

AT THE INTERSECTION OF CRITICAL THINKING AND ECONOMICS EDUCATION:
EXPLORING WHETHER LEARNING ECONOMICS AIDS IN
THE DEVELOPMENT OF CRITICAL THINKING IN
UNDERGRADUATE STUDENTS

by

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All errors in fact or interpretation are my own.

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Abstract

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University of Texas at Arlington, 2018

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Teaching students to think critically is the fundamental aim and overriding ideal of education. It has become increasingly clear that today's high-tech, knowledge-based economy demands excellent critical thinking skills. The challenge as educators is to determine whether there are disciplines, subdisciplines, or courses within disciplines or subdisciplines that are better at aiding student development of critical thinking skills. Using human capital theory as the theoretical framework, this study seeks to address whether students will have statistically significantly higher critical thinking test scores after taking a

Principles of Macroeconomics or Principles of Microeconomics course. Results show after analysis of the test data from both micro and macro students failed to find statistically significantly higher critical thinking test scores after taking their economics course.

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Chapter 1

Introduction

Teaching students to think critically is arguably the Holy Grail of education. An interactive panel of experts convened more than 25 years ago to work toward a consensus on the role critical thinking plays in education and society (Facione, 1990). The panel found that critical thinking “can help people overcome the blind, sophistic, or irrational defense of intellectually defective or biased opinions . . . (and) promote rational autonomy, intellectual freedom and the objective, reasoned and evidence-based investigation of a very wide range of personal and social issues and concerns” (pp. 12-13).

Statement of the Problem

Many observers believe today’s high-tech, knowledge-based economy demands excellent critical thinking skills (Borg & Stranahan, 2010). Each of us makes judgments that affect ourselves, our families, our country, and our world, and at all ages of life critical thinking skills and mindset are essential (Insight Assessment, 2016). Abrami et al. (2008) perhaps put it best when they suggested that “a democracy composed of citizens who can think for themselves on the basis of evidence and concomitant analysis, rather than emotion, prejudice, or dogma . . . sustains, builds, and perpetuates the democracy” (p. 1103).

According to Bailin and Siegel (2003), “critical thinking is often regarded as a fundamental aim and overriding ideal of education” (p. 188), and Sheffler

(1973) went so far as to suggest that “critical thinking is of the first importance in the conception and organization of education activities” (p. 1). Facione (1990) and Behar-Horenstein and Niu (2011) defined critical thinking as characterizing the process of purposeful, self-regulatory judgment—the cognitive engine which drives problem-solving and decision-making (Terry & Ervin, 2012). Higher order thinking skills include such things as analysis, synthesis, problem recognition and problem solving, inference, and evaluation. Maturation alone rarely yields the development of such skills and students typically find these skills difficult to learn even through direct instruction (Angelo, 1995).

The challenge as educators is to determine whether there are disciplines, subdisciplines, or courses within disciplines or subdisciplines that are better at aiding student development of critical thinking skills. One way to meet that challenge is by testing students’ critical thinking skills before and after concluding some part of their education to determine which educational experiences are most likely to aid in their development of these skills. Effort should be made to uncover how critical thinking develops in young students and what educators and policy makers can do to facilitate its development. This study is my contribution to that cause.

Purpose of the Study

Greenlaw and Deloach (2003) and Deloach and Greenlaw (2005) have shown that engaging students in electronic discussions about economics has the

potential to increase critical thinking skills in their undergraduate students. However, little effort has been made to determine whether studying economics can lead to similar gains in their critical thinking skills, save for one small study from Borg and Stranahan (2010), in which the scores of their students on the Test of Understanding College Economics (TUCE) were compared to those same students' scores on the Watson-Glaser Critical Thinking Appraisal (WGCTA-S) to examine whether a greater acquisition of economic knowledge as measured by the TUCE is associated with increased critical thinking skills. Their study found students who gained a high level of economic understanding in their introductory economics class have statistically significant gains in critical thinking.

Borg & Stranahan (2010) believe that their students' critical thinking skills improved because economics requires the students to not only think logically and analytically, but to apply logical and analytical thinking to a variety of real-world problems and evaluate related theories and assumptions in the light of evidence.

[S]tudents who learn more of the economics content . . . seem to achieve gains in their critical thinking skills. We believe that is because the concepts discussed in the course. . . [and] the emphasis that economics places on applying principles and theories to new problems as opposed to rote memorization of facts helps students who master its content to improve their abilities for logical inquiry and analytical reasoning (Borg & Stranahan, 2010, p. 84).

Additionally, introductory economics courses have a mild quantitative element, and it is widely believed that quantitative reasoning skills contribute to students' critical thinking abilities (Bok, 2009; Borg & Stranahan, 2010).

The purpose of this study is to determine whether learning economics as taught in a traditional introductory Principles of Macroeconomics and Principles of Microeconomics course can aid in the development of students' critical thinking skills. I will empirically test whether learning economics can improve college students' critical thinking abilities as measured by nationally normed assessments of critical thinking skills.

Hypothesis and Research Questions

This study hypothesizes that students will have statistically significantly higher critical thinking post-test scores after taking a Principles of Macroeconomics or Principles of Microeconomics course. To address this hypothesis, the study will address three research questions:

1. Is the mean difference between pretest and posttest scores of students who took a Principles of Microeconomics or a Principles of Macroeconomics course statistically significant?
2. Is the mean difference between pretest and posttest scores of students who took Principles of Microeconomics statistically significantly different than the mean difference between pretest

and posttest scores of students who took Principles of Macroeconomics?

3. Is the mean difference in posttest scores of students who took Principles of Microeconomics statistically significantly different than the posttest scores of students who took Principles of Macroeconomics after controlling for the students' pretest scores?

Theoretical Framework

Education is an investment in people that has both a public and private benefit. This idea is as old as the study of economics itself (Spengler, 1977) and is referred to by economists as “human capital,” a term popularized by the Nobel-prize winning economist Gary S. Becker in his 1993 book by the same name. Human capital theory (HCT) is an effective theoretical framework for addressing how pedagogy, instruction and various interventions can aid students in the development of critical thinking skills. For example, Deloach and Greenlaw (2005) used an educational production function to evaluate whether their use of electronic discussions created “critical thinking spillovers,” (p. 153). The function the authors used was originally developed by Davisson and Bonellow (1976) and consisted of three categories of inputs, one of which was human capital, which itself was defined as a function of a student's grade point average and credit hours completed, among other similar variables.

As Becker (1993) notes, “[e]ducation and training are the most important investments in human capital” (p. 17). The essence of HCT is that it suggests that education increases the productivity of individuals, and in so doing also increases that individual’s earning potential (Tan, 2014). Hence, education is an investment that is crucial for individuals, and aids the economic growth of a country. Put another way, “The most valuable of all capital is that invested in human beings” (Marshall, 1895, p. 635).

The literature on human capital theory (HCT) grew so large as to warrant an economic subdiscipline concerned specifically with education (Sweetland, 1996). The literature on the subject is so exhaustive that a full review is both impractical and well beyond the scope of this research, so I confine my discussion in the next chapter to the theory’s roots, critiques relevant to the application of this theory to this study, and the theory’s relationship to education.

Significance of the Study

This study attempts to uncover not simply how critical thinking develops in young students, but specifically whether learning economics aids in the development of students’ critical thinking skills. The underlying hypothesis of this study is that students who have taken a Principles of Macroeconomics (“the macro students”) or a Principles of Microeconomics (“the micro students”) course have statistically significantly higher critical thinking post-test scores.

Cultivating students' critical thinking skills is a major goal of American higher education (Roth, 2010). Because of the proliferation of definitions of critical thinking, a panel of experts was convened in 1987 and a more formal definition was articulated, (Simpson & Courtney, 2002). This panel defined critical thinking as "purposeful, self-regulatory judgment" (Facione, 1990, p. 3). Research has added to our understanding of what critical thinking is (Behar-Horenstein & Niu, 2011), and a large number of empirical studies have examined the effect of different teaching strategies and interventions aimed at promoting critical thinking skills among college student (Behar-Horenstein & Niu, 2011).

Research Methods

Previous studies that assess students' critical thinking abilities have used a myriad of measures (Borg & Stranahan, 2010). The Cornell Critical Thinking Test (CCTT) (R. H. Ennis, Millman, & Tomko, 1985) is one such instrument. The CCTT has two forms, Level X, aimed at students in the fourth grade through the first two years of college, and Level Z, aimed at gifted high school, college, and graduate students, and adults (Ennis, Millman, & Tomko, 2005).

Research has found that standardized tests like the Cornell Critical Thinking Test are a concrete way to measure critical thinking (Terry & Ervin, 2012). A panel of experts (Facione, 1990) identified four considerations in evaluating the acceptability of a critical thinking assessment instrument: (1)

content validity, (2) construct validity, (3) reliability, and (4) fairness. The Cornell Critical Thinking Test satisfies these considerations (R. Ennis et al., 2005).

The Level Z form is appropriate for this study not only because of its use with college students, but also because of its wider coverage of critical thinking aspects than the Level X form (Ennis et al., 2005). The CCTT-Z covers aspects of critical thinking such as induction; deduction; observation; credibility “of statements made by others,” (p.2); and assumptions and meaning, including “definition, sensitivity to meaning, and ability to handle equivocation,” (p.2). There is considerable overlap and interdependence among the different critical thinking aspects covered.

The current study analyzed 136 college students’ performance on a critical thinking test both before and after they completed either a Principles of Microeconomics course or a Principles of Macroeconomics course during the fall semester of 2018. The students were attending a large, urban research I university in the American Southwest. The test to measure the students’ critical thinking skills—the Cornell Critical Thinking Skills Test, Level Z—was administered at both the beginning and end of the semester.

The test scores were first analyzed using a paired-samples *t*-test to determine whether the mean difference between the students’ pretest and posttest scores was statistically significantly different from zero. This addressed the first research question. The independent-samples *t*-test, unbalanced design, was then

run to address the second research question, namely whether the mean difference between pretest and posttest scores of the macro students was statistically significantly different than the mean difference between pretest and posttest scores of the micro students. It was an unbalanced design because there are more micro students than macro students. The third and final research question was addressed using analysis of covariance (ANCOVA), which was used to determine whether the mean posttest scores of the macro students was statistically significantly different than the mean posttest scores of the micro students after controlling for the students' pretest scores.

Definition of Terms

Analysis of Covariance (ANCOVA). ANCOVA is a statistical technique in which main effects and interactions of independent variables are assessed after dependent variable scores are adjusted for differences associated with one or more covariates (Tabachnick & Fidell, 2013).

Cornell Critical Thinking Test, Level Z (CCTT-Z). A normed and validated test used to assess the critical thinking abilities of gifted high school students. The instrument covers aspects of critical thinking such as induction, deduction, observation, credibility, assumptions, and meaning.

Covariate. Also called control variables, covariates are additional explanatory variables that help explain variation in the outcome variable

(Wooldridge, 2006). For this study, the covariate was the CCTT-Z pretest scores of the micro and macro students.

Critical Thinking. I will use the definition of critical thinking used by Ennis et al. (2005), who created the Cornell Critical Thinking Test used in this study: “Critical thinking is reasonable and reflective thinking focused on deciding what to believe or do” (p. 1).

Human Capital. According to Garibaldi (2006), human capital is a reference “to any stock of knowledge or the innate/acquired characteristics a person has that contributes to his or her economic productivity,” (p. 152).

Human Capital Theory (HCT). Human capital theory is “a general theory applying to any kind of human capital” (Becker, 1993, p. 245), which “suggests that individuals and society derive economic benefits from investments in people” (Sweetland, 1996, p. 341). The application of this theory has evolved and the body of literature has grown such that a branch of economics concerned specifically with education has developed.

Independent-Samples *t*-test. The independent-samples *t*-test is a statistical technique used to determine whether there are any statistically significant differences between the means of two independent groups (Laerd Statistics, 2015a),

Paired-Samples *t*-test. The paired-samples *t*-test is a statistical technique regularly used to determine whether the mean difference between paired test scores is statistically significantly different from zero (Laerd Statistics, 2015b).

Principles of Macroeconomics. An analysis of the economy as a whole including measurement and determination of Aggregate Demand and Aggregate Supply, national income, inflation, and unemployment. Other topics include international trade, economic growth, business cycles, and fiscal policy and monetary policy. Emphasis on the U.S. economy. Required for business and economics majors (Tarrant County College District, 2018).

Principles of Microeconomics. Analysis of the behavior of individual economic agents, including consumer behavior and demand, producer behavior and supply, price and output decisions by firms under various market structures, factor markets, market failures, and international trade (Tarrant County College District, 2018).

Limitations and Delimitations

Paul Hanus, the first dean of the Harvard Graduate School of Education said in 1913 that “the only way to combat successfully mistaken common-sense as applied to educational affairs is to meet it with . . . technical information the validity of which is indisputable” (Hanus, 1920, p. 12). Indisputable validity is a standard that is difficult for researchers of any discipline to meet to the

satisfaction of everyone. For this reason and many others, the following limitations and delimitations apply to this study:

- A broad concern relates to the psychometric properties of existing standardized measures of critical thinking, including the CCTT (P. C. Abrami et al., 2014).
- Some researchers have expressed concerns about the inconsistent results from their efforts to establish the validity and reliability of such measures (Philip C Abrami et al., 2008).
- There is little consensus about whether critical thinking is a set of generic skills or whether it is subject-specific and how contextualized it is (Abrami et al., 2008; Ennis, 1989).
- There are thousands of research projects, books, papers, theses, and dissertations devoted to issues related to the teaching of critical thinking and at least as many definitions (Philip C Abrami et al., 2008). Even cautious, self-aware researchers may find it difficult to identify every assumption underlying their decisions about what and what not to include.
- Ultimately, the value of this research is almost wholly dependent upon the reliability and validity of the statistical analyses upon which it is based. Causal inferences of the sort contained herein are susceptible to challenges (Murnane & Willett, 2011).

