Improving Metacognition: A Case Study of a Business Critical Thinking Course

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Abstract

Employers expect college graduates to be critical thinkers. However, the impact of college curricula on critical thinking skills is debated. Furthermore, individuals with low critical thinking ability may have difficulty improving it, since they may lack the metacognition skills needed to accurately assess weaknesses in their thought processes. A case study of the effectiveness of a critical thinking course for business majors and instructional techniques designed to help students improve their thinking is reported here. The effect of the course and course design was measured using the quality of case reports, the Business Critical Thinking Skills Test, and students' self-perception of critical thinking skills. Students significantly improved their critical thinking and some were able to more realistically assess their critical thinking ability, demonstrating the potential of the course and its design to improve critical thinking and metacognition skills.

Keywords: Critical thinking; metacognition; reasoning; reflection; self-critique; case studies; Dunning-Kruger effect

Introduction

Critical thinking skills are among the most important soft skills employers seek in college graduates (French & Tracey, 2010; Jones, Leonard, & Lang, 2018; The Wallstreet Journal, 2010). Critical thinking is necessary for an informed citizenry and for dealing with an exponentially increasing volume of information (Halpern, 1998). Accrediting bodies, employers, and business colleges emphasize the importance of the ability to think critically for business majors.

Critical thinking can be learned, but persistence and effort are required to develop higher-order thinking skills, as well as apply them (Halpern, 1998). To be most effective, critical thinking must involve metacognition, the conscious self-reflection and self-critique of one's own thinking (Schoenberg, 2015); therefore, students should consciously critique their own thinking as it is reflected in artifacts such as case analyses, essays, and reports. However, students with low critical thinking skills may have difficulty recognizing mistakes in their own reasoning, while overestimating the quality of their thought processes (Kruger & Dunning, 1999). Criticism is often provided by instructors or peers in the form of discussions and feedback, as well as grades. Yet, it is not uncommon for instructors to express their frustration that students often ignore feedback from others without analyzing it to improve their thought process, and therefore continue to make the same mistakes.

This case study describes an instructional intervention used to supplement the case teaching method by providing instruction in metacognition and having students systematically critique their own thinking. Critical thinking and the importance of critical thinking in business curricula is first discussed, followed by descriptions of the course and its development and evolution. Data collection and data analysis are then discussed, followed by limitations of the study and future research.

Literature Review

Critical Thinking

There are numerous definitions of critical thinking. An American Philosophical Association study developed a consensus definition of critical thinking as '…purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based' (Facione, 1990). In business education research, critical thinking skills have been generally defined as the ability to evaluate sources of information, challenge assumptions, understand context, analyze arguments, and use metacognition (Brown & Bielinska-Kwapisz, 2015).

An important aspect of becoming a critical thinker is becoming a critic of one's thinking by asking such questions as 'What have I learned about how I think?' (Paul & Elder, 2001). Some consider metacognition, the awareness and understanding of one's own thought process (Merriam-Webster, n.d.), to be the most fundamental of critical thinking skills (Ku & Ho, 2010; Schoenberg, 2015). Teaching critical thinking involves helping students understand their thought process and providing opportunities for them to reflect and critique their thinking and be actively involved in improving it (Celuch & Slama, 1999).

Self-Assessment of Critical Thinking

Elder and Paul (1996) identify six stages of critical thinking development, ranging from unreflective thinkers who are unaware that there are standards for

thinking and cannot see problems in their reasoning, to master thinkers who have internalized critical thinking skills so that critical thinking, including self-assessment and improvement, is intuitive. They note that, in the early stages, thinking skills that individuals have unconsciously developed may actually inhibit the development of critical thinking skills, since the individuals may believe their thinking is better than it is (Elder & Paul, 1996).

Similarly, Kruger and Dunning (1999) found that individuals who are unskilled lack metacognition and overestimate their abilities and performance, since the skills needed to be competent in a particular area are often the same as those needed to judge one's competence in that domain - the Dunning-Kruger effect (Pennycook, Ross, Koehler & Fugelsang, 2017). Kruger and Dunning (1999) found that the bottom quartile of performers grossly overestimated their test performance and ability. Novice or unaccomplished individuals in a particular domain have lower metacognition capability in that domain and cannot recognize flaws in their thinking ability until they acquire sufficient knowledge and skills (Kruger & Dunning, 1999). Thus, in general, students with low critical thinking skills would be expected to overestimate their performance and be unable to detect mistakes in their own reasoning. If individuals cannot see mistakes in their thinking, they will not have the motivation to improve their thinking process.

Overconfidence in one's abilities has been seen in both skilled and unskilled individuals, although individuals skilled in a domain generally assess their skill more accurately (Simons, 2013) and may even underestimate their abilities and performance (Kruger & Dunning, 1999). After additional training, both low and high performing individuals have been found to more realistically assess their abilities (Kruger & Dunning, 1999).

