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PERCEIVED GAINS IN CRITICAL THINKING OF ONLINE LEARNERS: EFFECTS OF MOTIVATION AND LEARNING STRATEGIES

A Thesis in

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by

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ABSTRACT

This study surveys learners of three online courses (N=216) to examine 1) the extent of gains in critical thinking in an online course, 2) what factors among motivation and learning strategies have significant effects on perceived gains in critical thinking and 3) Do perceived gains in critical thinking vary by student characteristics such as race and gender?

This study defines critical thinking as the process by which one forms opinions, based on evidence rather than presumption, surmise, unsubstantiated beliefs, and other forms of supposition and conjecture. An instrument of critical thinking is created and pilot-tested. The reliability and validity of the instrument are established.

Data is run on Mplus and the results show the hypothesized SEM model fits the data relatively well. Two major findings: learning strategies have a dominating effect on the gains in critical thinking, pinpointing the importance of these skills to cognitive gains. In addition, race and gender have no significant effects on the gains, suggesting that online courses diminish these differences. Limitations and implications for research are discussed.

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Chapter 1

Introduction

Colleges have an effect on student cognitive gains such as critical thinking. However, extant research does not reveal much about what factors contribute to gains in critical thinking, whether measured by critical thinking tests or student self-reports. In particular, research on critical thinking seldom takes into account individual differences in motivation and learning strategies, though both factors have consistently been linked to achievement and performance. Investigating the causal relations between critical thinking and its contributing factors thus became a significant issue, given the permanence of critical thinking in college curricula and the essential nature of critical thinking to individuals and society.

Promoting critical thinking among students is a national educational goal embraced at colleges and universities. Courses and programs abound where the ability to think critically is emphasized as a key learning outcome. How does the tradition change with the onset of online education? Is it an attainable goal to cultivate critical thinking online? What factors are essential to the success of fostering critical thinking of online learners? This study means to address some of these questions. A series of circumstances support the rationale for the study: Since 1990s, online education has become a sizable, permanent and integrated part of campus teaching and learning at most universities. Accompanying this growth is the accommodation of critical thinking into the online courses and programs. In fact, as growing numbers of students use the Internet for academic and information-gathering purposes, many faculty members have required students to evaluate critically the websites they browse. How effective is the development

of critical thinking in online courses? What factors are crucial to the student-reported gains in critical thinking in online courses? These questions become urgent to campus as well as state administrators, faculty members, students and researchers as online discussion is increasingly used for fostering higher order thinking in online courses.

This chapter starts with the importance of critical thinking in higher education, then justifies the focus on critical thinking in online courses and finally explains why motivation and learning strategies are selected for variables of investigation.

Learning outcomes such as critical thinking are increasingly a concern for accreditation bodies, funding agencies such as state and federal governments, employers as well as students, faculty members and higher education institutions. Critical thinking is a valuable skill to possess for the graduates, who increasingly find their job requires them to make decisions by evaluating available data and information (Romiszowski, 1997). Surveys from students confirm the views of scholars. Tsui (1998a) reported students, 10 years after they left college, ranked the ability to think critically the second highest among various skills and abilities important to their careers (p161). The same study also reported students aiming for professions that require advanced education or highly prestigious professions tend to value critical thinking in their lives. The higher the educational level, the more importance attached to critical thinking.

Many programs such as nursing (Staib, 2003) and business administration are required to provide evidence that students are meeting critical thinking requirements to maintain accreditation. A search of critical thinking on Proquest found 186 theses and dissertations on critical thinking of college students; 69 of those relate to nursing programs.

Duffy, Dueber, & Hawley (1998, p.70) articulated the contemporary importance of critical thinking skills.

> "The changing nature of technology...increased the need for the skills of critical thinking. The easy availability...has made the ability to evaluate and sort information more important than ever. Furthermore, much of the information available on the Internet is not reliable, and some of it is deliberately and dangerously deceptive...Thus the ability to judge the credibility of an information source has become an indispensable critical thinking skill that needs to be deliberately and repeatedly taught in college and earlier."(p70)

This view is shared by other scholars, too (Halpern, 1999; Paul, 1995). Critical thinking is ever more essential in a changing society reliant on information processing and evaluation. Browne, Freeman, & Williamson (2000) reported about 80 percent of US-undergraduates used the Internet for daily study. The danger, they warned, was that students confused the easy access to information, which may or may not be valid with knowledge and cause them to cease evaluating information, thus jeopardizing one of the primary purposes of higher education.

A recent assessment titled the Value-Added Assessment Initiative (VAAI) undertaken by the RAND Corporation, illustrates the continuing concern in higher education on critical thinking. VAAI is on trial runs to assess the quality of undergraduate education in the United States by measuring its impact on students; critical thinking is one of the three skills measured in the test (Viviano, 2005). The persisting focus on critical thinking, combined with the intensified need for critical thinking in the present society, highlights the essentiality of critical thinking today. With online education taking up a sizable portion of educational offerings, higher education researchers need to examine to what extent critical thinking is developed in the new setting. The following sections review the growth of online education and its potential in developing critical thinking.

Growth of Online Education in the U.S.