- The active behaviors of the teachers, administrators, and a myriad of other potential stakeholders, not the least of whom is the students themselves, also have enormous impacts on the quality and engagement with instruction (Murnane & Willett, 2011).
- Attrition rates may be a concern (What Works Clearinghouse, 2014) as students frequently change their schedule based on their own needs or whimsy. Nonetheless, sample attrition can pose a threat to both the internal and external validity of the experiment (Murnane & Willett, 2011). Students who leave the economics course in the fall may be different in unobserved ways from those who remain. Additionally, it is also conceivable that withdrawal of students from the research sample means the results may no longer be generalizable to all economic students.
- Who receives economics instructions and when will not be random. This fact subjects the research and results to challenges to their internal validity by suggesting alternative explanations for the statistical relationships observed (Murnane & Willett, 2011), in this case, between the economics instruction and the growth in critical thinking skills. All efforts will be made to address all identifiable external and internal threats to the validity of these results.

Summary

In this study I am testing the hypothesis that learning economics improves college students' critical thinking abilities. One small study (Borg & Stranahan, 2010) found a statistically significant relationship between the growth in both economics understanding and critical thinking skills. However, most of the research related to learning economics and developing critical thinking skills has focused on instructional methods (e.g. Deloach & Greenlaw, 2005). Given the dearth of empirical evidence regarding the efficacy of learning economics and the impact such learning can have on the development of students' critical thinking skills, a thorough treatment of the issue may shed some light on this issue.

Chapter 2

Literature Review

This study seeks to determine whether students who have taken an introductory economics course have statistically significantly higher critical thinking test scores at the end of the course than they had at the beginning of the course. In order to provide a foundation for better understanding the importance of developing critical thinking skills in students and the possible relationship such skills may have to the study of economics, it is necessary to conduct a thorough review of literature related to the research questions.

This chapter begins with a review of human capital theory, the theoretical framework upon which this study is based, then moves on to discuss a common criticism levied at the economics discipline, specifically that studying economics “renders those influenced by its teachings less moral and more antisocial” (Etzioni, 2015, p. 228). This chapter then concludes with a discussion of how critical thinking has been historically defined and used in the research literature. A thorough treatment of the specific instrument used in this study, the Cornell Critical Thinking Test, is presented in Chapter 3.

Human Capital Theory

The literature on human capital theory (HCT) is so exhaustive that a full review is both impractical and well beyond the scope of this research. In this chapter the discussion of HCT will be confined to the theory’s roots and how it

has evolved in the face of heated criticism, as well as how it has been historically applied to education.

Human capital theory, its adherents argue, is a comprehensive approach for analyzing a wide spectrum of human affairs that can inform policies accordingly (Tan, 2014). The concept of human capital is the idea that people spend on themselves in diverse ways, and often do so for the sake of future monetary and nonmonetary return (Blaug, 1976). HCT further postulates that we—individuals and society—derive value from investing in people (Sweetland, 1996). The value derived from such benefits is primarily economic in nature and education has long been the prime human capital investment. The literature distinguishes among different types and means of education with regards to HCT, including formalized education at primary, secondary, and higher levels (Cohn & Geske, 1990).

The notion that investment in people has benefit is as old as the study of economics itself (Spengler, 1977). Adam Smith, the father of neoclassical economics and author of the influential tome, *The Wealth of Nations* (1776), articulated what is arguable the first definition of human capital, which he refers to as “fixed capital” here:

The acquisition of such talents, by the maintenance of the acquirer during his education, study, or apprenticeship, always costs a real expence (*sic*), which is a capital fixed and realized, as it were, in

his person. These talents, as they made a part of his fortune, so do they likewise of that of the society to which he belongs. The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labour (*sic*), and which, though it costs a certain expence, repays that expence with a profit. (p. 358)

Smith believed the development and use of human capital “to be closely associated with the degree to which the system of natural liberty, together with free competition, was allowed to prevail” (Spengler, 1977, p. 491). The sources of human capital included experience and education, both of which inform critical thinking (Ennis, 1993; Facione, 1990). In Smith’s work one finds many parallels with today's discussions of education incentive, specificity of reward, excessive educational costs, and unproductive training (Spengler, 1977).

Human Capital Theory began garnering widespread application after the publication of Gary Becker’s 1964 monograph *Human Capital* (Blaug, 1976), though John R. Walsh, (1935), Jacob Mincer (1958, 1962, 1970, 1974) and Milton Friedman and Simon Kuznets (1945) provided some of the key elements of the new theory. Hints and suggestions of the theme of human-capital formation occur all through the eighteenth and nineteenth centuries but Becker was among the first to tie these loose ends together (Blaug, 1976).

The common body of literature grew large enough to warrant a branch of economics concerned specifically with education (Sweetland, 1996). In 1966, a comprehensive annotated bibliography of writings on “human capital” contained 792 journal articles, books, and research studies. Four years later, a second edition of this same bibliography contained 1,350 items, and six years after that it contained almost 2,000 items (Blaug, 1976). Articles related to “human capital” in 114 major economic journals from 1970 to 1974 rose from 1.34 percent to 1.75 percent (Perlman & Perlman, 1976). Since 1971, five Nobel prizes have been awarded to scholars based in part on their work in or association with the field of human capital theory (Becker, 1993; Wright, 1992).

The attention paid to human capital by scholars and policy makers alike is not particularly surprising, as education has been found to increase the overall quality of life while affecting a control on population growth (Becker, 1993). Swanson & King (1991) add that education creates an enlightened citizenry able to participate in the governance of their community and pursue values such as equality and liberty. As research into human capital has evolved, however, some researchers point out that the opportunity cost of forgone wages creates a disincentive to pursue further schooling (Jepsen & Montgomery, 2012). One analysis (Light, 1995) found that holding a high-paying and/or full-time job made men less likely to go back to school.

In Schultz (1981) and Becker's (1993) work, human capital was more than simply investment in training or school. According to Blaug (1976), the formation and accumulation of human capital is conceived as being carried out by individuals acting in their own interests, but in some countries it is frequently carried out by governments. Blaug also notes that the rate of return on educational investment is calculated exclusively on the basis of observable financial reward. Thus, the same observed rates of return to education frequently produces quite different conclusions about the optimal educational strategy.

A number of scholars have attacked HCT based on the perception that its advocates within education are attempting to restructure the educational system away from one of meeting the social and individual needs of learners and toward meeting industry needs for a skilled technology workforce (Coupal, 2004). The processes for identifying desirable learning outcomes are subject to the influences of changing social conditions and different constituencies.

Some of these critics argue that education has been relegated to a mere supplementary component of business and industry (Tan, 2014). Education is conceived as a business activity driven by profit (Nussbaum, 2010) or as a commodity driven by the market (Ball, 2010). Thus, students and parents are consumers, teachers are producers, and education administrators become entrepreneurs and managers whose goal is to meet the rapidly changing needs of industry (Marginson, 1997).

To still other critics (Coffield, 1999; Field, 2000) the main objective of the economy-driven education policies is to put the burden on people's shoulders and expect them to take action for themselves, by themselves, with the ultimate objective of reducing the government's financial burden (Field, 2000). Others argue that HCT views human beings as a machine for the production of an income (Dilts, 2011).

The moral aspect of HCT is rather controversial and the idea of human capital has been bitterly criticized and sometimes sarcastically referred as human cattle (Tan, 2014). Becker later acknowledged that he was afraid of the potential criticisms for titling his book after the theory. Goodwin (2003), on the other hand, reminds us human capital theory has been a potent force in alleviating even more dehumanizing effects by encouraging investing in individuals and their skills.

Perhaps the most complete critical analysis of HCT comes from Bowles and Gintis (1975). They argue that neoclassical economists assume the labor-wage exchange identical to other exchanges, effectively stripping the social process of work of its more human characteristics. To Bowles and Gintis, capitalism is a system in which the means of production are owned and controlled by a small minority. The formation and accumulation of human capital play an essential, if indirect, role in the perpetuation of the entire economic and social order. Foucault (1979) argues that human capital represents two interrelated processes: "one that we could call the extension of economic analysis into a

previously unexplored domain, and second, on the basis of this, the possibility of giving a strictly economic interpretation of a whole domain previously thought to be non-economic” (p. 219).

A counter theory to HCT is known as signaling theory (Tan, 2014), coined by Spence (1973). Human capital theorists claim that education enhances a person’s skills and it leads to a higher productivity level in the workplace. Signaling theory, however, suggests that what the school does is to classify students according to their intelligence and commitment through the processes of admission requirements and grading (Soldatos, 1999). Schooling may reflect higher productivity without causing it, because education is not the source but the signal of higher productivity of educated people since schools identify the able and committed individuals and eliminates the less able ones in the process (Tan, 2014).

Some see signaling theory not as an alternative to HCT but as an extension of HCT (Weiss, 1995). As Machlup (1984) noted, the discussion on screening is not whether education has a sorting function—it obviously does— but rather whether it serves as a screening device (cited in E.Cohn, Kiker, & Oliveira, 1987). According to Becker (1993), it does not matter whether education enhances productivity or it just sorts out job applicants because “even if schooling also works in this way [as a sorting device], the significance of private rates of return to education is not affected at all” (p. 8).

Lastly, while neoclassical economists agree on the general contents and outcome of human capital investment, analytical techniques vary. Sandonà & Uchechukwu (2013) identified three different approaches in the literature. The production-function approach

consists of taking the total increase in economic output of a country over a given period of time, identifying as much of the total increase as possible with measureable (*sic*) and frequently selected capital and labor inputs, and then attributing the remainder to unspecified inputs, education, and advances in knowledge generally being regarded as the most important” (p. 26).

The stock-formation approach says that human capital comprises skills, knowledge, and abilities and that maximizing human capital “enables individuals to maximize earnings, companies to maximize profits, and nations to maximize wealth” (Sandonà & Uchechukwu, 2013, p. 27). The measurement of returns approach is related to whether education investments are more profitable than alternative investment options.

Human capital theory continues to significantly impact a range of disciplines from economics to education and sociology (Tan, 2014). The theory has always been controversial but despite bitter criticisms since its inception it has expanded its influence over other research disciplines. Not surprisingly and in

addition to its many perceived shortcomings, a considerable number of criticisms have been made as a reaction to this expansion as well.

Economics Education

While a great deal of criticism has been levied at the academic discipline of economics, perhaps the most damaging allegation is that economics “renders those influenced by its teachings less moral and more antisocial” (Etzioni, 2015, p. 228). Etzioni (2015) asserts that teaching neoclassical economics has a morals-debasing effect—that “neoclassical economics’ focus on self-interest, pleasure, and, hence, consumer goods . . . renders those influenced by its teachings less moral and more antisocial” (p. 228). He cites a multitude of studies to support his contention that learning economics makes a person less moral and more antisocial.

Some researchers point out that “the language of economics makes it especially difficult to differentiate self-interest from greed” (Wang, Malhotra, & Murnighan, 2011). Haucap and Müller (2014) similarly concluded that the “overwhelming majority of papers finds that economists . . . are more selfish and less trustworthy than others,” (p. 2). Wang, Zhong, and Murnighan (2014) summarized the state of the literature as pointing “to the field of economics and to business schools as primary contributors to the incidence of unethical corporate activity” (p. 46).

Not all economic theory engenders Etzioni's (2015) morals-debasing effect. Etzioni, like many other social scientists who published on this effect, identify neoclassical economics as the primary culprit (Brant & Panjwani, 2015; Elegido, 2009; Goldberg & DiMaggio, 2015; Haucap & Heimeshoff, 2014; Hühn, 2014; Lopes, Graça, & Gomes Correia, 2015; Racko, 2016; Thieme, 2013; Wang, Malhotra, & Murnighan, 2011; and Wörsdörfer, 2014), or what Wörsdörfer (2014) refers to as the *Homo oeconomicus* [*sic*] model, or the model of “rational economic individual” (Racko, 2017, p.2). According to Racko's reading of the literature, “[n]eoclassical economists conceive of economics as an objective science that is devoid of human values” (p. 2).

Sandonà and Uchechukwu (2013) argue that there are three basic assumptions underlying neoclassical economics and modern economics education. First, it defines man as a perfectly rational being capable of determining how they can maximize their own utility and why. The second assumption, a corollary to the first, is the assumption that human beings engage only in those activities in which their utility is maximized—activities in which they can maximize their material benefit. The third assumption is that neoclassical economics holds that there is a causal effect of human capital on economic productivity and assumes that educational investment assures socioeconomic mobility.

Gonin, Palazzo, and Hoffrage (2012) argue that “specialization, individualization and globalization led to a business world disembedded (*sic*) from broader societal norms. This emancipated business world promotes a literal interpretation of *Homo economicus* among business organizations and their members” (p. 31). According to Gonin et al. (2012), it is these three processes—specialization, individualization, and globalization—that has “allowed for the systemic, moral and legal disembedding of organizations and their members from the broader societal context and its civilizing norms” (p. 38).

Thieme (2013) takes the critique further, asserting “that economic criteria like efficiency, productivity, and utility are used as reasons to devalue people, to separate them into the productive or useful and the non-productive individuals,” and asks rhetorically whether economic theory is discriminatory since “economic criteria are used to discriminate against people” (p. 84). His central thesis is that the study of economics, primarily what he refers to as the “neo classical standard model” (p. 91), is misanthropic—that within the confines of some of the discipline’s theories and constructs there exists a strong dislike of humans generally, and the poor specifically.

Brant and Panjwani (2015) critiqued neoclassical economic ideology by arguing that the current economic curriculum “for a longtime now worked with a highly abstracted and decontextualized idea of human being which has forced other dimensions of human concerns to an absence” (p. 306). They claim that

economics as a discipline has become increasingly divorced from moral concerns, a trend that began in the last century and was part of a broader movement in the social sciences in which different traditions of studying society were adapting quantitative methods like the natural sciences. They believe the error in neoclassical economic ideology is in equating the economy with that of a physical system where causation can be used to predict future behavior of that physical system. Another “shortcomings of the orthodox position” (p. 310) is the fact that, according to Brant and Panjwani (2015), economists peddle a narrow or simplistic view of economics to serve vested interest and political. They conclude that it “is clear that all is not right with modern-day orthodox economics” (p. 311).