Critical Thinking in the Business Curriculum

Much has been written about how to teach problem solving and critical thinking skills in business curricula. Although critical thinking skills have usually been embedded in discipline specific courses, some business colleges include courses specifically created to teach critical thinking skills, similar to the course in this study. Some argue that a standalone critical thinking course may not enable students to transfer skills to their discipline, yet instructors may not know how to incorporate critical thinking skills into their courses in the major (Davis, Thomas & Kazlauskas, 2006). Elder and Paul (2010) maintain that students cannot learn to think critically in a single course or even over a few semesters, although most students can attain basic critical thinking skills when reinforced across the curriculum.

Results about the impact of college instruction in general and specific instruction in critical thinking have been mixed. Arum and Roska (2011) found that students only slightly improve critical thinking skills during college, and that business students, among all the majors assessed, improved the smallest amount during the first two years of college. However, Dwyer et al. (2015) concluded that college education improves general critical thinking and business-related critical thinking. Brown and Bielinska-Kwapisz (2015) administered the California Critical Thinking Skills Test (CCTST) to graduating business majors and concluded that the curriculum as a whole influenced the critical thinking scores. A more recent study shows that business students exhibited improvement in some critical thinking assignments but a decline in others, measured at two different times (Bandyopadhyay & Szostek, 2019). A mini-course, consisting of two sessions of a senior-level business capstone course to teach critical thinking skills, significantly improved students critical thinking skills as measured by the CCTST, indicating that critical thinking could be learned and transferred among domains (Reid & Anderson, 2012). Students in a standalone critical thinking course designed for first year information system majors evaluated the course as improving their thinking skills and being useful for other classes and their careers (Davis, Thomas, Kazlauskas, 2006).

There remains uncertainty about how to assess critical thinking in specific disciplines (Bandyopadhyay & Szostek, 2019). Critical thinking may be best assessed using multiple methods in multiple settings (Halpern, 1998). Instruments include the CCTST and Collegiate Learning Assessment (CLA+, n.d.), as well as the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1964), the Business Critical Thinking Skills Test, and the HEIghten Critical Thinking Assessment (https://www.ets.org). These assessments measure various dimensions of critical thinking, such as deductive and inductive reasoning, and interpretation and inference skills. Other studies have used student self-assessment (Davis, Thomas, & Kazlauskas, 2006) and instructor assessment (Bernstein & Greenhoot, 2014; Pomykalski, 2006; Wang & Wang, 2011).

Critical thinking may be taught through a range of problem-based learning formats including problem solving exercises, simulations, case analyses, and applied and live business projects (Klebba & Hamilton, 2007). Case analysis is considered effective in developing critical thinking since it helps students develop their own frameworks for analysis and decision making through active engagement in problem-solving (Klebba & Hamilton, 2007). Case analysis was selected as the primary learning activity in the critical thinking for business course described in the next section.

Development of the Critical Thinking Course

This section explains how the critical thinking course in this study was developed and has evolved.

Cycle 1: Development of Critical Thinking Course for Business Majors

A critical thinking course for business majors was developed to respond to assessment results at a business college at a university in Southwest Florida. The college assessed critical thinking skills of graduating seniors using a written assignment. The results consistently showed poor performance. The university-wide assessment program also evaluated critical thinking and writing skills of graduating seniors in various majors. Business majors performed worse than other majors in these assessments. The business college faculty formed a subcommittee in 2017 to develop a critical thinking for business course.

The course targeted sophomore business students since skill acquisition, especially critical thinking skills, requires hard work and takes time (Paul & Elder, 2001) and the course was intended to prepare students for upper division courses in their major. Therefore, it is important to present the concept of critical thinking early in the undergraduate curriculum to allow sufficient time to develop the skills. The course was first offered as an elective in Spring 2018 and was available as a choice in the business core starting in Fall 2018.

The course is based on published theoretical foundations of teaching critical thinking, as well as accreditation guidelines and empirical studies. Halpern (1997) published *Critical Thinking Across the Curriculum,* establishing a theoretical foundation to teach critical thinking (Reid and Anderson, 2012). The Foundation for Critical Thinking has developed a framework to teach critical thinking at the college level (Scriven & Paul, 1987). Critical thinking involves effective communication and problem-solving skills, as well as the ability to identify one's biases and limitations (Elder & Paul, 2010). Not only does writing help students learn to think critically (Elder & Paul, 2006), but one must communicate well in order to present an analysis or argument (Davis, Thomas, & Kazlaukas, 2006). Accrediting body AACSB-International states that students should be able to demonstrate 'higher-order cognitive skills to analyze an unstructured problem, formulate and develop a solution using appropriate technology, and effectively communicate the results to stakeholders' (AACSB, 2018, p. 35). Success at critical

thinking and writing are intertwined (Bailey, Zanchetta, Velasco, & Pon, 2015). Thus, the course addresses both critical thinking and effective writing.

