questions 1 through 3 and their perceptions of themselves in Questions 4 & 5. If they were attempting to provide responses that were perceived to be the desired ones, would they not have provided similar, strongly positive responses to questions regarding personal changes as they had towards interpersonal ones? Their qualitative responses are clear and explicit explanations of their use of critical thinking, and the situations in which they use it. The graduates even recognize their limitations or inconsistencies in their use of critical thinking, which is a clear demonstration of their reasoning ...a proof of their critical thinking.

5.2 Graduate Satisfaction

The highly skewed graphical representations of the respondents' responses are atypical, in that they are not Gaussian. Although these highly skewed response curves are insufficient to validate the graduate satisfaction results, the arguments presented to support the validity of the critical thinking responses also support the validity of the graduate satisfaction results. Not only have the graduates reported that the critical thinking treatment was used in their personal, academic and professional lives, but they expressed high degrees of satisfaction with the content of the course and the results of their educational experience.

Although we had hoped to gain insight into the satisfaction of graduates with the critical thinking treatment, we were not expecting such positive or statistically significant findings. We reconsidered these unexpected results, attempting to determine their significance. We delved into the literature to determine how these results could be interpreted.

Aldridge and Rowley (1998) used two different forms of the same survey to collect information on student satisfaction through the use of mailed paper surveys and electronic surveys. Although aspects of the students' service experience were identified, the major finding was that neither method of delivery was sufficient, and that both should continue to be used. Elliot (2001) found that students' satisfaction centered about such concepts as student centeredness, campus climate and instructional effectiveness.

Much work has been reported regarding student satisfaction relative to on-line courses. Picciano, for instance, reported that interaction is important for success in web-based courses (2002). Bollinger reported that student satisfaction with online courses was related to instructor variables, technical issues, and interactivity. Douglas, McClelland and Davies (2008) reported utilizing a critical incidents study to evaluate student satisfaction. They found that responsiveness, communication, and access were important to student satisfaction.

Student satisfaction and learning were investigated for web-based, hybrid and/or traditional delivery methods.

Rivera and Rice (2002) reported a serendipitous experience, in which the same course was being offered in a traditional lecture/discussion format, in a web-enhanced hybrid format, and in an on-line format. They reported that teacher evaluations were highest in the traditional classes, lowest for the web-based, and were intermediate for the hybrid. The exam scores for the traditional classes were the highest, while both the hybrid and the web-based were lower. Similarly, Vamosi, Pierce and Slotkin reported lower student satisfaction with the web-based version of a financial accounting course as well as diminished mastery in comparison with the traditional course (2004).

However, there is a lack of quantitative studies of satisfaction concerning specific courses of study, or of students who had graduated and who were working in the field of study of their baccalaureate degree. Our study is unique, in that results of this research provide such a quantitative evaluation. Our research demonstrates that a course of study that was used extensively by graduates in their personal, academic and professional lives was deemed to be a significant source of satisfaction. Such satisfaction could easily be transferred to the entire curriculum and the educational institution. Such satisfaction could also lead to improved recruitment, retention and graduate giving. If this correlation exists, then it might be concluded that this critical thinking treatment provides an unexpected benefit, not only providing a skill set deemed important by graduates of the program, but also provide an improved level of satisfaction in the quality of the education received.

Earlier in this paper, we quoted that the purpose of education is transfer (Halpern & Hakel, 2003, p. 38). The graduates who responded to this survey have confirmed clearly and unambiguously that they have transferred knowledge, skills, and strategies they learned as undergraduates into their personal, educational, and business lives. Based on this evidence, we conclude that our critical thinking pedagogical treatment is an outstanding success.

6. Future Studies

We recognize the limitations of this study. This report covers four years of students, who have graduated, and who now use their educational, business, and life experiences to guide them. Yet, this is a small number of people, all from one college of one Midwestern university. This treatment may not be applicable to any other college, population, or curriculum. In this regard, we encourage our colleagues in other institutions to continue this research.

When we considered the results of the personal questions, the graduates were very positive in asserting that they had transferred critical thinking into their daily lives, their interactions with others, and their perception of the world. Yet, the graduates demurred from concluding that the critical thinking treatment had changed them as individuals. Statistical analyses confirmed that these differences, but did not help us to determine the reasons for the apparent cognitive dissonance. What is the reason for the cognitive dissonance the graduates are reporting? Since the graduates report significant differences in their daily lives, their perceptions of the world, and their interactions with others, to what do they attribute these differences? To hold that they, as individuals, have not changed is illogical. This is an interesting phenomenon, which deserves to be studied.

Our long-term study is compelling evidence of a successful pedagogical treatment in critical thinking. The results of our studies must be considered by curriculum committees at colleges and universities. Critical thinking can be taught, can be learned, and can be transferred from the classroom into other domains. Critical thinking changes the way graduates perceive the world, perform their jobs, and interact with others. The reasons critical thinking is not taught in colleges and universities are unidentified. However, the continued intransigence of institutions of higher education towards teaching critical thinking and applying it throughout the curriculum is as incomprehensible as it is inexplicable.

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