In their review of the literature, Hummel, Pfaff, and Rost (2015) characterizes it as suggesting that theories and ideas taught in university business and economics classes neglects the ethical and moral dimensions of decision-making. Haucap and Müller (2014) claimed that the notion that “economists . . . are more selfish and less trustworthy than others . . . is not so much a hypothesis anymore, but can safely be considered a received wisdom by now” (p. 2).

Wörsdörfer (2014) goes so far as to boldly claim that much of the empirical studies on economic education have led to the unambiguous consensus that “the degree of anti-social and uncooperative behavior is on average significantly more pronounced among economics students compared to other student groups” (p. 6).

Wörsdörfer adds “a reform of the standard economics curriculum seems to be required” (p. 16).

However, the literature directly contradicts Haucap and Müller's (2014) “received wisdom” that “economists . . . are more selfish and less trustworthy than others” (p. 2) (Haucap & Heimeshoff, 2014; Hummel et al., 2015; and McCannon, 2014). McCannon's (2014) review of the literature, for example, suggested that “[I]ittle evidence of a learning or indoctrination effect can be found” (p. 28). Indeed, some of the literature suggests there is in fact a lack of evidence to support the neoclassical stereotype (Gaudeul et al., 2017; and Sadrieh & Schröder, 2016), while still others found that economics was not the only discipline whose disciples behaved in a self-serving or otherwise, presumably socially inappropriate manner (López-Pérez & Spiegelman, 2012).

There is also a great deal of debate in the literature whether this morals-debasing effect is due to selection or indoctrination (Boylan, 2015; Frey, Pommerehne, & Gygi, 1993; Haucap & Müller, 2014; López-Pérez & Spiegelman, 2012). It would be a selection effect if an already selfish student was drawn to the study of economics. Similarly, it would be an indoctrination effect if people become more selfish during or after the study of economics.

McCannon (2014) conducted several experiments to disentangle selection and indoctrination effects. The author found that each additional economics course a student had taken increased that student's reciprocation and altruism.

Additionally, trusting behavior was highly correlated with reciprocating behavior and taking more economics courses increased reciprocation rates. Finally, the author confirmed “that it is the decision to take economics which explains the reciprocation” (p. 33), and that it was “the type of person who chooses to study economics that matters” (p. 32). McCannon notes that the novelty of his “work is that it considers the amount of economics coursework taken, rather than just differentiate economics majors from other majors” (p. 33).

According to Hummel et al. (2015), the self-selection effect implies that “students choose to study economics and business because they are already different from other students with respect to their” (p. 4) Moral Judgment Competence (MJC), while the treatment effect relates to “the claim that management education has a negative impact on students’ MJC” (p. 5). In contrast to most of the existing literature, the authors argued

. . . that economic theories . . . give the learner the option of assimilating new knowledge into existing cognitive schemes and structures, but they do not alter existing cognitive schemes and subsystems. . . . Consequently . . . [o]ur results, based on a sample of 1773 bachelor’s and 501 master’s students across six different faculties, indicate that the study of economics and business has neither a self-selection nor a treatment effect on students’ MJC in general. This finding supports our reasoning that economics and

business education has no impact on students' MJC, and it is robust to a number of supplemental analyses and model variations. Moreover, we obtain similar results for almost all other study fields (Hummel et al., 2015, p. 16).

One way researchers have validated their hypotheses related to economists and economics education is by using experiments. According to Etzioni (2015), one of the earliest works to study the effect learning economics has on individual behavior was conducted by Marwell and Ames (1981), who conducted a series of experiments related to the theory of free-riding to compare the behavior of economics and non-economics students. Free-riding “refers to the absence of contribution towards the provision of a public good by an individual, even though he or she will not be excluded from benefiting from that good” (p. 296). Subjects were provided with tokens which they had to invest in either a group or an individual exchange and could divide their investment between the two exchanges in any way they wished. The group exchange was operationalized as the public good and investments therein provided returns based on a preset formula, with each member of the group receiving a share of the returns on their investment without regard to their own investment or lack thereof. The individual exchange, on the other hand, was considered a private good and the investment earned a set amount regardless of anything else.

In all, Marwell & Ames (1981) conducted 12 experiments, including an experiment involving economics graduate students. Mean investment in the group exchange (excluding economics graduate students) varied between a low of 28% to a high of 84%. In the experiment that included economics graduate students, the mean investment fell to 20%, meaning, according to the authors, that “[t]hey were much more likely to free ride than any of our other groups of subjects” (p. 307) and “the economics graduate students were about half as likely as other subjects to indicate that they were ‘concerned with fairness’ in making their investment decision” (p. 309). In contrast to the economics graduate students, other participants “voluntarily contribute . . . an average of between 40 and 60 percent to the provision of a public good” (p. 308).

Searching through the literature that cited Marwell and Ames’ (1981) work turned up almost a quarter of a million articles, books, book chapters, discussion papers, reports, and dissertations. While certainly not all the works referencing Marwell and Ames substantiate the negative stereotype of economics, the sheer volume alone suggests the negative stereotype is pervasive. I narrowed the literature referencing Marwell and Ames to those peer-reviewed journal articles published since 2010 to ensure a focus on the most recent findings. It is this narrow sliver of the Marwell and Ames-referenced literature that formed the basis for much of this review.

For example, Wang, Malhotra, and Murnighan (2011) evaluated the potential link between economics education and nefarious business decisions. They conducted a series of experiments and hypothesized that increases in economics education will be associated with increasingly greedy action and decreasing concerns for fairness, and that greater exposure to economics training will lead people to keep more of their endowment and to be more likely to keep the lion's share of the endowment when their choices are restricted to simply "greedy" versus "equal" outcomes.

As predicted (Wang et al., 2011), economics students did keep more money than education students. The authors also asked participants to complete a questionnaire that asked them to describe "the most important factors behind their decisions" (p. 648). More than half of the education students (56 percent) referenced "fairness," while less than a third of economics students or 31 percent did so. The authors also asked 166 undergraduates to tell two stories, one in which they describe an incident of their being tempted by greed and succumbed and another in which they had been tempted by greed but resisted. The authors concluded that

[m]ajoring in economics seemed to shape participants' definitions of greed . . . (and that) exposure to multiple economics courses was positively related to participants' post hoc feelings toward their

own greed . . . and to more positive views regarding the morality of greed (p. 651).

Also in that same study, Wang et al. (2011) addressed the issue of selection bias by exposing 92 non-economics undergraduates to economic perspectives on self-interest to test whether exposure to these ideas might influence their perceptions of greed. Wang et al. (2011) concluded “these results suggests that, even for people with no exposure to formal economics education, exposure to economic arguments that support self-interest can positively influence their opinions about greed” (p. 654).

In a different study, Zhong (2011) conducted a series of experiments using a math problem-solving task as a proxy for the kind deliberative decision-making economists are taught to test the effects of approaching a moral dilemma as a deliberative decision, as opposed to intuition, deception, and altruism. He hypothesized that “deliberative decision making may actually increase unethical behaviors and reduce altruistic motives” (p. 1). One experiment, for example, included two payment options: option A, in which the “advisee” received \$5 and the participant with whom s/he was paired, the “advisor,” received \$15, or vice-versa (option B). Both participants knew there were two options, but only the advisor knew the values of each option. The advisee chose between the two options after receiving one of two possible messages from the advisor: a true

message stating which option will earn the advisee more money, or a false message lying about which option will earn the advisee more money.

All participants, in fact, played the advisor role against a computer program, and the dependent variable was whether they lied to get more money, which the author argues isn't simply self-interested behavior but is overtly unethical because the "decision to lie explicitly exploited their counterpart's information disadvantage" (Zhong, 2011, p. 10). The author concluded that those who worked a math problem before making their choice, were almost twice as likely to lie as those in the intuition condition or who were asked about their feelings.

Zhong (2011) conducted two similar experiments in that same study, before finally remarking that "the perils of economic training may go deeper than promoting competitiveness or selfish behavior and may include clear unethical violations such as deception" (p. 19). He further concluded that "economics training may contribute to a broad culture that favors deliberation and reason over intuition, making it particularly difficult to assess the *alarming shortcomings* (emphasis mine) of economic education" (p. 20).

In similar research, Wang, Zhong, and Murnighan (2014) argued that a key assumption of economic theories is that the use of calculative strategies is essential to decision-making. They hypothesize that a calculative mindset, which they define as "an unintended cognitive predisposition to analyze (non-

quantitative) problems mathematically,” (p. 39) is potentially incompatible with morality, and may reduce “their consideration of the interpersonal, social, and moral aspects of their decisions” (p. 39). The authors conducted a series of experiments to examine the effects on people’s moral decisions of engaging in a calculative task in two different social interactions. The subjects reported that performing the monetary-based, calculative task “made them think less socially and more about themselves” (p. 41).

Wang et al. (2014) also had the subjects participate in an experiment in which they were offered the opportunity to promote their own self-interest at the expense of a stranger by keeping more money, or they were given the option to lie about how much money they would be willing to endow to another player. Those who engaged in a calculative task kept more money (\$7.44) than those who engaged in a non-calculative task (\$6.39). The research also found that those who engaged in a calculative task were two to three times more likely to lie than those players who engaged in a non-calculative task.

López-Pérez and Spiegelman (2012) studied business and economics students’ perceived penchant for being dishonest more frequently than students in other majors. They concluded from their review of the literature that people were often truthful even at some personal cost, and that this was in contradiction to “the standard *homo economicus* view that all agents are self-interested money-maximizers” (p. 3). The authors used an experiment with a simple decision

problem to investigate potential covariates like gender, field of study, political ideology, and religiosity. The decision problem consisted simply of a student (the “sender”) observing a colored circle on a computer screen and sending the message that either a blue circle had appeared, or a green circle has appeared. The sender would earn 14 Euros for saying the color was blue or 15 Euros for saying the color was green, irrespective of the true color. In turn, another student (the “receiver”) would receive a payoff of 10 Euros irrespective of either the message or the true color. The authors argued “there seems to be no other plausible reason to announce the true color than a preference for honesty” (p. 5). Even if the sender is altruistic there is no reason to tell the truth as the receiver always gets 10 Euros regardless of whether he is deceived.

López-Pérez and Spiegelman (2012) found significant variation in honesty rates across majors, ranging from more than half of humanities and law majors to less than a quarter of engineering and economics majors. They also found that expectations of other people’s dishonesty decreased the probability of an honest choice, particularly among business and economics students.

Hole (2013) examined whether economics students were more self-interested than non-economics students by conducting an experiment wherein each student had to endorse either a system of income distribution in which total income is distributed equally amongst the individuals; a system of income distribution in which each person receives a share of the total income equal to his

share of total investment; or a system of income distribution in which each person is entitled to what they have produced.

The experiment had three phases (Hole, 2013). In the communication phase, the participants were asked to choose the principle they thought would imply the fairest distribution in situations like the provided hypothetical situation. In the production phase, each participant was given approximately a sum of money and were randomly assigned either a low or a high rate of return. They were then asked to determine how much they wanted to invest in two different one-shot games simultaneously (income production was equal to the product of their investment and their rate of return). In the distribution phase, the participants were randomly assigned a co-player, and the winnings in the first game were distributed according to the fairness model chosen during the communication phase by one of the participants in the pair (selected randomly), and the winnings in the second game were distributed according to the fairness model selected by the other player.

Hole (2013) found that the non-economics students, on average, offered 50 percent more to their opponent than economists, and “appear to assign greater importance to fairness considerations than economists” (p. 26) Hole concluded that “[e]conomists are significantly more self-interested than engineers” (p. 26).

Haucap and Müller (2014) analyzed 577 economics and law students from both introductory and more advanced classes. The authors wanted to know

whether female economists behave more like typical economists (i.e. both less trusting and less trustworthy) or more like typical females (i.e., less trusting, but more trustworthy). They found that female economists are less trusting than both male economists and female (and male) law students, which the authors suggested might mean “that being female and an economist at the same time fortifies distrust in others” (p. 3). They also concluded that the lack of trust amongst female economics students “appears to be further nurtured through the study of economics in an even stronger fashion than for male economics students” (p. 3), in sharp contrast to female law students who became more trusting over the course of their studies. Based on their research, Haucap and Müller (2014) further concluded that female economists are the least trustworthy demographic both at the beginning and even more so at the end of their studies.

Noting the research related to the dishonesty and uncooperativeness of economics students, Muñoz-Izquierdo, Gil-Gómez de Liaño, Rin-Sánchez, and Pascual-Ezama (2014) conducted a coin toss experiment, in which participants flipped a fair coin. One side was selected as a prize-winning side and the reward was a piece of chocolate. Reporting the prize-losing side led to loss of chocolate under one of three possible conditions: (a) no penalty, (b) paying a monetary penalty, or (c) paying an altruistic monetary penalty. Although the authors were not able to determine who specifically lied, a coin-flip follows a binomial distribution, and either side of the coin would appear on average 50 percent of the

time. Therefore, inferences could be made based on how often the prize-losing side was reported.

The authors (Muñoz-Izquierdo et al., 2014) found that when there was no punishment for lying, economic students reported the prize-winning side (took a piece of chocolate) 77 percent of the time, psychology students 53 percent of the time, and engineering students 60 percent of the time. When there was a threat of a monetary punishment for reporting the prize-losing side, 73 percent of economics students took the chocolate, while 70 and 67 percent of psychology and engineering students respectively did so. In other words, penalties persuade participants to cheat. Under the third, altruistic condition, economics and psychology students decreased the percentage of chocolates taken to 50 and 57 percent respectively, but engineering students did not (67 percent). No difference in cheating was found between genders. From this the authors concluded “that economics is significantly the most dishonest major when no penalty is involved . . . (but economics majors) have the most altruistic behavior” (Muñoz-Izquierdo et al., 2014, p. 2).