The course's learning outcomes can be summarized as follows, emphasizing the several aspects of critical thinking:

1. Thoroughly understanding a given business scenario and context.
2. Defining the main problem by identifying patterns and evidence.
3. Identifying and ensuring reasonable validity of assumptions.
4. Identifying and presenting relevant evidence from credible sources.
5. Interpreting and logically synthesizing qualitative and quantitative information.
6. Presenting likely outcomes of recommended actions by logically relating the problem and the evidence while considering uncertainty in the current and future situations.

Readings were selected to expose students to the fundamental concepts of critical thinking, especially the staged development of critical thinking skills, the role of assumptions, Socratic questions, credible evidence, metacognition, and deductive and inductive reasoning, as well as how to prepare for the business case method.

Cases were selected to develop students' critical thinking skills and address both qualitative issues (e.g. industry, target customer or competitor analysis) and quantitative analyses such as cash flow or breakeven point analysis. Students were also asked to synthesize information and recommend actions. Throughout the course, cases became progressively more complex. For each case, the course required students to write a report that includes the introduction, background to summarize, problem and goals, key factors and supporting evidence, recommended actions, and conclusion sections, as well as credible references and details of any quantitative analyses. Students were expected to demonstrate their understanding of the business scenario and context, the problem and its significance, relevant evidence and facts, assumptions, recommended actions and their impact. The instructor provided feedback for each student's writing and critical thinking on report drafts. To provide individual feedback to each student, each section of the course was capped at 25. Students received instructor feedback on most of the drafts before resubmitting them for a final grade. However, two of the reports were the midterm and final exams – no drafts were submitted and no feedback given.

The effectiveness of the course was initially evaluated in Fall 2018 by comparing performance on the midterm and final case reports, as an indicator of improved critical thinking ability. Students performed significantly better on the final case than on the midterm, suggesting the course was effective in improving students' critical thinking skills (Nakatani & Wynekoop, 2019).

Addressing Course Shortcomings

During the first three semesters the course was taught (Spring 2018, Fall 2018 and Spring 2019), faculty identified several issues. First, many students did not read or respond to the feedback they received from the instructor and showed no improvement on the final version of the report, although instructors spent significant effort providing extensive feedback on both. The adjunct professors who taught the course continuously reported to the course coordinator that many students continued to make the same mistakes and showed little or no improvement on subsequent reports.

In addition to the feedback from instructors, students reviewed drafts written by their peers and provided feedback. However, many students did not provide constructive feedback to their peers or provided feedback on only spelling and grammatical errors, and not on reasoning or critical thinking.

Students were asked to use feedback from the instructors and peers to improve their own thinking and writing skills. The process of learning in this "draft=> external feedback=> revision" cycle is presented in Figure 1. When feedback was very specific, students simply revised their draft as specified without using it as an input to critique their current way of thinking. When feedback was not specific enough, students often did not respond to the feedback because they did not know how. Individual reflection on, and critique of, one's own work was missing in this cycle.

Facione (1990) and Halpern (1998) emphasized the importance of self-consciously monitoring one's own cognitive activities to develop critical thinking skills. Metacognition, a core component of critical thinking, has two components: knowledge about oneself as a thinker, characteristics of a given task, and available strategies to complete the given tasks and regulation, the ability to plan how to approach a task and to monitor and evaluate progress and performance (Brown 1987; Flavell 1979; Ku & Ho, 2010). Ku and Ho (2010) concluded that both knowledge and regulation must be improved to be an effective critical thinker because they complement each other. Although instructor feedback is important for learning, active engagement in evaluating one's progress and performance in the thinking process used to create a product, and in identifying specific actions required to improve the quality of the artifact is key. Such active engagement was missing from this course as originally designed.

Figure 1:
'Draft-External Feedback-Revision' Learning, Cycle 1

Draft of Case Report	Instructor & Peer Feedback	Revision of Case Report
Initial Learning of Critical Thinking	Artifacts Reviewed by Instructor & Peers	Passively Enhance "Thinking" & "Writing" by Responding to Instructor's & Peer's Feedback

An additional factor preventing students from using instructor feedback to improve their thinking may have been that they were at an early stage of critical thinking and thus unable to recognize that their critical thinking skills need to be improved (Elder & Paul, 1996; Kruger & Dunning, 1999). Individuals in an early developmental stage, unreflective thinkers, lack the ability to explicitly assess their thinking and therefore cannot improve it. Elder and Paul (1996) suggest that those who become aware of problems in their thinking can move to later stages and improve critical thinking skills. Therefore, a necessary goal of a dedicated critical thinking course, such as the one in this study, would be that students can recognize problems in their own thinking and be motivated to improve their thinking. This led to a modification of the course.