The number of institutions offering Internet courses, the number of courses offered online, and the number of students taking an online course or an online degree have grown geometrically in the past decade and the trend remains strong (Allen & Seaman, 2003; 2004). Allen and Seaman reported that over 1.6 million students took at least one online course during Fall 2002. Over one-third of these students (578,000) took all of their courses online. Of all U.S. higher education students in Fall 2002, 11 percent took at least one online course. In Fall 2003, more than 1.9 million students were studying online, an increase of 19% from 2002. Schools expected the growth to continue.

Waits, Lewis, & Greene (2003) also estimated that ninety percent of institutions delivering distance education reported they offered Internet courses using asynchronous computer-based instruction, where students and instructors are not online simultaneously. Grooms (2003) concluded from Bianco and Carr-Chellman (2002) that "online delivery was becoming an increasingly integral and prevalent part of institutions today".

Not only is online education permanent in U.S. higher education settings, it is commanding academic attention and respect, too. There has been the argument (Noble, 2002) that online education is just a rerun of technology not a transformation. He claimed that the push toward online delivery indicates universities' intention to expand market and make profits for the most part. Allen and Seaman (2003; 2004), however, showed that "a majority of academic leaders already believe that the learning outcomes for online education are equal to or superior to those of face-to-face instruction." A NEA survey in 2000 also revealed that most faculty members teaching distance education hold positive views of the quality of online courses (The National Education Association, 2000).

Grooms (2003) summarized the significance of studying online education. "With a growing number of institutions using some form of CMC when entering the arena of electronic delivery systems, it becomes increasingly important to gain a better understanding of student perceptions of this learning environment".

Online courses adopt different formats, as Winiecki (2003) explicated, "In asynchronous communication, the interactants are not online at the same time. E-mail, list-serves, newsgroups, and threaded discussion systems are common communication media". Other formats include video clips of classroom lectures, chatrooms, web tutorials, or a mixture of those. This study focuses on the threaded discussion boards where postings of ideas, opinions and discussions are launched onto a website and organized by topics/threads, as courses under study in this research uses this format and anecdotal evidence seems to suggest it is a common format for online courses.

Features of Online Education

Online learning offers benefits in abundance. The biggest advantage is that universities can reach underserved populations such as professionals, the physically challenged, the geographically-bound individuals, and single parents who don't have the time to physically attend a traditional classroom. Also enjoying this learning alternative are traditional on-campus undergraduates.

Other advantages are,

- Convenience (Harasim, Hiltz, Teles, & Turoff, 1995), as students can access the materials any time
- Equity (Harasim et al., 1995; Mallam & Wee, 1998)
- Increased participation (Oblinger & Maruyma, 1996)

- Interaction (quantity and intensity) (Harasim et al., 1995) and collaboration (Alavi, 1994)
- Better access to group knowledge and support, more, increased motivation. (Harasim et al., 1995)

Angeli et al. (2003) contrasted the discussions between classroom settings and online formats. “Time constraints and teaching in crowded classrooms restrict in-depth dialogical interaction in teaching and learning. Electronic conferencing systems, however, have the potential to foster online discussions beyond class time”. In particular, online discussions encourage reflections (Mason, 1991). Students are more likely to think before posting, as opposed to blurting out in a classroom discussion, resulting in a carefully thought-out reply. In addition, being able to access peer postings and their own postings anytime also allows for reflection and revision of thoughts. Chong (1996) is quoted in Bonk (1997): "one longitudinal study of asynchronous environments found that these interactive conferences and discussions tend to be more extended and engaging for students than traditional lecture-based instruction".

Garrison et al. (2003) added the potential for critical thinking online discussions can create. “The use of the written word may encourage discipline rigor, and the asynchronous nature of the communication may encourage reflection, resulting in contributions to the discussion that are more complex and demonstrate more advanced stages of critical thinking " In fact a workshop on the best practice of online learning tentatively concluded that higher order learning, of which critical thinking is a component, is a manifestation of learning effectiveness online, one of the five pillars of quality online education established by the Sloan Consortium of the Sloan Foundation

(Lorenzo & Moore, 2002). The other four pillars are student satisfaction, faculty satisfaction, cost effectiveness, and access.

Writing and reflective discussions as featured in online courses are apparently marvelous recipes for critical thinking theoretically, but do they hold in reality? At least it seems to hold in the traditional settings. Tsui (1999) investigated how different types of courses and instructional techniques affect students' self-reported growth in critical thinking. She found taking certain courses like writing, math and women's studies are positively associated with self-reported growth in critical thinking. Pascarella & Terenzini (1991, p.141) quoted McKeachie et. al's (1986) research conclusion that curricula that stresses student discussions have the potential to enhance critical thinking.

Research on critical thinking in online settings is not that clear. The studies tended to be qualitative, inconclusive and sparse. Kuh & Vesper (1999) revealed that student gains in computer familiarity had a positive impact on their self-reported gains in analytical thinking. Dill (2003) reported that students in an online course perceived that online course as an instructional design feature as a factor that enhanced development of critical thinking skills.

However, Bishop (2002) suggested that because of the threat of the abuse of postings and the greater efforts to read and type in a Web-based discussion, Web-based courses are not ideal for fostering critical thinking. Dill (2003) also found that students reported lack of real-time feedback, lack of teaching presence, channel of contact with the professor and inability to see classmates as hindrances to develop critical thinking.