It is worth noting, however, both the ubiquity of laboratory experiments in economic research, and the significant manner in which they differ from lab experiments in other disciplines like psychology; namely that they often include a monetary reward for participation (Abeler and Nosenzo, 2015). To investigate the selection process in economic lab experiments, Abeler and Nosenzo (2015)

altered a recruitment letter sent to first-year university students inviting them to join the experimental subject pool. Subjects in the pool were given one of three possible treatments: (a) money for participating, (b) money and a plea for them to participate, and (c) a plea for them to participate for free. The authors found no significant differences in sign-up rates between economics students and non-economics students. Their conclusion was “that the main reason for students to self-select into becoming lab-experimental subjects is to earn money” (p. 22). Sadrieh and Schröder (2016) similarly concluded from their review of the literature “that human decision making is often . . . driven by materialistic incentives” (p. 114).

In almost every single experiment discussed thus far, students were given an endowment (Haucap & Müller, 2014; Hole, 2013; Marwell & Ames, 1981; McCannon, 2014; Sadrieh & Schröder, 2016; Wang et al., 2011; and Wang et al., 2014).¹ However, some of the literature also involved analysis of data obtained from sources other than experiments to validate or invalidate the authors’

¹ It is worth noting that asking students who have virtually no experience being financially independent whether they support giving a portion of an unearned endowment to support some hypothetical public good is arguably vastly different than asking mature adults, presumably with a great deal of experience being financially independent—or perhaps more accurately struggling to become financially independent—to sacrifice a portion of their earned income in support of some hypothetical public good. It may be worth speculating whether the differences between economic students and other students noted in some of the studies reviewed here may have disappeared had those same experiments asked instead that students sacrifice their own earned grade points rather than some unearned endowment. While economic students on average are no more likely to be financially independent than other students, “economics students acquire in their academic training insights that make them more appreciative of the beneficial roles of markets and economic freedom” (Fischer et al., 2017; p. 195).

hypotheses. Bauman and Rose (2011), for example, used administrative data on donations to social programs by students at the University of Washington to determine whether economists were less generous than other professionals and whether economic students were less generous than other students. Their data set allowed them to track student donations and economics training over time to distinguish selection effects from indoctrination effects.

According to Bauman and Rose (2011), the “bulk of the relevant academic literature” supports the belief that “economists are less generous than other professionals and that economics students are less generous than other students” (p. 318). They concluded

that economics majors . . . are less likely to donate than non-majors even prior to having any training in microeconomics, and there is no evidence that their donation rates are influenced by exposure to introductory or intermediate microeconomics. . . . [O]ur study lends support to the idea that the behavior of econ majors is primarily the result of selection, not indoctrination (p. 326).

Ruske (2015) argues that there is “a substantial body of research in the economic literature” (p. 240) showing economists and businessmen are lacking pro-social behavior, but what is lacking from the literature is compelling evidence that “shows whether the less-social [*sic*] behavior of economists compared to

others found in experiments and surveys also applies . . . in real world situations” (p. 241).

To empirically test the impact of an economics education on social behavior beyond an experimental situation—whether the less social behavior of economists found in experiments also applies in real world situations—Ruske (2015) analyzed the academic, demographic, and financial background of each of the 695 members of the United States Congress who served between 2005 and 2009, 154 of whom held a degree in economics. He relied on data provided by the non-profit organization Citizens for Responsibility and Ethics in Washington (CREW) regarding the number of corruption cases assigned to each member of Congress. His analysis found “the probability of an economist being corrupt is about twice as high as that of a non-economist” (p. 248).

To examine the impact of economics study on students’ values, Racko (2017) surveyed first- and second-year undergraduate students from the University of Latvia at the beginning and end of the academic year. The Schwartz Value Survey (SVS) was used to measure hedonism, power, universalism, and self-direction values. The author found that economics students valued hedonism and power more and self-direction less at the end of the academic year than they did at the beginning of the year, but detailed analysis “suggests that economics education had a relatively weak effect on student value change” (p. 7).

Recall, Racko (2017) said neoclassical economists believe economics is a science “devoid of human values” (p. 2), which implicitly assumes that the sort of self-serving behavior ascribed to neoclassical economists and students of neoclassical economics is immoral and unethical, and by extension, socially destructive, but little evidence for this position exists in the literature itself.² Wang et al. (2011) also noted that “sustained exposure to the assumptions and tools of economics may . . . provide people with assumptions, language and rationales that they can use to justify greedy behavior (p. 647). Zhong (2011) ominously suggested we should “think more carefully about the social consequences of economics education” (p. 19), while acknowledging the difficulty in assessing what he deems “the alarming shortcomings of economic education” (p. 20).

Critical Thinking

Cultivating students’ critical thinking skills is a major goal of American higher education (Roth, 2010). It is not a method to be learned, but rather a process, an orientation of the mind (Simpson & Courtney, 2002). In 1916, John Dewey proposed that critical thinking involves suspension of judgment and healthy skepticism (Higgins & Coffield, 2016). Twenty-five years later, more formal definitions began to appear in the literature, arguing that critical thinking is

² Again, it is worth noting that even if self-serving behavior is the antithesis of the sort of behavior required to construct a just society—one presumably free from the evils of greed and self-serving behavior—it’s a much bigger stretch to suggest that if not for neoclassical economists and their teachings there would be less selfishness, which is the logical conclusion their rhetoric leads one to draw. Neoclassical economists would likely argue that it was observed behavior that informed their theories, not the other way around.

an attitude and logical application of skills in problem-solving contexts (Glaser, 1941). Another two decades later that definition was expanded upon by Ennis (1962), who ultimately created the instrument used in this study to measure critical thinking. Ennis' definition was that critical thinking was a logical process and characterized it as the ability to critically assess the accuracy of statements.

Research has added to our understanding of what critical thinking is (Behar-Horenstein & Niu, 2011). Current conceptualizations suggest that critical thinking is a process of purposeful reflection that requires logic (Ennis, 1989). Simpson and Courtney (2002) suggest that critical thinking processes require active argumentation, initiative, reasoning, envisioning, analyzing complex alternatives, and making contingency-related value judgments. Others add that it involves scrutinizing differentiating and appraising information as well as reflecting on the information that will be used to make judgments and inform decisions (Banning, 2006).

Some prominent theorists view critical thinking as being “a composite of skills, knowledge and attitudes” (Simpson & Courtney, 2002, p. 6). For McPeck (1981), teaching someone to think critically entails both the cognitive and reasoning domains, what he referred to as “reflective skepticism” (p. 7). Brookfield (1988) adds that critical thinkers continually question assumptions of right and wrong. Kurfiss (1988) suggests that critical thinking is associated with the justification of beliefs and that argumentation is the process by which this

justification is presented. Bell (1991) extends Kurfiss' analysis, suggesting that debates can aid in the development of critical thinking skills.

Regardless, the question remains as to whether critical thinking is dependent on predispositions and purposeful reflection or whether it can be learned independent of disposition and reflection (Behar-Horenstein & Niu, 2011). The issue essentially centers on whether critical thinking skills can be promoted through instruction (Tsui, 2002). A large number of empirical studies have examined the effect of different teaching strategies and interventions aiming at promoting critical thinking skills among college student (Behar-Horenstein & Niu, 2011). However, their findings are inconclusive and the question remains: Should critical thinking instruction be integrated into subject-specific knowledge and skills, or should it be taught as a separate, generalized subset of skills (Ennis, 1989)? For the purposes of this study the former is assumed, but the findings herein will not conclusively answer that question one way or the other.

Definitions of critical thinking continue to appear in the literature. It was this multiplicity of definitions that led the American Philosophical Association to ask Peter Facione, a prominent critical thinking theorist, to convene a panel of other experts in 1987 (Simpson & Courtney, 2002). The panel sought to answer important questions about critical thinking (Facione, 1990), including what skills and dispositions characterize critical thinking, how can critical thinking be effectively taught, and how can critical thinking be assessed. The final report

notes that these “questions take on social, fiscal, and political dimensions when asked by campus curriculum committees, school district offices, boards of education, and the educational testing and publishing industries” (p. 2).

Their definition, referred to as a “consensus statement” in the report (Facione, 1990), is as follows:

We understand critical thinking [CT] to be 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. . . . CT is a pervasive inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers . . . combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society (p. 3).

The authors are careful to note that “not every useful cognitive process should be thought of as CT. . . . CT is one among a family of closely related forms of higher-order thinking, along with, for example, problem-solving, decision making, and creative thinking” (Facione, 1990, p. 12). Despite this overlap, there was widespread accord among the panel participants on which skills and sub-skills are consistent with critical thinking (Table 2-1).

According to Facione’s panel, in addition to possessing the cognitive skills listed in Table 2-1, the good critical thinker can be characterized by certain affective dispositions or habits of mind. In other words, a person who is proficient in a cognitive skill “can be said to have the aptitude to execute that skill” (Facione, 1990, p. 20). The report notes, however, that there was considerably less agreement among the panelists on whether the affective dispositions are part of the meaning of critical thinking in the same way the cognitive skills are.

Table 2-1 Consensus List of Critical Thinking Cognitive Skills and Sub-Skills

(Facione, 1990, p. 12)

Interpretation	Categorization Decoding Significance Clarifying Meaning
Analysis	Examining Ideas Identifying Arguments Analyzing Arguments
Evaluation	Assessing Claims Assessing Arguments
Inference	Querying Evidence Conjecturing Alternatives Drawing Conclusions
Explanation	Stating Results Justifying Procedures Presenting Arguments
Self-Regulation	Self-examination Self-correction

The dispositions identified by the panelists are listed in Table 2-2 and Table 2-3. The experts were quick to point out that they “are not saying that a person whose metaphysical, epistemological, political, cultural or religious view of the world is different from one’s own is, *ipso facto*, not a good critical thinker,” and explicitly eschewed “ideological conformity” as a basis of determining whether a person is or is not a critical thinker (Facione, 1990, p. 26). The panelists also made it a point to say they did not intend that each cognitive skill or

disposition be considered a necessary condition for a person to be a critical thinker.

More importantly for this study, the expert panel drafted a “consensus statement,” in which they identified four ways of assessing critical thinking skills (Facione, 1990): (1) observation of the person performing activities, processes, or procedures regarded as presupposing critical thinking; (2) comparing outcomes that result from executing an activity, process, or procedure regarded as presupposing critical thinking against a set of criteria; (3) comparing outcomes that result from executing a task that has been shown to correlate strongly with exercising a critical thinking skill; and (4) direct query of a person to receive their descriptions of the activity, process, or procedure they used as they exercised a critical thinking skill.

Table 2-2: Affective Dispositions of Critical Thinking (Facione, 1990, p. 25)

APPROACHES TO LIFE AND LIVING IN GENERAL:

- inquisitiveness with regard to a wide range of issues,
- concern to become and remain generally well-informed,
- alertness to opportunities to use CT,
- trust in the processes of reasoned inquiry,
- self-confidence in one's own ability to reason,
- open-mindedness regarding divergent world views,
- flexibility in considering alternatives and opinions,
- understanding of the opinions of other people,
- fair-mindedness in appraising reasoning,
- honesty in facing one's own biases, prejudices, stereotypes, egocentric or sociocentric tendencies,
- prudence in suspending, making or altering judgments,
- willingness to reconsider and revise views where honest reflection suggests that change is warranted.

Table 2-3: Affective Dispositions of Critical Thinking (Facione, 1990, p. 25)

APPROACHES TO SPECIFIC ISSUES, QUESTIONS OR PROBLEMS:

- clarity in stating the question or concern,
- orderliness in working with complexity,
- diligence in seeking relevant information,
- reasonableness in selecting and applying criteria,
- care in focusing attention on the concern at hand,
- persistence though difficulties are encountered,
- precision to the degree permitted by subject and circumstances.

Kurfiss (1988) suggests a range of strategies teachers can employ to encourage students to think critically, including writing assignments, answer questions that involve reasoning skills and the ability to organize and articulate knowledge, and discussing and debating solutions to complex problems. According to Kurfiss, “in critical thinking all assumptions are open to questioning, divergent views are aggressively sought, and the inquiry is not biased in favour of a particular outcome” (p. 2). Other researchers suggest the use of questioning, small group activity, role-play, and journaling as ways of teaching students to think critically (Simpson & Courtney, 2002). Still others provide guidelines for developing or selecting curriculum that will foster critical thinking (Behar-Horenstein & Niu, 2011).

Subsequent research has found that standardized tests like the Cornell Critical Thinking Test are also a concrete way to measure critical thinking (Terry & Ervin, 2012). Noted critical thinking theorist Robert H. Ennis created the CCTT (Ennis et al., 2005). His definition is that “critical thinking is reasonable and reflective thinking focused on deciding what to believe or do” (Ennis, 1993, p. 180). He elaborated on his definition by describing 10 things a person characteristically needs to do interdependently, delineated in Table 2-4.

Table 2-4 Ennis' Interdependent List of Abilities and Dispositions (Robert H.

Ennis, 1993, p.180)

1. Judge the credibility of sources.
2. Identify conclusions, reasons, and assumptions.
3. Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence.
4. Develop and defend a position on an issue.
5. Ask appropriate clarifying questions.
6. Plan experiments and judge experimental designs.
7. Define terms in a way appropriate for the context.
8. Be open-minded.
9. Try to be well informed.
10. Draw conclusions when warranted, but with caution.

Chapter 3

Research Methods

The purpose of this study is to determine whether learning economics aids students in the development of critical thinking skills by analyzing college students' performance on a critical thinking test both before (pretest) and after (posttest) they completed either a Principles of Microeconomics course or a Principles of Macroeconomics course. First, a paired-samples *t*-test was used to determine whether the mean difference between the students' pretest and posttest scores was statistically significantly different from zero. Second, the independent-samples *t*-test, unbalanced design, was then run to address the second research question, namely whether the mean difference between pretest and posttest scores of the macro students was statistically significantly different than the mean difference between pretest and posttest scores of the micro students. It was an unbalanced design because there are more micro students than macro students. Lastly, analysis of covariance (ANCOVA) was used to determine whether the mean posttest scores of the macro students was statistically significantly different than the mean posttest scores of the micro students after controlling for the students' pretest scores. The research design, sample selection, measures and procedures for analysis of the data are outlined in this chapter.