Cycle 2: Revision of Critical Thinking Course for Business Majors

During the 2019-2020 academic year, several changes were made in the course to address the problem of students not benefitting from instructor and peer feedback. To increase their knowledge of critical thinking and to help students identify weaknesses in their reasoning, new short quizzes, followed by in-class discussions of the quizzes, were added to the course. Examples of the added quizzes include:

- Identifying the differences between business reports and school essays.
- Identifying the role of headings, subheading, bullet and numbered lists and other important writing guidelines.
- Recognizing differences between speculation and fact.
- Recognizing the difference between well-written business report examples, which are logically consistent throughout the report, and poorly-written business report examples, which contain logical inconsistencies.
- Identifying differences among problems, goals, evidences and recommended actions.
- Completing exercises to practice inductive reasoning.
- Completing exercises to practice deductive reasoning.

Fundamental reasoning and writing concepts and skills were taught during the first three weeks. Since instruction in both rules and examples has been shown to be effective in deductive reasoning training (Cheng, Holyoak, Nisbett, & Oliver, 1986), both rules and examples were provided to students.

After students wrote the draft case analysis, instead of receiving feedback from the instructor on the draft, students answered a set of reflection questions. These questions mirrored how the course instructor would critically read and evaluate a student's draft based on an instructional model called 'cognitive apprenticing' (Collins, Brown & Newman, 1989). Transforming the model of traditional apprenticeship to cognitive apprenticeship requires identification of the processes of the task and making them visible to learners (Collins, Brown & Holum, 1991). Cognitive apprenticing was leveraged in this course through additional training, discussions, and reflection questions demonstrating how a reflective person would read or write a report.

The reflection questions focused on critiquing an artifact produced as the result of critical thinking. Examples of the questions used are:

- Does the title of your report clearly show which company this report is written for and also the problem or opportunity this report addresses?
- Is the Introduction section of your report logically coherent or does it contain information that should be in the Background or another section of the report?
- Does the background section of your report clearly describe a few important events that have led the company to the problem or opportunity they are currently facing (which will be described in the first sentence of the next section)?
- Does the first sentence of the Problem (Opportunity) And Goals section (1) clearly describe a problem or an opportunity the report addresses, (2) is consistent with the report title, and (3) is a logical result from a series of events described in the background section?
- Are all facts and evidence included relevant to the descriptive heading of the sub-sections of the Evidence section?
- Are all sources of facts or evidence you used credible enough?
- Is each fact or evidence written as a fact with its source, not as a speculation?
- Are all recommended actions clearly actionable and do they address specified goals, NOT as goals themselves that cannot be carried out?
- Based on your draft, summarize the logical connection of your problem (opportunity) and recommended actions as shown below:
  "I recommend (your 1st recommended action) to solve the problem of (your problem description in the report title)."
  Does the above statement make sense to you?
- Based on your draft, summarize the logical connection of your evidence and your 1st recommended action as shown below:

> *"I recommend (your 1st recommended action) because (one relevant fact you listed before, another relevant fact you listed before, the third relevant fact you listed before)."*
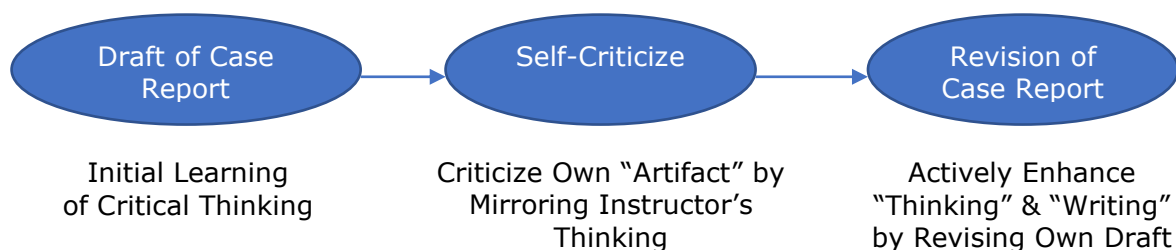
Does the above statement make sense to you?

- Does your report clearly describe important assumptions you made for the recommended actions?

These questions mirror questions the instructor might ask a student in a face-to-face conversation regarding his/her draft. By answering these questions, students can learn how a higher-order thinker reads and evaluates reports. More importantly, every student can have an opportunity to critique their own thinking at their own pace without worrying about shyness or embarrassment, compared to in-class discussions where a few students can dominate the discussion or students do not feel comfortable publicly expressing their thoughts.

These learning activities were implemented in Fall 2019 and Spring 2020. In Fall 2019, they were used in addition to instructor feedback on drafts. In Spring 2020, the instructor provided no feedback on the draft, but only on the final version of a report. Student responses to the reflection questions were recorded and the instructor reviewed them to identify those students who did not put effort into the review process or who did not identify problems in their thinking. The instructor used this information in discussions as examples.