Research on online instruction has focused on interaction, participation (Oliver & Shaw, 2003; Poole, 2000; Rovai, 2003), and satisfaction (Hong, 2002; Howland &

Moore, 2002). However, these aspects do not reveal much about the learning outcomes. Satisfaction does not guarantee learning. Students could be very satisfied with the course and the instructor while achieving little intellectually.

The interaction and participation may be frequent while remaining on the surface level (Hawkey, 2003). Participants didn't raise challenging questions often. As Rourke (2002) showed, students questioning online discussions raised a complaint commonly observed in computer conferencing research: the discussions were not sufficiently critical or challenging.

Hawkey (2003) analyzed discussions on a 4-week online reflective forum for preservice teachers. He noted that "disagreement (among students) is cautious and rather indirect...The real challenge (of ideas in the postings) comes from some of the tutor's comments." Students' critiquing the views of others is largely superficial; little evidence showed that participants modified their views in light of the discussions. Greater freedom in the online environment did not result in much critical engagement in the topics and reflections on their own or peer discussions.

Angeli et al. (2003) investigated the potential of computer conferencing to foster quality discourse and promote students' critical-thinking skills. Their conclusion is not that different from that of Hawkey's (2003): students' online discourse was mostly an exchange of personal experiences and did not reflect well-supported reasoning. Anderson, Howe, Soden, Halliday, & Low (2001) concurred that "justification (in the postings) tended to be of a weak kind (using anecdotes or experience-based generalisations), and strong (i.e. formal research-based) evidence remained relatively infrequent and sometimes inappropriately used."

These results cast doubt on the potential learning benefits of online discussions to foster critical thinking as articulated in Garrison (2003) and Mason (1991). Yet, Bullen (1998) reported findings from quantified data and interviews of 18 students of an undergraduate online course. Bullen defined critical thinking as thinking that is reasonable and reflective and focused on what to believe or do. Student messages were rated 1 (no critical thinking, frequent uncritical thinking), 2 (moderate critical thinking, some uncritical thinking and 3 (extensive critical thinking, minimal uncritical thinking). The results of student messages showed all students were thinking critically to some degree, but none were doing so consistently. Student interviews reflected the students had an incomplete understanding of the concept of critical thinking as defined by the instructor. This finding complements Garrison et al (2003) that an earlier study found that most of the discussions suggested lower levels of critical thinking while only a small portion had evidence of higher levels of critical thinking.

The afore-cited studies are basically qualitative in nature. While qualitative research offers depth and complexity of an issue, it lacks generalization due to small sample size. To understand the extent of critical thinking in online courses, large quantitative studies are required.

Problem Statement

Current literature fails to incorporate student motivation and cognitive strategies into the model of achievement of critical thinking. Most often, motivation is simplified into behavioral indicators such as the hours spent on studies each week. Those indicators masked the effects of prior achievement and academic motivation. Student motivation and learning strategies play key roles in academic performance. The hypothesis used to

be that when learning fails to occur, the blame is on the instruction. However, learning theories have enlightened researchers on the roles of student motivation and their cognitive strategies. When learning fails to occur, it is likely that students are not motivated or they are not using the right strategies. To improve the quality of learning outcomes requires a better understanding of what happens in the learning process from the perspective of the learner (Zeegers, 2004).

Research has shown that students made gains in critical thinking while in college. The situation is similar when courses move online (Bullen, 1998). However, no evidence exists regarding the factors that promote critical thinking. For decades, critical thinking research has focused on the design of courses and student characteristics such as gender and race. Not enough attention was given to the psychological factors such as motivation and student goals. Astin's theory on student involvement indicated a welcome step in recognizing the importance of student input in the equation; it made complete the loop of student learning, teaching and student involvement.

Motivation has consistently shown to a strong predictor of learning outcomes. It is assumed that motivation in online courses is no exception. However no evidence exists as to whether student motivation experienced by students changes when they take courses online. It is not clear whether their motivation contributes to their gains in critical thinking. Lynch (2002) reminds that researchers need to attend to both outcomes and experience that lead to those outcomes (p129). Not only it is necessary to know about where students end up but also about the kind of student effort that lead to particular outcomes.

Focusing on online courses, a growing phenomenon in U.S postsecondary education, this study examines the effects of student motivation and learning strategies on student perceived gains in critical thinking. In particular, all students enrolled in three online courses at a major northeastern university will be surveyed to understand their end-of-course gains in critical thinking. In addition, the study brings motivation and learning strategies into the critical thinking research on college students in online courses. It is expected this inclusion will integrate the model on student gains in critical thinking. Literature and framework for the study are presented in Chapter Two.

Chapter 2

Literature Review

The following literature review includes four sections: critical thinking, motivation, learning strategies and other variables that affect critical thinking. In this chapter, critical thinking is defined, its significance and value to various stakeholders in the society elucidated, and critical thinking instruments reviewed and justification for the study's instrument given. Literature on critical thinking among college students in traditional classroom and online is synthesized, too. In addition, the roles of motivation and learning strategies in critical thinking as well as in achievement are analyzed in detail. Thirdly, other variables associated with critical thinking will be introduced, defined and research reviewed. Finally research questions and hypotheses are presented.

Critical Thinking

To promote college graduates' critical thinking abilities is an educational objective of primary importance to national government, universities and employers as well as individuals. Critical thinking ability is "an enduring skill, a central element in lifelong learning and an appropriate (if not essential) skill for colleges and universities to develop among students" (Terenzini et al., 1995). A panel of faculty, employers, and policymakers of believed that certain reasoning skills are important (Jones et al., 1994). Critical thinking is an educational value often reflected in the goals of many general education programs at colleges and universities (Halpern, 1999).