Research Design

In the current study, students at a large, urban research I university in the American Southwest, who were enrolled in either a Principles of Macroeconomics or Principles of Microeconomics course in the fall semester of 2018 were administered the Cornell Critical Thinking Test (CCTT) at the beginning and again at the end of the semester. The students used scantrons to answer the questions, and their answer sheets were coded per Table 3-1 and electronically scanned to determine their raw score (the number correct). Identifying information was redacted before statistical analysis began.

Table 3-1: Answer Sheets Coding Nomenclature

	Principles of Microeconomics	Principles of Macroeconomics
CCTT Pretest	11	12
CCTT Posttest	21	22

Sample Selection

True random sampling was not possible for this study because students self-enroll in economics courses based on their degree plan, course demand, instructor availability, etc. Both principles classes are popular with college students, as at least one if not both courses are required to complete every degree offered by the subject university's College of Business. Further, either course can

be used to meet the student's Social and Behavioral Sciences elective requirement. For those students required to take both as a sequence, most, though not all, will take their first in the fall semester and the other in the spring semester. Although, prior coursework completed by the students who participated in this study was not provided, the fall semester was selected specifically to ensure the likelihood that it was the first college economics class the students had taken at the *post-secondary* level.

At the beginning of the fall semester, 89 students in a Principles of Micro course had their pretest answer sheets scanned, while only 78 students in the same course had their posttest answer sheets scanned. Similarly, 99 students in a Principles of Macro course had their pretest answer sheets scanned, while only 72 had their posttest answer sheets scanned. Ten answer sheets were scanned but unreadable, leaving 140 answer sheets of students across both classes and who took both the pretest and the posttest. Of those, 4 students were unable to complete at least one of the tests and were removed from the sample, leaving a sample size of 136 students with paired pretest and posttest scores.

Measures

Previous studies that assess students' critical thinking abilities have used a myriad of measures of critical thinking (Borg & Stranahan, 2010). The Cornell Critical Thinking Test (CCTT) (R. H. Ennis et al., 1985) is one such instrument. CCTT has two forms, Level X, aimed at students in the fourth grade through the

first two years of college, and Level Z, is aimed at gifted high school, college and graduate students, and adults (Ennis, Millman, & Tomko, 2005).

The Level Z form is appropriate for this study not only because of its use with college students, but also because of its wider coverage of critical thinking aspects than the Level X form (Ennis et al., 2005). The CCTT-Z covers aspects of critical thinking such as induction, deduction, observation, credibility (“of statements made by others” p.2), assumptions and meaning (including “definition, sensitivity to meaning, and ability to handle equivocation,” p.2). There is considerable overlap and interdependence among the different critical thinking aspects covered.

As Facione (1990) reminds us, “[t]he development of valid and reliable assessment strategies from which teachers can draw reasonable inferences about students’ CT . . . is essential” (p. 30). To this end, the expert panel identified four considerations in evaluating the acceptability of a critical thinking assessment instrument: (1) content validity, (2) construct validity, (3) reliability, and (4) fairness.

Content validity will be addressed shortly. Construct validity means that each question on the assessment have been evaluated to insure correct answers indicates adequate critical thinking and that incorrect responses indicates inadequate critical thinking (Facione, 1990). Ennis (2005) argues that “a great deal of information about a test must be available before a construct validity

judgment can be made,” (p. 20) and that despite forty years of use he could only say that the Cornell Critical Thinking Test is likely substantially valid.

Based on Messick (1988), Ennis (2005) identified eleven sorts of information that are relevant to a construct validity judgment about the Cornell Critical Thinking Test. These are enumerated in Table 3-2.

The first three items listed in Table 3-2 correlate best to Facione's (1990) idea of content validity. Under Facione (1990), content validity refers to whether the instrument is based on an appropriate conceptualization of critical thinking and an understanding of which aspects of critical thinking are being targeted. Ennis (2005) addresses content validity head on in the Administration Manual for the Cornell Critical Tests by exploring first “whether the conception of critical thinking ability on which these tests are based is a satisfactory conception,” and second, “whether the items fairly represent the content of the . . . conception of critical thinking (and other closely-related conceptions)” (p. 21).

Table 3-2 Information Relevant to Construct Validity Judgment (R. Ennis et al.,
2005)

1. The rationale upon which the tests are built.
2. The degree to which the tests appear to cover the items in the rationale.
3. Reasonable judgments about the acceptability of the answers.
4. Simple internal statistical analyses, such as item analyses and internal consistency indices.
5. Consistency of test results over time for individuals (including test-retest consistency).
6. Correlations between the test and other tests and criteria intending to assess roughly the same thing.
7. Correlations between the test and assorted other variables.
8. Consistency across groups or settings (generalizability).
9. Results of experimental studies in which the test was used as an indicator of critical thinking ability.
10. Factor analyses.
11. The contribution the tests have made to our knowledge of the relationship between critical thinking ability and other things.

Ennis' (1962) conceptualization of critical thinking is based primarily in particular skills, such as observing, inferring, generalizing, reasoning, evaluating reasoning, and other, similar skills. This conceptualization is supported by other education theorists, but some are critical of his conception's exclusive dependence on skills, to which he has responded by including more recently in his definition a notion of a tendency to think critically (Mason, 2009). Ennis' conceptualization of critical thinking is widely regarded in the literature, and the Cornell Critical Thinking test is internationally regarded for assessing critical thinking skills (Sahin, French, Hand, & Gunel, 2015).

Table 3-3 suggests that most of the skills identified by Ennis (2005) and Facione (1990) in their definitions of critical thinking are reasonably represented by the items in the Cornell Critical Thinking Test, Level Z. Only the "value judging" aspect of critical thinking is not tested and "dispositions" is only indirectly addressed by the instrument (Ennis et al.).

Table 3-3 Aspects of Critical Thinking Incorporated in the Cornell Critical Thinking Test, Level Z and Rough Assignment of Items Thereto (Ennis et al., 2005)

Aspects of Critical Thinking	Items of Level Z
Induction	17, 26-42
Deduction	1-10, 39-52
Value Judging	not tested
Observation	22-25
Credibility	22-25
Assumptions	43-52
Meaning	11-21, 43-46
Dispositions	not directly tested

The basic notion of test validity is that “a test is valid to the extent that it measures what it is supposed to measure” (Ennis et al., 2005,p. 18). The trouble with this is test scores also depend on the circumstances of assessment. A more appropriate definition, therefore, is an assessment is valid to the “extent to which the test measures what it is supposed to measure in . . . *conditions that do not adversely affect performance on a test*” (emphasis mine; p. 19). Users of the Cornell Critical Thinking Test, therefore, are cautioned by Ennis to evaluate the

conditions under which the test is administered and determine the extent to which validity is weakened, if at all.

Item #4 and #5 in Table 3-2 relates to analysis of questions on the instrument and their reliability, the latter of which correlates to Facione's (1990) third consideration. Analyzing instrument questions shows the extent to which an item correlates with the total score, known as the discrimination value, as well as indicating the proportion of a sample that answered an item correctly, known as a difficulty index (R. Ennis et al., 2005). Item discrimination estimates and the values of difficulty indices are provided in Table 3-4.

Table 3-4 Item Discrimination Estimates and Difficulty Indices (R. Ennis et al., 2005)

SAMPLE SIZE	DISCRIMINATION VALUE	MEAN DIFFICULTY INDEX
224	0.23	0.57
62	0.24	N/A
100	0.22	0.55
100	0.23	0.61

Reliability refers to whether good critical thinkers generally do better than weak critical thinkers on each question (Facione, 1990). One way of estimating this is to correlate the odd-numbered items with the even-numbered items (R.

Ennis et al., 2005). Estimates for this correlation vary with a high of 0.76 and a low of 0.55.

Item #6 in Table 3-2 relates to what Ennis (2005) calls criterion-related evidence of validity and is best estimated from correlations with other critical thinking tests. These correlations between Level Z and other critical thinking tests ranged around 0.50. The last five items (#7-#11) in Table 3-2 related to construct validity, covered earlier.

The last of Facione's (1990) considerations, fairness, simply means that the instrument “should not unfairly disadvantage or advantage groups of students on the grounds of reading ability, domain-specific knowledge, . . . gender or age-related life experience, ethnicity or socio-economic status, differences in social norms or differences in cultural assumptions” (p. 31). This, too, is addressed directly in the Cornell Critical Thinking Tests Administration Manual (R. Ennis et al., 2005). Correlations between IQ/Aptitude and the Level Z range from 0.25 to 0.71. Gender was found to not significantly correlate to critical thinking, while academic accomplishment correlations ranged between -0.02 and 0.38 (one outlier score of 0.62 was reported as well). The instrument was found to be as good as the Graduate Record Exam as a predictor of grades in graduate school. Only one study correlated the Level Z with socio-economic status, with a low positive correlation of 0.24.

Data Analyses Procedures

There are three research questions in this study. Each of these questions will be discussed in turn and the analysis conducted to determine the statistically appropriate answer to the question will be detailed. Recall that 136 students from a large, urban research I university in the American Southwest were administered a critical thinking test at both the beginning and again at the end of a Principles of Macroeconomics or Principles of Microeconomics course during the fall semester of 2018. Their pretest and posttest scores were analyzed using IBM® SPSS® Statistics, Version 23.

Research Question Number One

The first question is whether the mean difference between pretest and posttest scores is statistically significant. The paired-samples *t*-test is appropriate to address this question; it is regularly used to determine whether the mean difference between paired test scores is statistically significantly different from zero (Laerd Statistics, 2015b).

For results of a paired-samples *t*-test to be valid, the data had to meet four critical assumptions (Laerd Statistics, 2015b): (1) there could only be one continuous dependent variable; (2) there is one dichotomous independent variable; (3) there are no outliers in the data set; and (4) the difference in pretest and posttest scores was normally distributed. The results of the assumption tests are presented in AnalysisChapter 4.

The null hypothesis related to whether the mean difference between pretest and posttest scores is statistically significant is simply $H_0: \mu_{diff} = 0$, and the alternative hypothesis is $H_A: \mu_{diff} \neq 0$. Please see Chapter 4 for a detailed analysis of the results of this hypothesis test.

Research Question Number Two

The second research question to be addressed for this study is whether the mean difference between pretest and posttest scores of the macro students is statistically significantly different than the mean difference between pretest and posttest scores of the micro students. The independent-samples t -test, unbalanced design, is used to determine whether there are any statistically significant differences between the means of two independent groups (Laerd Statistics, 2015a), such as students who took Principles of Microeconomics and students who took Principles of Macroeconomics class. It is an unbalanced design because there are more students in the Principles of Microeconomics group ($n = 81$) than in the Principles of Macroeconomics group ($n = 55$).

For the results of the independent-samples t -test to be valid there are six assumptions that must be considered (Laerd Statistics, 2015a): (1) there is one continuous dependent variable; (2) there is one dichotomous independent variable; (3) the observations are independent; (4) there should be no outliers; (5) the dependent variable is normally distributed; and (6) the variance of the test score differences of the macro students is equal to the variance of the test score

differences of the micro students. The results of the assumption tests are presented in AnalysisChapter 4.

The null hypothesis related to whether the mean difference between pretest and posttest scores of the macro students is statistically significantly different than the mean difference between pretest and posttest scores of the micro students is $H_0: \mu_{micro} = \mu_{macro}$, and the alternative hypothesis $H_A: \mu_{micro} \neq \mu_{macro}$. Please see Chapter 4 for a detailed analysis of the results of this hypothesis test.

Research Question Number Three

The third and final research question is whether the mean posttest scores of the macro students is statistically significantly different than the mean posttest scores of the micro students after controlling for the students' pretest scores. One-way analysis of covariance (ANCOVA) is commonly used to determine whether there are any statistically significant differences between covariate-adjusted means of two or more independent (unrelated) groups (Laerd Statistics, 2017). This test is used when a covariate, in this case, the pretest scores, is believed to be exerting some influence over the results.

For the results of one-way ANCOVA to be valid, the data must satisfy ten assumptions (Laerd Statistics, 2017): (1) there must be one continuous, dependent variable; (2) there must be one independent variable consisting of two independent groups; (3) there must be one continuous, independent covariate

variable; (4) no relationship exists between the observations in each group of students and between the groups themselves; (5) the pretest scores had to be linearly related to the posttest scores across both groups of students; (6) there is no interaction between the pretest scores; (7) the posttest scores are approximately normally distributed for each group of students; (8) the random disturbance in the relationship between the independent variables and the dependent variable is the same across all values of the independent variables; (9) the variance of the residuals is equal for all groups of the independent variable; and, finally, (10) there should be no significant outliers in the posttest scores of either group of students. The results of the assumption tests are presented in AnalysisChapter 4.

Chapter 4

Analysis

In this chapter, I will present the findings of the statistical analysis described in the previous chapter. Recall 136 students at a large, urban research I university in the American Southwest were administered a critical thinking test at the beginning and again at the end of the fall 2017 semester. All the students in the sample were enrolled in either a Principles of Microeconomics or a Principles of Macroeconomics course, and the instrument used to measure their critical thinking was the Cornell Critical Thinking Test, form Z (CCTT-Z). The test score data is summarized in Table 4-1.

Also recall the three research questions are (1) whether the mean differences between pretest and posttest scores is statistically significant; (2) whether the mean difference between pretest and posttest scores of the macro students is statistically significantly different than the mean differences between pretest and posttest scores of the micro students; and lastly, (3) whether the mean difference in posttest scores of the macro students were statistically significantly different than the posttest scores of the micro students after controlling for the students' pretest scores.