Students' reports were in five sections: Introduction; Background; Problem (or Opportunity) and Goals; Key Factors and Supporting Evidence; and Recommended Actions and Conclusion. Students responded to the reflection questions appropriate for one or two sections in several class sessions. For example, in one class session students answered the reflection questions about the Introduction and Background sections, followed by reflection quiz, the instructor showing alternate ways to write each of the sections by sharing examples from the class and discussing their strengths and weaknesses. Students then shared their reflection question responses and explained why they thought their section was well-written or poorly-written and how it could be improved. The instructor asked other students to support or counter the claim as an in-class discussion to learn the fallacies in their own reasoning. Finally, students were asked to revise their draft. This process was repeated to cover each of the remaining report sections in separate class sessions. Active self-critique of the report and learning improved ways to write them, addresses the aspects of critical thinking emphasized in this course, as shown in Figure 2.

Figure 2:
'Draft-Self-Criticize-Revision' Learning, Cycle 2

Draft of Case Report → Self-Criticize → Revision of Case Report

Initial Learning of Critical Thinking | Criticize Own "Artifact" by Mirroring Instructor's Thinking | Actively Enhance "Thinking" & "Writing" by Revising Own Draft

Research Method

This longitudinal case study describes the first two cycles of the development of a course to investigate the complex nature of improving critical thinking within a single course environment. During the first cycle, the foundation of the course was researched and the objectives, pedagogy, and assignments were developed using case analysis as the primary learning activity. In the second cycle, modifications were made to address shortcomings identified in the course. This report describes student outcomes from Cycle 2, addressing the impact of course modifications.

This study explored the following questions:

- Will a standalone critical thinking in business course with specific learning activities to enhance metacognition improve critical thinking skills?
- Can 'cognitive apprenticeship' implemented as instruction and practice in reflection and active self-critique contribute to the development of metacognition and critical thinking?

As reported earlier, the original course was evaluated using the scores of the midterm final case reports to validate the reasonableness of the case study as the primary method and the overall course design in Fall 2018. The impact of the changes made in the course design during Cycle 2 was also assessed by student performance on reports, as well as student self-reports. Additionally, the Business Critical Thinking Skills Test (BCTST) was used as a pre- and post-test as an objective measure of critical thinking ability in two sections of the course. The BCTST provides scores on multiple dimensions of critical thinking ("The BCTST Returns Scores", n.d.):

- Overall Reasoning Skills: Overall measure of critical thinking skills.
- Analysis: Ability to identify assumptions, reasons, patterns, and evidence used in arguments.
- Inference: Drawing conclusions or seeing consequences from reasons, evidence, observations, experiences, values or beliefs.
- Evaluation: Ability to evaluate the credibility of sources and the information they contain.
- Induction: Estimating likely outcomes; dealing with uncertainty.
- Deduction: Rigorous reasoning using clear logic, rules, procedures, values, principles.
- Numeracy: Making judgments based on quantitative information; requiring use of the other critical thinking skills.

To investigate the impact of the course and the intervention on students' assessment of their own critical thinking ability, students in Spring 2020 completed a Critical Thinking Ability (CTA) Questionnaire (see Appendix A) based on Halpern's Self-Ratings of Critical Thinking Skills and Dispositions (1998). For each question, students responded using a Likert scale (1 through 7). The scales were tested for reliability: the 10 items measuring perceived critical thinking ability had a Chronbach's Alpha of 0.84. A critical thinking ability index was created by adding responses on questions.

Data Collection

Performance data was collected from three sections of the critical thinking course for business majors (68 students) in Spring 2019 (the end of Cycle 1) and from four sections of the course (74 students) in Spring 2020 (Cycle 2) to assess the impact of the modifications made during Cycle 2. Only students who completed all the case reports were included in this study. The rubric used to score these reports was based on the Association of American Colleges and Universities (AACU) rubrics for writing, critical

thinking and information literacy, and adapted by university faculty (see Appendix B). The grade of each case report was determined by the total points assessed in seven criteria: three criteria for writing, two criteria for reasoning and two criteria for evidence use. The average grade of each case report collected from Spring 2019 was compared to those of Spring 2020 to see if there was improvement. A two-sample t-test was used to conduct a statistical analysis.

Additionally, at the beginning and end of the semester, students in all four Spring 2020 sections completed the CTA Questionnaire and the students in two of the Spring 2020 sections also completed the BCTST to objectively assess improvement in critical thinking in the course. A paired sample t-test was used to compare the BCTST pre-test and post-test scores. Self-reported CTA was compared with performance on the BCTST to identify the impact of the course on students' perceptions of their own critical thinking ability, and thus the impact on their metacognitive ability.