Critical thinking is also an important national educational goal. In 1990 the commission responsible for drafting educational goals for the United States laid down that "The proportion of college graduates who demonstrate an advanced ability to think

critically, communicate effectively, and solve problems will increase substantially"(National Education Goals Panel, 1991, p.237). In a major national report released in 2002 entitled *Greater Expectations: A New Vision for Learning as a Nation Goes to College*, a national panel of educators urged the development of intentional learners who excel at "interpreting, evaluating, and using information discerningly from a variety of sources" (Association of American Colleges and Universities, 2002).

The significance of critical thinking to individuals is notable as well. "Higher order cognitive skills, such as the ability to think critically, are invaluable to students' futures; they prepare individuals to tackle a multitude of challenges that they are likely to face in their personal lives, careers, and duties as responsible citizens"(Tsui, 2002). Halpern (1998) argued for the personal benefits accompanying critical thinking: "critical thinking skills increases the probability of a desirable outcome where "desirable" is defined by the individual, such as making good career choices or wise financial investments". Kuhn (1991) claimed that critical thinking is implicated in all the beliefs, judgments, and conclusions and arises whenever a decision needs to be made (p.3).

Reality of Critical Thinking Performance

Meanwhile, Norris (1985) concluded that systematic research suggests that most high school and college students do not perform well on tests designed to measure critical thinking competence. Norris' conclusion still rings true today. "Critical thinking, social responsibility, reflective judgment, and evidence-based reasoning ... are the most enduring goals of a first-rate liberal education," says Ms. Schneider, president of the Association of American Colleges and Universities in Washington. Yet research shows "many college graduates are falling short in reaching these goals" (Clayton, 2003).

Halpern (1998) rounded up some facts about the critical-thinking practices of college students and the American public in general. It is hard to believe that individuals with average reasoning ability would harbor thoughts or beliefs as described in the following paragraph.

> "Approximately 78% of women and 70% of men read their horoscopes, with many believing that these horoscopes are so often correct that they were written especially for them (Lister, 1992); in a survey of college students, more than 99% expressed their belief in at least one of the following: channeling, clairvoyance, precognition, telepathy, psychic surgery, psychic healing, healing crystals, psychokinesis, astral travel, levitation, the Bermuda triangle mystery, UFOs, plant consciousness, auras, or ghosts, and more than 65% reported that they personally experienced at least one of these phenomena (Messer & Griggs, 1989)."

Definitions

As the last few sections showed, the importance of critical thinking contrasts sharply with the gloomy reality of critical thinking among college students and public in general. What is more, the term itself is fraught with contentions. No consensus exists for the term 'critical thinking'(Baker, 1981; Furedy & Furedy, 1985; Greenlaw & Deloach, 2003; Johnson, 1992; Tsui, 1998b). Critical thinking, according to Duffy et al. (1998), is the same as problem-solving. They proposed the five components of the structure of inquiry: define the problem, develop and evaluate solution alternatives, come to some resolutions, develop a plan of action, and reflect on the process. These five components, they claimed, can be thought of as essential focus points for critical thinking.

Other definitions range from a focus on skills to outcomes to processes (Bailin, Case, Coombs, & Daniels, 1999). Halpern (1999) refers critical thinking to the use of cognitive skills or strategies that increase the probability of a desirable outcome. It is also "an attitude or disposition to recognize when a skill is needed and the willingness to exert the mental effort needed to apply it". Paul (1995) referred the critical thinking disposition

as the affective dimension of critical thinking, including such traits as thinking independently and exercising fair-mindedness etc (p129).

Halpern (1999) also argues that "...there are identifiable critical thinking skills that can be taught and learned"(p70). A list of skills applicable in any college courses could include: understanding how cause is determined, recognizing and criticizing assumptions of an argument, analyzing means-goals relationships, giving reasons to support a conclusion, assessing degrees of likelihood and uncertainty. The skills approach is also found in Facion (1990), who, after iterative rounds of panel experts, classified critical thinking skills into interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Paul's definition is oriented toward process and outcome (1995). According to Paul, critical thinking is an art of thinking about one's thinking in order to make it better (p91). This definition involves both the process of going through one's thinking and the end product: better thoughts. Staib (2003) found that each definition in the nursing programs includes outcomes; students are not only expected to think critically but also act as a critical thinker. This definition seems to entail a different outcome: acting upon the critical thinking.

Bailin et al (1999) criticized the prevailing conceptualizations of critical thinking in higher education and defined critical thinking in terms of intellectual resources, "They (the intellectual resources) include background knowledge, knowledge of critical thinking standards, possession of critical thinking concepts, knowledge of strategies or heuristics useful in thinking critically, and certain habits of mind". This hodgepodge of a definition tried to squeeze various strands of critical thinking elements under one umbrella, but

failed by blurring the boundaries among disciplinary knowledge, metacognition and critical thinking. This sweeping term undermines any efforts to identify and measure the concept.