Table 4-1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Pretest	136	10	37	25.16	4.842	23.440
Posttest	136	11	42	25.04	5.580	31.139
Test Score Differences	136	-11	9	-.12	4.437	19.690
Valid N (listwise)	136					

Research Question Number One

A paired-samples *t*-test was run to determine whether the mean difference between the critical thinking pretest and posttest scores of the students studying economics is statistically significant. Formally, the paired-samples *t*-test will test the following hypotheses:

$$H_0: \mu_{diff} = 0$$

$$H_A: \mu_{diff} \neq 0$$

For results of a paired-samples *t*-test to be valid, the data had to meet four critical assumptions (Laerd Statistics, 2015b). First, there could only be one continuous dependent variable, in this case the difference between pretest and posttest critical thinking test scores. The second assumption is that there is one dichotomous independent variable, in this case whether the test score is from a micro student or a macro student. A third assumption, that there are no outliers in the data set, was assured upon visual inspection of a boxplot of the data, seen in Figure 4-1. The fourth and final assumption is that the difference in pretest and posttest scores was normally distributed. With a sample size this large ($n = 136$),

visual inspection of the Normal Q-Q Plot (Figure 4-2) provides ample evidence of normality. In this case, the differences between the pretest and posttest scores were normally distributed.

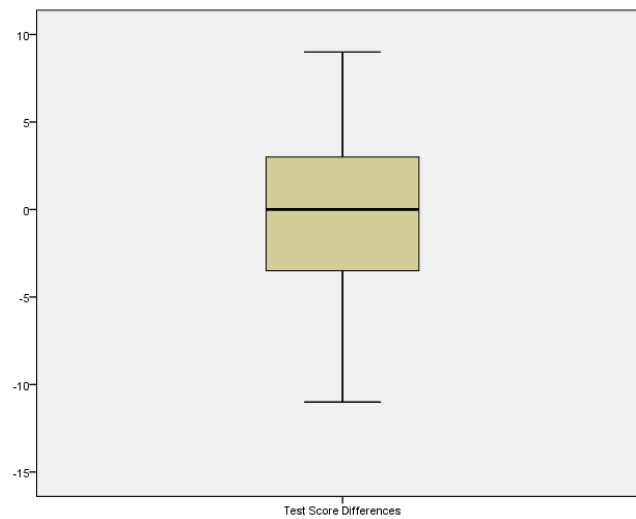


Figure 4-1: Boxplot of Pretest and Posttest Score Differences

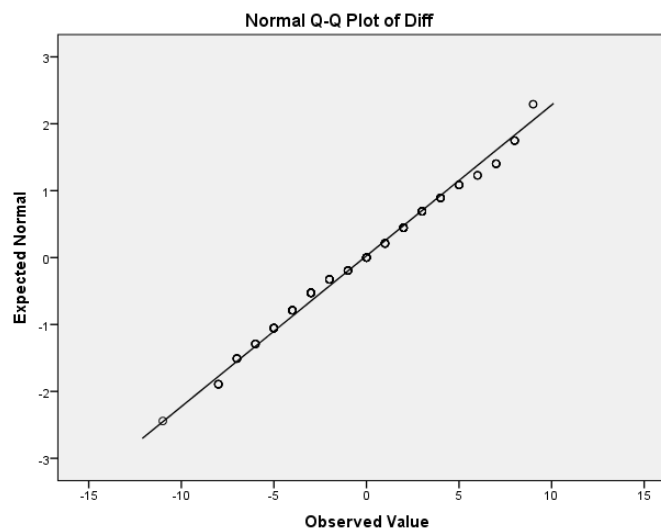


Figure 4-2: Normal Q-Q Plot of Pretest and Posttest Score Differences

Results for Research Question Number One

On average, student participants scored higher on the critical thinking pretest ($M = 25.16, SD = 4.84$) than on the posttest ($M = 25.04, SD = 5.58$; Table 4-2). The mean difference between students' pretest and posttest scores ($\mu_{post} - \mu_{pre}$) was -0.12 points, 95% $CI [-0.87, 0.64]$ (Table 4-3). The mean difference was not statistically significant, $t(135) = -0.31, p = 0.76$. Therefore, I am unable to reject the null hypothesis that the mean difference between the critical thinking pretest and posttest scores of economics students is equal, as $p > 0.05$. The effect size, as measured by *Cohen's d*, is small ($d < 0.2$):

$$d = M/SD \text{ (Laerd Statistics, 2015b)}$$

$$d = -0.118/4.437 = -6.75 \times 10^{-5}$$

Table 4-2: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Posttest	25.04	136	5.580	.478
	Pretest	25.16	136	4.842	.415

Table 4-3: Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Posttest - Pretest	-.118	4.437	.380	-.870	.635	-.309	135	.758

Research Question Number Two

The second research question to be addressed for this study is whether the mean difference between pretest and posttest scores of the macro students is statistically significantly different than the mean difference between pretest and posttest scores of the micro students. The independent-samples *t*-test, unbalanced design, is used to determine whether there are any statistically significant differences between the means of two independent groups (Laerd Statistics, 2015a), such as students who took Principles of Microeconomics and students who took Principles of Macroeconomics class. It is an unbalanced design because there are more students in the Principles of Microeconomics group ($n = 81$) than in the Principles of Macroeconomics group ($n = 55$). Formally, the independent samples *t*-test tested the following hypotheses:

$$H_0: \mu_{micro} = \mu_{macro}$$

$$H_A: \mu_{micro} \neq \mu_{macro}$$

For the results of the independent-samples *t*-test to be valid there are six assumptions that must be considered (Laerd Statistics, 2015a). The first assumption is the same as for the paired-samples *t*-test, namely that there is one continuous dependent variable, in this case the difference between pretest and posttest critical thinking test scores. The second assumption is, again the same as for the paired-samples *t*-test, which is that there is one dichotomous independent variable, in this case whether the test score is from a micro student or a macro

student. The third assumption is that the observations are independent, meaning there is no relationship, in this case, between the pretest and posttest scores of micro and macro students. Although it is possible that students in one class had taken the other course prior to the start of the semester, their test scores were nonetheless independent of the students in that other class at the times the tests were administered.

Assumptions four and five are again the same as assumptions three and four for the paired-samples *t*-test, namely that there should be no outliers and the dependent variable is normally distributed (Laerd Statistics, 2015a) and, again, as assessed by a simple visual inspection of a boxplot of both groups' test score differences (Figure 4-3) and Normal Q-Q Plots (Figure 4-4 and Figure 4-5) from both groups' test score differences, both assumptions are met.

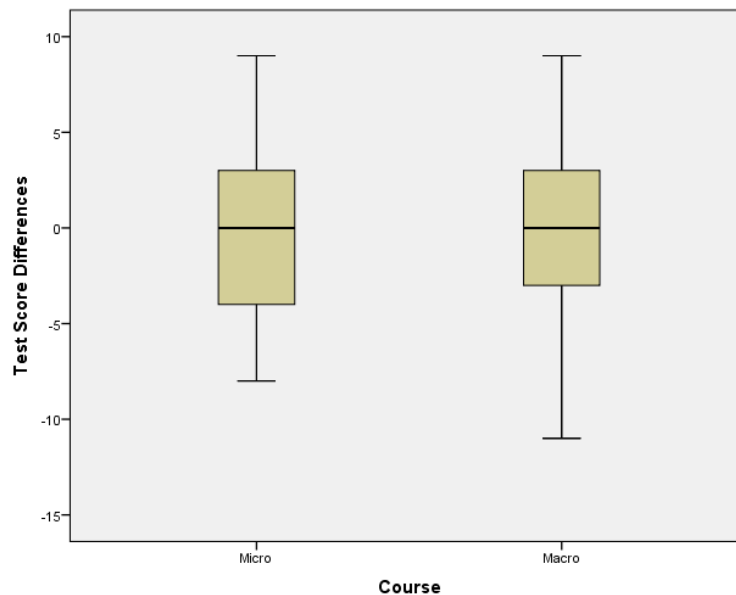


Figure 4-3: Boxplot of Pretest and Posttest Score Differences by Group

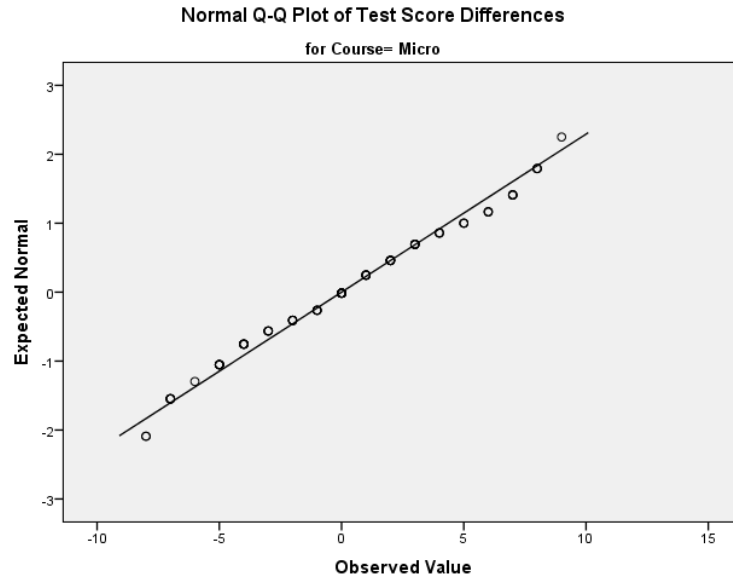


Figure 4-4: Normal Q-Q Plot of Test Score Differences of “Micro” Students

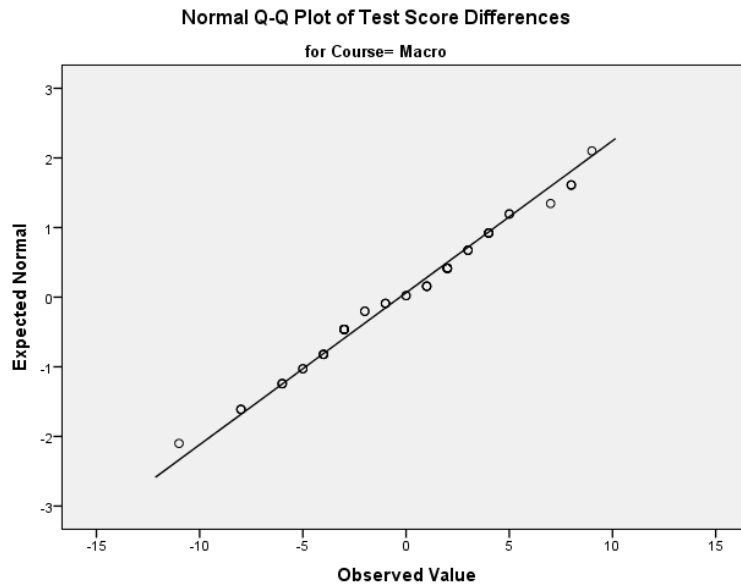


Figure 4-5: Normal Q-Q Plot of Test Score Differences of “Macro” Students

The sixth and last assumption is that the variance of the test score differences of the macro students is equal to the variance of the test score

differences of the micro students—this assumption is referred to as the homogeneity of variances (Laerd Statistics, 2015a). Because the sample sizes of the two groups are quite different, the independent-samples *t*-test may be sensitive to the violation of this assumption. Fortunately, Levene’s test for equality of variances, which tests that the variances of the test score differences for both groups of students are equal ($H_0: \sigma^2_{micro} = \sigma^2_{macro}; H_A: \sigma^2_{micro} \neq \sigma^2_{macro}$), showing homogeneity of variances ($p = 0.474$).

Results for Research Question Number Two

On average, macro students test score differences were larger than micro student test score differences ($\mu_{macro} = 0. -0.29; \mu_{micro} = 0.0$), but as indicated in Table 4-4, macro students performed worse on the posttest than they did on the pretest, unlike micro students, whose posttest scores were on par with their pretest scores. Specifically, macro student mean score differences was 0.29 points lower than micro student mean score differences, 95% *CI* $[-1.25, 1.83]$, which was not statistically significant, $t(134) = 0.37, p = 0.71$ (see Table 4-5). Therefore, I am unable to reject the null hypothesis that the mean difference between pretest and posttest scores of micro students is equal to the mean difference between pretest and posttest scores of macro students, as $p > 0.05$. The effect size is small:

$$d = \frac{|M_{micro} - M_{macro}|}{\sqrt{\frac{s_{micro}^2(n_{micro}-1) + s_{macro}^2(n_{macro}-1)}{n_{micro} + n_{macro} - 2}}} \text{ (Laerd Statistics, 2015a)}$$

$$d = \frac{|0.00 - (-0.29)|}{\sqrt{\frac{4.36^2(81-1) + 4.58^2(55-1)}{81+55-2}}} = \frac{0.29}{\sqrt{\frac{1,520.77 + 1,132.73}{134}}} = \frac{0.29}{4.45} = 0.065$$

Table 4-4: Group Statistics

Course	N	Mean	Std. Deviation	Std. Error Mean
Test Score Differences Micro	81	.00	4.362	.485
Macro	55	-.29	4.581	.618

Table 4-5: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Test Score Differences	Equal variances assumed	.517	.474	.374	134	.709	.291	.778	-1.247	1.829
	Equal variances not assumed			.371	112.232	.712	.291	.785	-1.265	1.847

Research Question Number Three

The third and final research question is whether the mean posttest scores of the macro students is statistically significantly different than the mean posttest scores of the micro students after controlling for the students' pretest scores. One-way analysis of covariance (ANCOVA) is commonly used to determine whether there are any statistically significant differences between covariate-adjusted means of two or more independent (unrelated) groups (Laerd Statistics, 2017).

This test is used when a covariate, in this case, the pretest scores, is believed to be exerting some influence over the results.

For the results of one-way ANCOVA to be valid, the data must satisfy 10 assumptions (Laerd Statistics, 2017). As with the previous tests, there must be one continuous, dependent variable—the students' posttest scores, in this case.

Similarly, the second assumption is that there must be one independent variable consisting of two independent groups. In this case, one group consists of micro students, and the other group consists of macro students. Unique to this test, a third assumption requires a continuous, independent covariate variable, in this case the students' pretest scores. The fourth assumption that must be met is that no relationship exists between the observations in each group of students and between the groups themselves. Each student in each group took the test independent of the other students in their group, and, likewise, no student was in both groups. Therefore, we can safely say that the fourth assumption has been met.