Results and Discussion

To test whether the intervention improved performance, the average grades of each case report collected from Spring 2019 was compared to those of Spring 2020. Results of a one-tailed two-sample t-test are shown in Table 1. In the Case 1 report, where Spring 2020 students did not receive feedback from the instructor on their draft but actively critiqued their drafts, the average grade were almost identical to Spring 2019, when students received only feedback from the instructor and peers on the drafts but not training and reflection question quizzes. In the Case 2 (midterm) report, on which students in both semesters did not receive instructor feedback on a draft or use self-reflection questions, the average grade increased by 3.28 in Spring 2020 and the difference was significant at $p < 0.1$. In the Case 3 report, when Spring 2020 students did not receive feedback from the instructor but used the training, discussions and reflection questions to critique their drafts, the average score improved only slightly by 1.37, which was not significant. In the Case 4 (final exam) report, where students in both semesters did not receive feedback or complete self-reflection questions, the average grade decreased by 4.89%, which was significant at $p < 0.01$. However, this may be due to the complexity of Case 4 used in Spring 2020. Qualitative and quantitative analyses involved in the fourth case used in Spring 2019 were significantly less complex than those involved in the Spring 2020 case, where complicated issues relating to ethics and corporate social responsibility were involved.

Table 1:
Case Report Average Grades Compared

Average Report Grade	Spring 2019 Mean Scores (n= 68)	Spring 2020 Mean Scores (n=74)	Improvement (Mean Difference)	t	p-value
Case 1	76.44	77.29	0.85	0.44	0.33
Case 2 (Midterm)	75.88	79.16	3.28	1.51	0.07*
Case 3	79.15	80.51	1.37	0.63	0.26
Case 4 (Final)	84.79	79.91	-4.89	-2.54	0.01**

    * Significant at 0.10
    ** Significant at 0.05

Since the scores of Case 1, Case 2 and Case 3 improved in Spring 2020, the modified course design may have helped Spring 2020 students improve critical thinking and writing skills faster, although the improvement was statistically significant only in Case 2 (Midterm). As the authors believe the complexity of cases used in Case 1, Case 2 and Case 3 were comparable, students in Spring 2020 performed as well as or better

than those in Spring 2019 without receiving individual feedback on their drafts from the instructor, indicating their metacognition ability may have improved.

To assess how the course and its design improved students' critical thinking ability, the Business Critical Thinking Skills Test (BCTST) was used in two sections of the course in 2020 Spring. The first test was administered in February as a pre-test and the second test was conducted during the final exam in May as the post-test. One-tailed paired t-tests were used to test for improvement in the scores. The results are shown in Table 2.

Table 2:
Results of the Business Critical Thinking Skills Test

n= 39	Pre-Test	Post-Test	Improvement (Post-Pre)	t	p-value
Overall Score	86.3	87.4	1.1	1.87	0.034**
Analysis	91.1	91.2	0.1	0.10	0.460
Inference	82.6	84.1	1.5	1.54	0.066*
Evaluation	87.4	88.8	1.4	1.42	0.082*
Induction	88.5	88.9	0.4	0.68	0.251
Deduction	83.5	85.4	1.9	2.29	0.014**
Numeracy	84.3	86.3	2.0	2.22	0.016**

   * Significant at 0.10
  ** Significant at 0.05

The overall score, as well as deduction and numeracy scores, improved significantly ($p < 0.05$). Inference and evaluation scores were also improved. Analysis and induction scores were only slightly improved, which may indicate that the course and treatments may not effectively target analysis and induction. However, the analysis and induction scores were already relatively high in the pre-test (91.1 and 88.5) and this could be a reason why improving them into a higher score is difficult. Due to administrative issues, the pre-test was given during the fourth week of the semester, so students had been exposed to a few weeks of critical thinking instruction before the test. It is possible that the difference between pre-test and post-test scores would have been greater had the pre-test been taken earlier.

To test the effect of the Spring 2020 course design on students' perception of their own critical thinking ability, scores on the critical thinking ability (CTA) self-assessment taken at the start of the semester were compared to those from the end of the course. The impacts of critical thinking instruction on self-perceived CTA was tested using the Wilcoxon Ranked Signs test to compare students' self-reported scores at the start and end of the course. CTA mean scores were lower at the end of the course than at the start (Table 3). The mean CTA scores decreased significantly across the four sections of the course. Thus, self-perceived CTA was lower after completing the course. These results reflect the Dunning-Kruger effect, and the impact of training on one's ability to realistically assess one's abilities. Since critical thinking ability as measured by the BCTST was higher at the end of the course and perceived critical thinking ability was lower, this suggests that the instruction in critical thinking and self-reflection helped students evaluate their skills more realistically.