Although scholars may not agree on the whole gamut of skills for critical thinking, Johnson (1992) summarized Paul (1989), Ennis (1987, 1989), McPeck (1981), Siegel (1988) and Lipman (1988)'s definitions and concluded that they share three similarities. First, critical thinking requires many cognitive skills. Second, all require information and knowledge. Third, all include a dispositional or affective dimension (p51). Scholars also recommended moving beyond the definitional barriers because "there is sufficient overlap in the various definitions" (Halpern, 2001; Tsui, 1998b). This study concurs with this recommendation. In this study, critical thinking, as defined by the course instructor, is "the process by which one forms opinions, based on evidence rather than presumption, surmise, unsubstantiated beliefs, and other forms of supposition and conjecture" (course website, 2005). This process involves four steps: assembling evidence, examining evidence, exploring alternative explanations and drawing valid conclusions. Critical thinking allows individuals to form opinions rationally through an examination of evidence and reasoned evaluation, which produces opinions that have greater authority and credibility.

As Table 2.1 shows, the skills used in the critical thinking in this definition are also covered in many definitions of scholars and critical thinking instruments. The definition used here does not try to cover all the dimensions in critical thinking, but it is representative enough and most importantly it suits the purpose of measuring critical thinking of the particular online courses in this study. In particular, these cognitive skills

have been consistent with those identified in the three courses, the subjects of which are the participants of this study.

Table 2.1. Critical Thinking Skills Covered in this Study

Critical Thinking Skills	Relevant Literature
Providing Evidence	Kuhn (1991), Paul (1995), CTAB*
Examine Evidence	WGTCA, CZ, CCTST, Furedy & Furedy (1985) Halpern (1997), Dressel & Mayhew (1954)
Exploring Alternative Explanations	WGTCA, CTAB*, Ennis (1979)
Drawing Valid Conclusions	Furedy & Furedy (1985), WGCTA, CCTST, Halpern (1997), Dressel and Mayhew (1954)

*CTAB=CAAP Critical Thinking Assessment Battery

Research

Since critical thinking is valuable to the students and their future career and lives, how have colleges and universities been promoting it? Research (Facione & Facione, 1997; Flowers & Pascarella, 2003; McMillan, 1987) has generally concluded that college students' critical thinking improves while attending college. On the whole, however, college students' performance on critical thinking is low (Tsui, 1998b). Seniors as well as freshmen could not recognize assumptions in arguments or identify critical thinking errors such as logical flaws. In addition, institutional context played a significant role in the critical thinking performance at the end of freshmen year (Hagedorn et al., 1999; Tsui, 1998a; 1998b). Students at the most selective colleges answered five more questions out of 32 correctly than students at the lowest selective colleges. It is not known what factors caused this difference (Tsui, 1998b).

Terenzinni et al. (1995) conducted a study in 1991 using Collegiate Assessment of Academic Proficiency (CAAP) to measure student critical thinking and found that

college experiences contributed a modest amount to student critical thinking skills after controlling for student precollege critical thinking skill. Meanwhile student precollege characteristics such as parents' education and degree aspirations accounted a large amount of the total variance in critical thinking gains. This finding is disturbing in that having a college education had a limited effect on improving students' critical thinking. On the other hand, the finding is not surprising in that SES and student effort and involvement have consistently proved to be key players in academic achievement.

Gelder (2000) investigated the available empirical evidence on the efficacy of courses in critical thinking. One conclusion, he reached, was: "Currently it is difficult to make a convincing case that CT/IL courses make an appreciable difference to CT or informal reasoning skills. There is a serious need for more and better research on this issue. " However, Dressel and Mayhew (1954) found compared with other colleges, colleges with specifically devised for general education purposes had an edge in garnering larger critical thinking gains for their students" (Tsui, 1998b). These colleges often integrate the studies of basic liberal arts and sciences, in which synthesis of knowledge are required of coursework instead of specialized information.

It can be concluded that colleges and universities promotes students' critical thinking ability in the classroom settings, albeit modestly. Nonetheless, as pointed out by McMillan (1987), "paucity of research suggests strongly great attention needs to be devoted to the measurement of critical thinking skills and to demonstrating the conditions that maximizes positive change in these skills".

Measurement of Critical Thinking

There is no well-accepted critical thinking instrument in both online discussions and classroom settings. Existing instruments vary in the attributes of good thinking measured and the extent to which they focus on well-or ill-structured problems (an ill-structured problem has many possible defensible solutions whereas a well-structured problem is designed to have only one reasonable solution) (King & Kitchener, 1994, p.76). Among the widely used instruments are Watson-Glaser Critical Thinking Assessment (WGCTA), Cornell Critical Thinking Tests (CCTT), California Critical Thinking Skill Tests (CCTST) and the Collegiate Assessment of Academic Proficiency (CAAP).

CCTT tests induction, deduction, value judgment, observation, credibility, assumptions and meaning. Its reliability ranges from .50 to .77 (Ennis et al., 1985, p13). Developed by American College Testing, CAAP has individual modules in five areas: reading, writing, mathematics, science reasoning, and critical thinking (CAAP, 2001). The critical thinking module measures students' ability to clarify, analyze, evaluate, and extend arguments. Minnesota Test of Critical Thinking is designed to measure both critical thinking skills and a key disposition of critical reasoning: “the willingness to critically evaluate arguments which are congruent with one’s own goals and beliefs” (Edman, Bart, Robey, & Silverman, 2000, p.3).