The fifth assumption that was met is that the pretest scores had to be linearly related to the posttest scores across both groups of students (Laerd Statistics, 2017), which was assessed by visual inspection of a scatterplot (Figure 4-6). The sixth assumption is that there is no interaction between the pretest scores, which was assessed by determining whether there was a statistically significant interaction term between the pretest scores and the two groups of

students. The interaction term, in fact, was not statistically significant, $F(1, 132) = 0.363, p = 0.548$ (Table 4-6), and the assumption of homogeneity of regression slopes was satisfied.

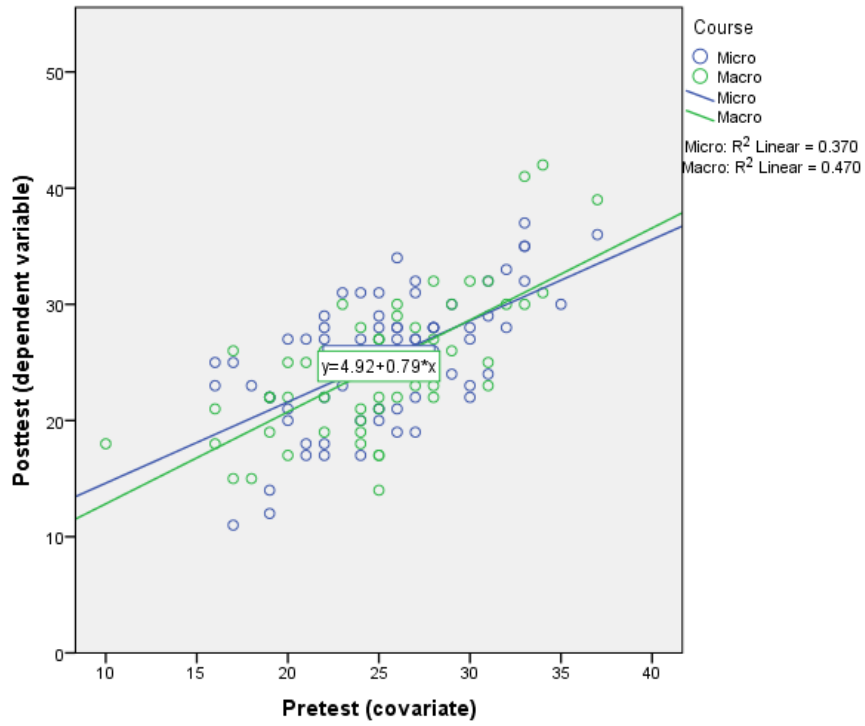


Figure 4-6: Scatterplot of the Posttest Scores Against the Pretest Scores by Course

Table 4-6: Tests of Between-Subjects Effects to Test Homogeneity of Regression

Slopes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1764.197 ^a	3	588.066	31.819	.000
Intercept	189.618	1	189.618	10.260	.002
Course	8.789	1	8.789	.476	.492
Pretest	1749.606	1	1749.606	94.669	.000
Course * Pretest	6.713	1	6.713	.363	.548
Error	2439.538	132	18.481		
Total	89504.000	136			
Corrected Total	4203.735	135			

a. R Squared = .420 (Adjusted R Squared = .406)

The seventh assumption is that the posttest scores are approximately normally distributed for each group of students (Laerd Statistics, 2017). One-way ANCOVA is considered robust to violations of normality, which means that some violation of this assumption can be tolerated, but unfortunately there is no consensus over how best to ensure that the normality of distributions assumption is met. I used two methods to verify this assumption is met, both of which utilize the Shapiro-Wilk test for normality, but where one method tests within-group residuals, the other tests the overall model fit. In both cases, standardized residuals were normally distributed, with $p > 0.05$ (Table 4-7 and Table 4-8).

Table 4-7: Tests of Normality, Within-groups Residuals

		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for Posttest	Micro	.083	81	.200*	.978	81	.175
	Macro	.074	55	.200*	.987	55	.805

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 4-8: Tests of Normality, Overall Model Residuals

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for Posttest	.057	136	.200*	.992	136	.665

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Another important assumption is that the random disturbance in the relationship between the independent variables and the dependent variable is the same across all values of the independent variables (Laerd Statistics, 2017). This is known as homoscedasticity, which was assessed by visual inspection of a scatterplot diagram of the standardized residuals plotted against the predicted values. The scatterplot clearly shows the standardized residuals are randomly scattered with approximately constant spread (Figure 4-7), which confirms the presence of homoscedasticity.

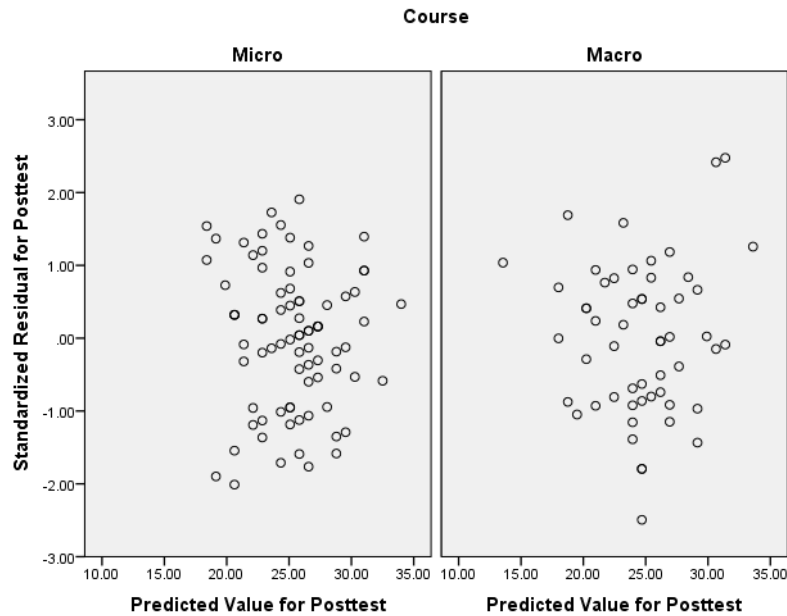


Figure 4-7: Scatterplot Diagram of the Standardized Residuals Plotted Against the Predicted Values For Each Course

One-way ANCOVA also assumes that the variance of the residuals is equal for all groups of the independent variable (Laerd Statistics, 2017), which is known homogeneity of variances. This assumption is met as assessed by Levene’s test of homogeneity of variance, $p = 0.618$ (Table 4-9).

Table 4-9: Lavene’s Test of Equality of Error Variances

Dependent Variable: Posttest

F	df1	df2	Sig.
.250	1	134	.618

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

The tenth and final assumption is that there should be no significant outliers in the posttest scores of either group of students. For the purposes of this study, an outlier will be any standardized residuals where the posttest score is greater than ± 3 standard deviations. Table 4-10 lists the standard deviation ($\sigma = 0.99256$) and the minimum and maximum score residuals are less than ± 3 standard deviations (± 2.97768). Visual inspection of the boxplot (Figure 4-8: Boxplot of the Standardized Residuals for the Posttest Scores) for both student groups likewise confirms there are no significant outliers.

Table 4-10: Brief Descriptive Statistics of Standardized Residual for Posttest Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Standardized Residual for Posttest	136	-2.49	2.48	.0000	.99256
Valid N (listwise)	136				

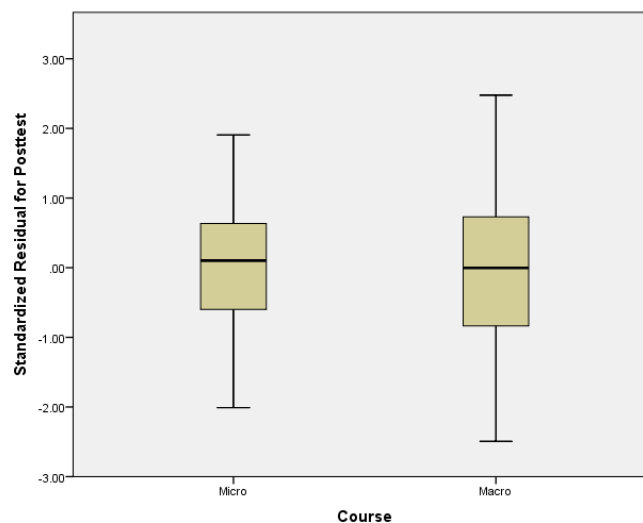


Figure 4-8: Boxplot of the Standardized Residuals for the Posttest Scores

Results for Research Question Number Three

The unadjusted mean posttest score (Table 4-11) of the micro students ($M = 25.3, SD = 5.2$ points) is greater than the unadjusted mean posttest score of the macro students ($M = 24.65, SD = 6.1$ points). Similarly, the adjusted mean posttest score (

Table 4-12) of the micro students ($M = 25.2, SD = 0.48$ points) is greater than the adjusted mean posttest score of the macro students ($M = 24.82, SD = 0.58$ points). After adjusting for pretest scores, no statistically significant difference could be found between the posttest scores of macro students and micro students, $F(1, 133) = 0.26, p = 0.61, \text{partial } \eta^2 = 0.002$ (Table 4-13).

Table 4-11: Descriptive Statistics

Dependent Variable: Posttest

Course	Mean	Std. Deviation	N
Micro	25.31	5.217	81
Macro	24.65	6.105	55
Total	25.04	5.580	136

Table 4-12: Estimates

Dependent Variable: Posttest

Course	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Micro	25.200 ^a	.477	24.257	26.142
Macro	24.815 ^a	.579	23.671	25.960

a. Covariates appearing in the model are evaluated at the following values: Pretest = 25.16.

Table 4-13: Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1757.484 ^a	2	878.742	47.776	.000	.418
Intercept	192.438	1	192.438	10.463	.002	.073
Pretest	1743.469	1	1743.469	94.790	.000	.416
Course	4.832	1	4.832	.263	.609	.002
Error	2446.251	133	18.393			
Total	89504.000	136				
Corrected Total	4203.735	135				

a. R Squared = .418 (Adjusted R Squared = .409)

Chapter 5

Conclusions

This study sought to address three questions all related to the broad hypothesis that learning college economics will aid students in the development of critical thinking skills. A paired-samples *t*-test was run to determine whether the mean difference between the critical thinking pretest and posttest scores of the students studying economics was statistically significant. The mean difference between students' pretest and posttest scores was, in fact, not statistically significant. The effect size, as measured by *Cohen's d*, was small.

The independent-samples *t*-test was used to determine whether there were statistically significant differences between the students who took Principles of Microeconomics and the students who took Principles of Macroeconomics class. The mean difference between pretest and posttest scores of micro students was not statistically significant to the the mean difference between pretest and posttest scores of macro students. The effect size was, again, small.

Finally, one-way analysis of covariance (ANCOVA) was used to determine whether there were statistically significant differences between means of the critical thinking posttest scores of the micro and macro students after controlling for pretest scores. This test was used to determine whether the pretest scores were exerting some influence over the posttest results. However, after

adjusting for pretest scores, no statistically significant difference could be found between the posttest scores of macro students and micro students.

In all three cases, the results could not be clearer nor more consistent. Statistical analysis of the test scores of micro and macro students did not find statistically significantly different critical thinking test scores after taking their economics course. This result is not particularly surprising as it is rather unrealistic to suppose critical thinking skills can develop over such a short period of time or simply by taking a single class. A more robust study that tested students' critical thinking skills as entering freshman and again just prior to graduation might more effectively help policy makers and administrators determine whether certain degree paths improve students' critical thinking skills more than other degree paths.

It is also worth mentioning that students scored higher on average on the critical thinking pretest than on the posttest—0.12 points lower, to be precise (Table 4-1). While this difference was not found to be statistically significant it is remarkable that students would lose even a small fraction of their critical thinking skills after taking an introductory economics course. The critical thinking posttest was administered at the end of a long semester, and perhaps in the absence of an incentive to the contrary, students simply did not take the critical thinking posttest as seriously as they might have otherwise.

Further, it would be wrong to interpret the results of this study to mean that taking economics does not affect the development of critical thinking skills. Not only is such a conclusion not warranted given the results of a single study, but strictly statistically speaking, the only true conclusion that can be drawn from this study is that we simply do not know to any degree of statistical certainty whether taking an introductory economics course will statistically significantly improve student's critical thinking skills. Recall that Borg and Stranahan (2010) compared the scores of their students on the Test of Understanding College Economics (TUCE) to those same students' scores on the Watson-Glaser Critical Thinking Appraisal (WGCTA-S) and found that those students who gained a high level of economic understanding in their introductory economics class did in fact have statistically significant gains in critical thinking.

Finally, it is worth noting that the mean difference between pretest and posttest scores of those students with the 10 lowest pretest scores regardless of which economics course they took was almost eight points (Table 5-1)—a statistically significant difference. Similarly, the mean difference between pretest and posttest scores of those students with the 10 highest pretest scores was almost two points—also statistically significant. This hints at the possibility that learning economics may, in fact, statistically significantly affect critical thinking test scores. A more detailed analysis of the data may unearth similarly compelling evidence of such an effect. For example, a narrower definition of a pretest-posttest

difference outlier might remove scores that are adversely affecting the mean difference calculation, revealing a statistically significant relationship. However, manipulating the data to produce specific results opens up challenges to the validity of the research.

Table 5-1: Lowest and Highest Test Score Comparison

Lowest 10 Pretest Scores	Matching Posttest Score	Highest 10 Pretest Scores	Matching Posttest Score
17	25	33	35
18	23	33	35
16	25	33	35
17	25	37	36
16	25	33	35
16	25	35	30
18	23	33	35
17	25	37	36
10	18	33	35
17	25	34	42
16	25	34	42
$\mu = 16.18$	$\mu = 24.00$	$\mu = 34.09$	$\mu = 36.00$

As noted earlier, developing the ability to think critically “can help people overcome the blind, sophistic, or irrational defense of intellectually defective or biased opinions . . . (and) promote rational autonomy, intellectual freedom and the objective, reasoned and evidence-based investigation of a very wide range of personal and social issues and concerns” (Facione, 1990). One can argue that public education should include the nurturing of those civic and personal values which insure that the heritage of intellectual, political and economic freedom will

be passed to future generations. Therefore, effort should be made to uncover not just how critical thinking develops in young students and what educators and policy makers can do to facilitate its development, but also whether there are disciplines or subdisciplines or courses within disciplines and subdisciplines that are conducive to the development of critical thinking skills in its students. This study is merely my small contribution to that cause.