Table 3:
Perceived Critical Thinking Ability[1] Wilcoxon Ranked Signs Test

	N	Pre-Course Mean	Post-Course Mean	p-value
All sections	64	60.4	59.0	0.03*

* Significant at 0.05 (two-tailed)
[1] Based on 70 possible points

To test whether students with lower critical thinking ability would inflate their perceived ability, students in the two sections taking the BCTST were classified into two groups based on their BCTST percentile scores. Students scoring in the 70th percentile and higher were classified in the "High" group, and those lower, in the "Low" group. Table 4 shows the self-perceived critical thinking ability score (CTA) of the high and low groups. When the pre-BCTST test score was used to group students, the mean of the "high" group's pre-course CTA was 60.25 while the mean of the "low" group's pre-course CTA was 62.21. When students were grouped by their post-test BCTST scores, results were similar, with the "high" group's post-course CTA mean of 57.63 lower than the "low" group's mean of 61.57. In both cases, students scoring lower on the BCTST evaluated their critical thinking ability higher than did better performing students.

Table 4:
Comparison of Self-Reported Critical Thinking Ability Based on BCTST Score

Pretest BCTST Percentile	Pre-Course Self-Perceived CTA[1]		Posttest BCTST Percentile	Post-Course Self-Perceived CTA[1]	
High	N	16	High	N	16
	Mean	60.25		Mean	57.63
	Std. Dev.	4.37		Std. Dev.	6.13
Low	N	14	Low	N	14
	Mean	62.21		Mean	61.57
	Std. Dev.	5.58		Std. Dev.	7.14

[1]Based on 70 possible points

To further investigate impacts of critical thinking instruction on CTA, students were divided into three groups based on the difference in their pre-test and post-test overall BCTST scores (Table 5). CTA scores declined from the pre-course to the post-course for those whose BCTST scores improved, while the CTA scores remained the same or slightly increased for those who did not improve their BCTST scores, supporting the idea that critical thinking instruction can improve individuals' insight into their critical thinking abilities. This would be characteristic of the first stage of the six stages of critical thinking development (Elder & Paul, 1996), in which students do not recognize problems in their thinking.

Table 5:
Comparison of Mean CTA and BCTST Score Improvement

BCTST Score Change	n	Mean BCTST			Mean CTA[1]		
		Pre	Post	Difference	Pre	Post	Difference
Decrease (≤0 points)	9	87.2	84.3	-2.9	61.4	61.7	0.2
Small Increase (1-3)	10	84.5	86.4	1.9	61.5	58.7	-2.8
Moderate Increase (4-7)	10	86.1	91.2	5.1	60.4	57.5	-2.9

[1]Based on 70 possible points

Conclusion

This study provided evidence that exercises designed to replace instructor personal feedback with student self-reflection, along with cognitive apprenticing scaffolding, facilitate metacognition and expose students to the limitations of their abilities. This has the potential to improve student critical thinking skills without putting an overwhelming workload on the instructor since they do not need to provide customized feedback to each student. The method may be used in many different fields. This is important since critical thinking skills are important in virtually all disciplines.

The Dunning-Kruger effect is reflected in this study. Individuals with lower initial critical thinking skills did significantly inflate their abilities. Additionally, instruction did impact perceived critical thinking ability negatively, suggesting students were able to more realistically assess their abilities after instruction in critical thinking, reflecting improvement in metacognition. Students with lower BCTST scores assessed their own critical thinking ability higher than did those who performed well on the BSCST both at the beginning and end of the course. Therefore, a necessary goal of a dedicated critical thinking course, such as the one in this study, would be that students can recognize problems in their own thinking and be motivated to improve their thinking. If students can recognize the problems, they have a better chance to improve their critical thinking skills in subsequent upper-level major courses.

Since this was not a controlled study, different cases were used in the two semesters, and reports were assessed only by the instructors, there are limitations to this study. Future work should ensure that cases with the same complexity are used and that reports are evaluated multiple people. The generalization of the conclusions is limited, since this is a case study, the subjects were not randomly selected, and the sample is small from a single college. However, the study showed the potential of a business course designed to teach critical thinking and the techniques to improve metacognition. Also, long-term effects of the course on student critical thinking must be evaluated since students may not retain their improvement over time.

Students with low BCTST scores evaluated their critical thinking ability higher than did those who performed well on the BCTST. This is consistent with previous research findings that unskilled individuals may overestimate their abilities, and high-performing individuals may more realistically assess their abilities (Kruger & Dunning, 1999; Simons, 2013). This has implications for the effectiveness of self-reported measures of thinking (Pennycook, Ross, Koehler & Fugelsang, 2017), an opportunity for future research.

Students need to recognize that their critical thinking ability is not as high as they believe it is in order to improve, supporting the staged development of critical thinking by Elder and Paul (1996). We did not identify where students were in the critical thinking development process. Individuals at the first stage of the six-stage model, unreflective thinkers, cannot assess their own thinking and therefore cannot improve it (Elder & Paul, 1996). The development of a measure to determine an individuals' stage of critical thinking would be useful in exploring the Dunning-Kruger effect in this context and its impact on self-perceptions of critical thinking ability as an individual progresses through the stages.