As shown above, each test assesses different cognitive skills, which causes much confusion and possibly conflicting findings (Pascarella & Terenzini, 1991). Each critical thinking test has its own weaknesses and limitations (McMillan, 1987; Norris & Ennis, 1989; Staib, 2003; Tsui, 1999). Paul (1995) claimed none contained a “comprehensive model for elements of thought, the abilities of critical thinking or the affective

dimensions" (p133). WGCTA, for example, is charged with many weaknesses: it tests personality rather than inference (Helmstader, 1985, p.1347-1348). Confident students will tend to choose certain answers while introverted students will choose other answers. In addition, there was low correlation between available critical thinking tests and competence to defend one's opinions in discussions (Oliver & Shaver, 1966), casting doubt on the validity of the test. In fact, McMillan (1987) asserts, "When WGCTA is used, it is likely that non-significant difference will be found". It was argued that generalized tests of critical thinking intended to measure transfer of learning skills may show few or no significant differences in an experimental setting (Oliver & Shaver, 1966). Baker (1981) suggests, if students are taught specific types of skills covered in the tests, they might produce significant improvement by groups.

Some of the weaknesses also apply to other commercial critical thinking tests, too. CCTT was rated as biased, lacking cross-validation and stability regarding the alternative tests (Modjeski & Michael, 1983).

In online education, on the other hand, most researchers use content analysis, a method similar to text coding (Anderson et al., 2001; Astleitner, 2002; Bullen, 1998; Hara, Bonk, & Angeli, 2000; Newman, Johnson, Webb, & Cochrane, 1997; Newman, Webb, & Cochrane, 1995; Oliver & Shaw, 2003). Specifically, student postings of a certain week or weeks would be selected for evidence of critical thinking elements. As diverse as the operational definitions of critical thinking in classroom research, content analysis of online discussions uses a variety of definitions for critical thinking.

A common approach is to look for evidence in student postings that exhibits Bloom's (1956) taxonomy of knowledge (knowledge, comprehension, application,

analysis, synthesis, and evaluation) or a modified version. For example, Oliver & Shaw (2003) and Hara et al. (2000) both used this approach. Percentages of postings showing analysis, synthesis and evaluation as opposed to the total number of postings in one week were given as an index of whether critical thinking was achieved by the students or not.

Newman et al. (1995) questioned the superficiality of studies showing only the presence and frequency of Bloom's taxonomy. The number of postings showing analysis, synthesis and evaluation does not reveal whether a satisfactory level of critical thinking is achieved or not. Furthermore, it is not clear whether the student had those skills before the course under study or the course helped develop those skills. Another problem is the week of postings chosen could be so random as to be misleading; student postings could be influenced by motivation, workload and topic under discussion for that week selected for inclusion.

Another approach of content analysis is whether student postings demonstrate both critical and uncritical thinking (Bullen, 1998; Newman et al., 1995). For example, Bullen (1998) analyzed the content of all the messages in the computer conferences for evidence of critical thinking and also uncritical thinking. He argued that evidence of uncritical thinking provided a balanced picture of each student's level of critical thinking because he assumed that the ratio of critical to uncritical thinking will vary from student to student. It might help the instructor to monitor the progress of individual students and identify students who are uncritical thinkers, but from the perspective of researchers, its use is limited. It is methodologically hard to monitor how the class as a whole has improved in critical thinking.

Other approaches are used, too. Newman et al (1995) used Garrison (1992)'s framework of critical thinking and developed their own set of paired indicators of critical thinking such as relevance, importance, novelty and bringing outside knowledge/experience to bear on a problem. Some of these indicators should not be difficult for a rater to identify while other indicators rely on subject knowledge, making it necessary for the instructor to mark, thus rendering control for rater bias impossible. Duffy et al. (1998) cited Paul (1993)'s proposition that such indicators as clarity, precision, specificity, plausibility, accuracy, relevancy, significance, logic, depth, breadth, completeness, adequacy, and consistency be used in judging the quality of critical thinking. This method, however, mixed elementary thinking with critical thinking.

Using content analysis certainly does reveal evidence of critical thinking, as those researchers has demonstrated. However, as pointed out earlier, each approach has problem of its own. A conclusion by Rourke, Anderson, Garrison, & Archer (2001) was that content analysis, valuable for descriptive and experimental purposes, lacks objectivity and reliability.

With the review of literature related to measuring critical thinking I decided to use students' self-reported growth of critical thinking. Under the right conditions, student self-reports of their behavior and college experiences are both valid and reliable (Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984). These conditions are: (1) the information requested is known to the respondents; (2) the questions are phrased clearly and unambiguously; (3) the questions refer to recent activities; (4) the respondents think the questions merit a serious and thoughtful response; and (5) answering the questions

does not threaten, embarrass, or violate the privacy of the respondent or encourage the respondent to answer in socially desirable, rather than truthful, ways.

This study meets these conditions. For example, assuming that 'critical thinking' might be construed differently among respondents, I intentionally didn't use the term in the questionnaire and instead request students to report their skills in specific areas as defined in this study. This effort produces a situation that respondents know what information is requested. In addition, the survey items included in this study seem to ensure honest responses rather than socially desirable ones.

In addition, use of a self-report measure can extend and test our understanding of critical thinking, given the fact that the bulk of critical thinking research has been on standardized tests for critical thinking (Tsui, 1999). For example, there is value in knowing whether student self-reports of critical thinking match the performance in commercialized critical thinking tests.