Appendix A:

Institutional Review Board Notification of Exemption (Redacted)

**Institutional Review Board
Notification of Exemption**

July 27, 2017

Jack Reynolds
Dr. James Hardy
Educational Leadership

Box 19575

Protocol Number: 2017-0778

Protocol Title: *At the Intersection of Critical Thinking and Economics Education: Exploring Whether Learning Economics Aids in The Development of Critical Thinking in Undergraduate Students*

EXEMPTION DETERMINATION

The Institutional Review Board (IRB) Chair, or designee, has reviewed the above referenced study and found that it qualified for exemption under the federal guidelines for the protection of human subjects as referenced at Title 45CFR Part 46.101(b)(1).

- (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

You are therefore authorized to begin the research as of July 27, 2017.

Pursuant to Title 45 CFR 46.103(b)(4)(iii), investigators are required to, “promptly report to the IRB any proposed changes in the research activity, and to ensure that such changes in approved research, during the period for which IRB approval has already been given, are **not initiated without prior IRB review and approval** except when necessary to eliminate apparent immediate hazards to the subject.” All proposed changes to the research must be submitted via the electronic submission system prior to implementation. Please also be advised that as the principal investigator, you are required to report local adverse (unanticipated) events to the Office of Research Administration; Regulatory Services within 24 hours of the occurrence or upon acknowledgement of the occurrence. All investigators and key personnel identified in the protocol must have documented Human Subject Protection (HSP) Training on file with this office. Completion certificates are valid for 2 years from completion date.

The Office of Research Administration; Regulatory Services appreciates your continuing commitment to the protection of human research subjects. Should you have questions or require further assistance, please contact Regulatory Services at regulatoryservices@uta.edu or 817-272-2105.

Appendix B:
Student Consent Form (Redacted)

Critical Thinking & Economics Education Research Project

Participants MUST BE at least 18 years old to participate

Dear Participant:

You are invited to participate in a research study. The information in this form is written to assist you with deciding whether to participate. Please ask if you have any questions.

We are requesting your voluntary participation in a research study titled, "At the Intersection of Critical Thinking and Economics Education: Exploring Whether Learning Economics Aids in The Development of Critical Thinking in Undergraduate Students." You are being asked to be in this study because you are currently enrolled in principles of macroeconomics (ECON 2305) and/or principles of microeconomics (ECON 2306). This study will take place during the fall semester of 2017, during which time all students enrolled in ECON 2305/6 will be administered the Cornell Critical Thinking Test (CCTT) by the economics department at the . The test will be administered twice during the semester: once at the beginning of the semester before any economics instruction has been given, and again at the end of the semester after all economics instruction has been given.

Your decision to participate in this study does not affect the economics department's decision to administer the CCTT this semester. We are, however, also seeking your permission to use your test scores in a dissertation study, the purpose of which is to empirically test whether learning economics can improve college students' critical thinking abilities as measured by nationally normed assessments of critical thinking skills.

Specifically, a doctoral student is seeking your permission to access your test scores and be provided with data collected by the university to include the total credit hours completed prior to the start of the fall of 2017, the total number of semester credit hours attempted during the fall of 2017, as well as your ethnicity, race, and gender. This doctoral student will NOT have access to personally identifiable information. All data will be matched to test scores and deidentified by Dr. Tim Wunder, Clinical Assistant Professor of Economics and member of my dissertation committee, prior to the doctoral student's access and analysis. Only authorized individuals will be allowed to access the data used in the study. If results of the study are published or presented, names and other identifiable information will not be used.

There are no perceived risks for participating in this research study, but potential benefits associated with your participation include a better understanding of the role economics education plays in students' development of critical thinking skills. The doctoral student conducting the research is Jack Reynolds; he is the Principal Investigator for the study.

By signing this form, you have (1) read and understood this consent form, (2) have had the consent form explained to you, (3) have had your questions answered, and (4) have decided to be in this research study.

Questions about this research study may be directed to Jack Reynolds at jackie.reynolds@mavs.uta.edu or the faculty advisor supervising the research, Dr. James C. Hardy, at jimhardy@uta.edu. Any questions you may have about your rights as a research subject or a research-related injury may be directed to the Office of Research Administration; Regulatory Services at 817-272-3723 or regulatoryservices@uta.edu.

Participant's name: _____

Participant's signature: _____

Date: _____

Principal Investigator's Signature: _____

Date: _____

Appendix C:

Authorization Letter from The Critical Thinking Co.TM



The Critical Thinking Co.™
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info@CriticalThinking.com • www.CriticalThinking.com

9 July 2018

Jack Reynolds
The University of Texas at Arlington - UTA
jackie.reynolds@mavs.uta.edu

Dear Jack Reynolds,

We grant you the right to include the instructions and one sample question from each section of the Cornell Critical Thinking Test Level X and/or Level Z in the appendix of your dissertation.

You do NOT have permission to include the test in its entirety or the answers in your appendix.

Please acknowledge our copyright by including the following statement in your appendix:
"Reproduction rights for Cornell Critical Thinking Test, Level X & Z by Robert H. Ennis, granted by The Critical Thinking Co. | 800-458-4849 | www.criticalthinking.com."

Nile Duppstadt

7/9/2018

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~

Appendix D:

Cornell Critical Thinking Test: Instructions and Sample Questions

INSTRUCTIONS

This is a test to see how clearly and carefully you think.

There are 52 items. You should be able to finish in the 50 minutes given, but be careful not to waste time. Avoid wild guessing, although it is all right to make shrewd guesses when you have good clues. There is one best answer to each item.

Mark your answers with soft pencil on the answer sheet. Do not make any marks on this booklet. **If you finish within the given time, go back and check your answers.**

SECTION IA

In the _____ items, two men are debating about voting by eighteen-year-olds. Mr. Pinder is the speaker in the first three items, Mr. Wilstings in the last two. Each item presents a set of statements and a conclusion. In each item, the conclusion is underlined. Do not be concerned with whether or not the conclusions or statements are true.

Mark items _____ through _____ according to the following system:

If the conclusion **follows necessarily** from the statements given, mark **A**.

If the conclusion **contradicts** the statements given, mark **B**.

If the conclusion **neither** follows necessarily nor contradicts the statements given, mark **C**.

If a conclusion follows necessarily, a person who accepts the statements is unavoidably committed to accepting the conclusion. When two things are contradictory, they cannot both be correct.

CONSIDER EACH ITEM INDEPENDENTLY OF THE OTHERS.

“Mr. Wilstings says that eighteen-year-olds haven’t faced the problems of the world, and that anyone who hasn’t faced these problems should not be able to vote. What he says is correct, but eighteen-year-olds still should be able to vote. They’re mature human beings, aren’t they?”

SECTION IB

In the next items, the two men are debating about immigration. Mr. Pinder is speaking in the first three items, Mr. Wilstings in the last two.

Use the same system to mark items through :

- A. Conclusion **follows necessarily** from the statements given.
- B. Conclusion **contradicts** the statements given.
- C. **Neither**.

CONSIDER EACH ITEM INDEPENDENTLY OF THE OTHERS.

“Mr. Wilstings has proposed that we open our doors to all the foreigners who want to enter our beloved country. But foreigners always have made trouble and they always will. Most of them can’t even speak English. Since anybody who makes trouble is bad, it follows that foreigners are bad.”

SECTION II

The discussion that follows is divided into parts to correspond to items through . There is faulty thinking going on in each part. Your job for each item is to **pick the one best reason why the thinking is faulty**.

To take this part of the test, you need not know anything about the chlorination of water supplies.

DOBERT: I hear that you and some other crackpots are trying to get Gallton to chlorinate its water supply. You seem to think that this will do some good. There can be no doubt that either we should chlorinate or we shouldn't. Only a fool would be in favor of chlorinating the water, so we ought not do it.

ALGAN: You are correct at least in saying that we are trying to get the water chlorinated.

Pick the one best reason why some of this thinking is faulty.

- A. Dobert is mistakenly assuming that there are only two alternatives.
- B. Dobert is using a word in two ways.
- C. Dobert is using emotional language that doesn't help to make his argument reasonable.

SECTIONS III, IV, AND V
REFER TO THE FOLLOWING EXPERIMENT:

An experiment was performed by Drs. E. E. Brown and M. R. Kolter in the veterinary laboratory of the British Ministry of Agriculture and Fisheries. The doctors were interested in what happens to ducklings that eat cabbage worms. Several cases had been reported to them in which ducklings had “mysteriously” died after being in cabbage patches containing cabbage worms.

Three types of ducklings were secured (Mallards, Pintails, and Canvasbacks), two broods of each. Each brood was then split into two equal groups as much alike as possible. For a one-week period they were provided an approved diet for ducklings. All had this diet, except that half of each brood were provided something more: two cabbage worms daily per duckling. The condition of the ducklings at the end of the week was observed and is reported in the following table:

(table omitted)

SECTION III

The experiment attracted a great deal of attention. Many statements were made about the experiment and about the protection of ducklings.

Items through each contain a pair of statements (A & B), which are underlined. Read both, then decide which, if either, is more believable.

Mark items through according to the following system:

If you think the **first** is more believable, mark **A**.

If you think the **second** is more believable, mark **B**.

If **neither** statement is more believable than the other, mark **C**.

In making your decisions, use the information already provided and the information in parentheses after each statement.

- A. Cabbage worms are poisonous to ducklings (said by Dr. Kolter).
- B. Six Canvasbacks died during the week of the experiment (said by Dr. Kolter).
- C. Neither statement is more believable.

SECTION IV

From the original experiment, the doctors drew this conclusion:
CABBAGE WORMS ARE POISONOUS TO DUCKLINGS.

Mark items through according to the following system:

A. If true, this information **supports** the conclusion.

B. If true, this information **goes against** the conclusion.

C. This information does **neither**.

CONSIDER EACH ITEM INDEPENDENTLY OF THE OTHERS.

The experiment is repeated. The results are similar.

SECTION V

A research worker sets out to test the truth of the statement:

IF ANY DUCKLING EATS A CABBAGE WORM,
THE DUCKLING WILL DIE WITHIN SIX HOURS.

The research worker has developed an accurate, painless, and noninjurious stomach-testing method for telling whether a duckling has eaten a cabbage worm during the previous twelve hours. The method can be used both with dead ducks and live ducks.

In planning his experiments, he needs to make some *predictions from the above statement*.

- a. PREDICTIONS TELL WHAT WOULD BE TRUE, IF THE STATEMENT WERE TRUE.
- b. PREDICTIONS SHOULD BE USEFUL IN GUIDING AN ACTUAL EXPERIMENT.

Remembering these two rules about predictions, answer items through . The items refer to the possible predictions listed after item .

Of j, k, and l, which is the best prediction? Mark A for j; mark B for k; mark C for l.

Possible predictions:

- j. If any duckling eats a cabbage worm, the duckling will be dead within six hours, and if a stomach test is performed within twelve hours after eating the worm, the results of the stomach test will show that the duckling has eaten at least one cabbage worm.
- k. If any duckling does not die within six hours after a given period, then it did not eat any cabbage worms during that period.
- l. Suppose six hungry Pintail ducklings are put for one hour in a cabbage patch containing cabbage worms and then put in a clean cage for six hours. If any do not die during that period, the results of the stomach test will show that these ducklings did not eat any cabbage worms.

SECTION VI

Items through provide situations in which a definition is called for. From the three definitions that follow each description, pick the one (A, B, or C) that best gives the meaning.

“That’s a nice stock car you have there, Bill,” his mother remarked.

“Stock car!” exclaimed Bill. “That’s no stock car. Did you ever see a car in a dealer’s showroom with bumpers made out of heavy pipe? Do the automobile manufacturers turn out cars with no fenders? Of course not.”

Bill’s mother then asked, “Just what do *you* mean by ‘stock car’?”

Of the following, which is the best way to state Bill’s notion of a stock car?

- A. A stock car is an automobile that is, for the most part, made of standard parts put out by automobile manufacturers, but which might have missing fenders and special bumpers.
- B. A stock car is an automobile that has fenders and does not have bumpers made out of pipe.
- C. A stock car is a standard automobile, as turned out by the factory and sold to the public.

SECTION VII

In items through , someone is speaking, but in each case there is an unstated assumption. An assumption is a statement that is taken for granted. From the choices that follow each item, select the one (A, B, or C) that is most probably the unstated assumption. Consider each item by itself.

MR. DOBERT: The fact that Gallton's children have been forced to work explains their misbehavior.

- A. Children who have never been forced to work behave properly.
- B. Children who behave improperly have been forced to work.
- C. Children who have been forced to work behave improperly.

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Biographical Information

My life narrative is a testimony to the capacity for education to utterly transform one's life. I am a twice-honorably discharged Army Infantry and Desert Storm veteran. After my military service I leveraged my personal computer experience—something that was at a premium at that time—to find employment in the budding IT industry in Austin, Texas. After the dot-com bubble burst several years later those of us with no college education were among the first let go. I spent much of the next decade taking any job I could as the labor market shifted beneath my feet. There were sporadic bouts of homelessness as I struggled to eke out a meager living.

I made the decision to go to college in 2007 after a series of menial, low-wage jobs, the last of which was in a cardboard box factory. I graduated *cum laude* at the age of 42 with a Bachelor of Science in economics and a minor in mathematics. I worked my way through graduate school as a highly qualified and certified high school math and economics teacher, graduating in December 2013 with a master's degree in economics at the age of 45. Now, at the age of 50, I am on the cusp of being awarded a doctoral degree in Educational Leadership & Policy Studies. Along the way I got married and am today the proud father of a five-year old boy. I am currently an economics instructor at Tarrant County College.