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APPENDIX A

Critical Thinking Ability (CTA) Questionnaire

Items measuring perceived critical thinking ability and dispositions, measured using a Likert scale ranging from "Not at All Descriptive of me" (1) to "Very Descriptive of me" (7).

I recognize, control, or weigh multiple factors when solving problems.
I recognize when I fail to understand something because I don't know what a term means.
I recognize when I have incomplete information.
I consider the strength of reasons that support a conclusion or decision.
I consider biases and counterarguments that impact a conclusion or decision
I use facts and rational criteria when I make a decision.
I apply problem-solving strategies systematically when faced with a difficult decision.
I monitor my understanding when I read difficult text and know when to reread.
I make an effort to generate novel and useful responses or solutions to problems.
I recognize propagandistic techniques that are designed to appeal to emotions.

APPENDIX B

Rubric Used to Assess Case Reports

	Exceeds Expectations	Meets Expectations	Needs Improvement	Below Expectations	Fails to Meet Minimal Criteria
Written Communication: Context of and Purpose for Writing	Demonstrates a thorough understanding of context, audience, and purpose that is responsive to the assigned task(s) and focuses all elements of the work	Demonstrates adequate consideration of context, audience, and purpose and a clear focus on the assigned task(s) (e.g., the task aligns with audience, purpose, and context)	Demonstrates awareness of context, audience, purpose, and to the assigned tasks(s) (e.g., begins to show awareness of audience's perceptions and assumptions)	Demonstrates minimal attention to context, audience, purpose, and to the assigned tasks(s) (e.g., expectation of instructor or self as audience)	Demonstrates little or no attention to context, audience, purpose, and to the assigned tasks(s) (e.g., expectation of instructor or self as audience)
Written Communication: Genre and Disciplinary Conventions	Demonstrates detailed attention to and successful execution of a wide range of conventions particular to a specific discipline and/or writing task (s) including organization, content, presentation, formatting, and stylistic choices	Demonstrates consistent use of important conventions particular to a specific discipline and/or writing task(s), including organization, content, presentation, and stylistic choices	Follows expectations appropriate to a specific discipline and/or writing task(s) for basic organization, content, and presentation	Attempts to use a consistent system for basic organization and presentation	Little attempt to use a consistent system for basic organization and presentation
Written Communication: Control of Syntax and Mechanics	Uses graceful language that skillfully communicates meaning to readers with clarity and fluency, and is virtually error-free	Uses straightforward language that generally conveys meaning to readers. Language has few errors	Uses language that generally conveys meaning to readers with clarity, although writing may include some errors	Uses language that sometimes impedes meaning because of errors in usage	Uses language that generally impedes meaning because of errors in usage

Critical Thinking: Content Development	Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, critical analysis and synthesis skills that convey the writer's understanding	Uses appropriate, relevant, and compelling content to explore ideas using critical thinking skills within the context of the discipline	Uses appropriate and relevant content to develop and explore ideas through most of the work	Uses appropriate and relevant content to develop simple ideas in some parts of the work	Generally fails to use appropriate and relevant content to develop simple ideas in some parts of the work
Critical Thinking: Evaluation of Information; Conclusion	Skillfully analyzes and evaluates information / evidence related to thesis; conclusion is insightful, logical and justified based on a skillful evaluation of evidence	Adequately analyzes and evaluates information / evidence related to thesis; conclusion is logical and justified based on the evaluation of evidence	Attempts to analyze and evaluate information / evidence related to thesis and use the evidence in order to justify conclusions	Takes information at face value (little or no attempt to evaluate quality of information / evidence, relationship to thesis, or support of conclusions)	Absolutely no attempt to evaluate quality of information / evidence, relationship to thesis, or support of conclusions
Information Literacy: Identification and Access of Information / Evidence	Demonstrates skillful identification and access of high-quality, credible, relevant sources to develop ideas that are appropriate for the discipline and genre of the writing	Demonstrates consistent identification and access of credible, relevant sources to support ideas, that are situated within the discipline and genre of the writing	Demonstrates an attempt to identify and access credible and/or relevant sources to support ideas that are appropriate for the discipline and genre of the writing	Has difficulty identifying and accessing sources to support ideas in the writing	Fails to identify or use sources to support ideas in the writing
Information Literacy: Use Information Effectively to Accomplish a Specific Purpose	Skillfully communicates, organizes and synthesizes information from sources to fully achieve a specific purpose, with clarity and depth	Communicates, organizes and synthesizes information from sources. Intended purpose is achieved	Communicates and organizes information from sources. The information is not yet synthesized, so the intended purpose is not fully achieved	Communicates information from sources. The information is fragmented and/or used inappropriately (misquoted, taken out of context, or incorrectly paraphrased, etc.), so the intended purpose is not achieved	The information is most often used inappropriately (misquoted, taken out of context, or incorrectly paraphrased, etc.)