Self-reports are also easy to administer and convenient to enter and analyze. The fact that it can be used for large and diverse samples can increase the generalizability of the findings (Garcia & Pintrich, 1995). Self reports have been employed in these research studies on critical thinking: Astin (1993); Garcia & Pintrich (1992); Kuh & Vesper (1999); Li, Long, & Simpson (1999); Newman, Johnson, Cochrane, & Webb (1996); Pace (1974); Tsui (1998a, 1999); Williams (2002).

King & Kitchener (1994) recommended the consistency in the choice of instrument with the evaluation needs. Tsui (1998b) also recommended matching an instrument with a specific research question. This study tries to tap the factors that determine the gains in critical thinking in three online courses. Therefore, the content and

format of the instrument should be consistent with the definition of critical thinking in the courses specified. As defined earlier in this section, critical thinking in this study consists of the following indicators: assembling evidence, examining evidence, exploring alternative explanations and carefully reaching conclusions. Therefore the self-reported growth of critical thinking will be measured in these aspects.

Motivation

Research on critical thinking in both classroom and online environment has neglected important factors such as motivation and cognitive strategies. The lack of control for student motivation and learning strategies is common or only limited attention to motivation at best (Bullen, 1998; Li et al., 1999; Terenzini et al., 1995; Tsui, 1999). This negligence is unwarranted as these factors have consistently been related to achievement, performance, perception of acceptance of computer conferencing and self-reported use of critical thinking skills.

Paulsen et al. (1999) stated "research has consistently demonstrated that the motivational beliefs of college students have direct effects on their academic performance". Motivation theories are concerned with energization and direction of behavior" (Pintrich, 2003). They "attempt to answer questions about what gets individuals moving (energization) and toward what activities or tasks (direction)". Pintrich listed five basic families of social-cognitive constructs on motivation in classroom contexts.

1. Self-efficacy

Self-efficacy refers to students' judgments about their abilities to succeed at specific academic tasks. Patterns of academic successes and failures and the causes to which they are attributed are very important sources of self-efficacy evaluations. When students attribute success to ability, or attribute failure to a lack of effort, their expectations of success increase.

There are different constructs, such as self-efficacy, perception of competence, and expectancy for success, self-worth, self-determination and expectancy-value theories, but they appear to be the same in principle. Major research findings include: When people expect to do well, they tend to perform better (Teresa & Pintrich, 1995; Wilhite, 1990; Wolters & Pintrich, 1998). There are multiple motivational pathways for the energization and direction of behavior (Pintrich, 2000). Some students may be motivated and sustained by their self-efficacy beliefs while some may be more motivated by their goal orientation, personal interest or values (Pintrich, 2003).

2. Control beliefs

The construct refers to "beliefs about the causes of success and failure and how much perceived control one has to bring about outcomes or to control one's behavior" (Skinner, 1996; Weiner, 1986). Internal control beliefs refer to students' perceptions that academic outcomes are contingent on their own actions, for example, increased effort or effective study techniques, rather than on external factors beyond their control, for example, task difficulty or a teacher's bias. The general finding is that students who believe they have more personal control of their own learning and behavior are more likely to achieve at higher level than students who do not feel in control (Pintrich, 2003).

3. Value beliefs

Value belief consists of four components---intrinsic interest, utility, importance, and cost. Intrinsic interest is similar to personal interest, whereas utility is defined as individuals' perceptions of the usefulness of the content or task. Importance or attainment value refers to how important it is to do well on the task for the individuals as well as how central the task is perceived to be to the individual. Cost beliefs refer to the perceptions of the costs or negative consequences of engaging in the task. Task value and interest (Garcia & Pintrich, 1995; Hofer & Yu, 2003) has been shown to predict achievement.

4. Goal orientations

Goal orientation theory deals with the purpose and meaning that an individual attaches to achievement behavior (Ames, 1992). Dweck & Leggett (1988) explained this phenomenon of different response pattern in face of failures by conceptualization of goals: "goals individuals are pursuing create the framework within which they interpret and react to events". Representing different reasons for involvement in academic tasks and different conceptions of success, these goals foster different response patterns in that the performance-oriented individuals are vulnerable to the helpless pattern while the learning-oriented individuals promote the mastery-oriented pattern.

Performance goals mark individuals concerned with gaining favorable judgments of their competence while learning goals characterize individuals are concerned with increasing their competence. Intrinsically oriented students are motivated by challenge, curiosity, or independence, while extrinsically oriented students are motivated by instructor approval, good grades, or less difficult tasks.

Intrinsic goal orientation has been positively linked to a number of cognitive and motivational outcomes (Deci & Ryan, 1985; Ryan & Deci, 2000). Extrinsic goal orientation, on the other hand, has mixed effects. Some studies show a positive association between extrinsic goal orientation and achievement while others report a negative association. In addition, goal orientation has been shown to be related to achievement (Dweck & Leggett, 1988; Elliott & Dweck, 1988; Paulsen & Gentry, 1995; Teresa & Pintrich, 1995). Goal orientation determined the achievement of children (Dweck & Leggett, 1988). There was no difference in the strategy use for children with a learning goal whereas children with performance goals showed a different pattern. Only children of high ability for the latter group performed better at strategy use.

Although there are agreements in positive links between achievement and motivational variables as listed above, some motivational variables have not been consistent in predicting achievement. Intrinsic motivation is consistently correlated to achievement, Pintrich & De Groot (1990), however, found that intrinsic value does not directly affect achievement, but rather mediate its influence through self-regulation. This finding is inconsistent with other researchers like Paulsen & Gentry (1995), who found intrinsic goal orientation had both direct and indirect effects on grades.

Despite the salience of motivational variables in the above studies, Donald (1999) found that motivation does not predict final grade for neither physical science or engineering students. In addition, different motivational variables emerged as best predictors, depending on types of achievement, whether it was homework, quizzes, tests or essays or reports (Pintrich & De Groot, 1990). Another contradiction is that some

models explained quite a lot of variance in achievement (Paulsen & Gentry, 1995) while others low (Pintrich & De Groot, 1990).

All this suggested that motivational variables have differential effects on achievement depending on the context of courses and achievement types. In the context of the courses under study, it is interesting to see how these motivational variables affect perceived gains in critical thinking, the learning strategies and how they interact with one another.

Learning Strategies, Motivation & Achievement

Motivation provided the driving force for learners to engage in learning. However, learning cannot be effective or successful without appropriate learning strategies. On the one hand, training in the skills of motivation and self-regulation tend to positively influence GPA and student motivation (Hofer & Yu, 2003; Tuckman, 2003). On the other hand, the following questions need to be answered: Can anyone learn any subject, any skill anywhere at anytime? What strategies and skills online learners need to be successful (Blocher, Montes, Willis, & Tucker, 2002) ?

Weinstein & Mayer (1986, p.315) described the contribution to the learning process from cognitive science in the following paragraph:

> "The cognitive approach has changed our conception of the teaching-learning process in several ways. Instead of viewing learners as passively recording the stimuli that teacher presents, learning is viewed as an active process that occurs within the learner and which can be influenced by the learner. Instead of viewing the outcome of learning as depending on what the teacher presents, the outcome of learning is supposed to depend jointly on what information is presented and on how the learner processes that information."

Learning strategies are defined as the behaviors and thoughts that students use to select, organize, and integrate new knowledge (Weinstein & Mayer, 1986 p.315). For example, summarizing an expository passage on the part of a learner is one of the learning strategies.

The construct learning strategies describes the answers to the question: "How can I do this task?" Learning strategies are divided into two conceptual categories: cognitive strategies and self-regulation strategies. Weinstein & Mayer (1986) arrange the basic cognitive strategies for information processing into three categories: rehearsal, organization, and elaboration. Students use rehearsal strategies to retain items of new information in short-term memory and organization strategies to make connections among them (internal connections). Elaboration strategies are used to make external connections, that is, to integrate new information with prior knowledge from long-term memory.

Boekaerts (1997) defined self-regulation as a "simple, habitual and automatic activity, or as a complex, demanding, deliberate and volitional activity". Students use self-regulation strategies to monitor and manage their thoughts, behaviors, and personal and environmental resources, thus influencing the effectiveness of their cognitive strategies. This construct contains metacognition and resource management. Metacognition strategies, based on students' awareness of and knowledge about their cognitive strategies, are used to plan, monitor, and regulate their cognitive progress. Resource management strategies are used by students to self-regulate both personal and environmental resources for academic tasks. McKeachie et al. (1986) put resource management strategies into four categories: time management, study environment, effort management, and managing support of others.

Research has shown that students who are self-regulating, in other words those who set goals or plans, and try to monitor and control their cognition, motivation, and behavior in line with these goals are more likely to do well in school (Pintrich, 2003;

Zimmerman, 1990). However, the strength of relationships between self-regulation and achievement were reportedly moderate (Pintrich & De Groot, 1990; Pintrich, Smith, Garcia, & McKeachie, 1993) or slight (Wolters & Pintrich, 1998). On the other hand, Schutz, Drogosz, White, & Distefano (1998) found that elaboration strategies did not explain at all the variance in student course grade in statistics, which was echoed by the findings in Valle et al. (2003).

Kuhn (1999) defined metacognitive skills as "second-order meta-knowing skills that entail knowing about one's own and others'knowing" (p.17). "Because it has to do with awareness, understanding, and management of one's cognition (in contrast to simply its execution), this is a meta-knowing attainment" (p18). She argued that metacognition is a prerequisite competence to critical thinking, as most definitions of educational philosophers contained some elements of metacognition. For example, Paul's (1990) "thinking about your thinking" and Lipman's (1991)'s critical thinking as thinking "that can be assessed by appeal to criteria", which implicates metacognition. She concluded that developing metacognitive competencies are central and most relevant to critical thinking, because "critical thinking by definition involves reflecting on what is known and how that knowledge is justified. Individuals with well-developed metacognitive skills are in control of their own beliefs in the sense of exercising conscious control over their evolution in the face of external influences. They know what they think and can justify why. Their skills in the conscious coordination of theory and evidence also put them in a position to evaluate the assertions of others"(p23).

Not only learning strategies influence achievement and critical thinking. They have connections with motivation variables, too. Perceptions of high self-efficacy, a

focus on mastery goals and high value and interest in the task or content are positively related to greater cognitive engagement in terms of the use of cognitive and metacognitve strategies (Ames, 1992; Garcia & Pintrich, 1995; Pintrich & De Groot, 1990). Good evidence, in addition, shows that these students will be more cognitively engaged in learning and thinking than students who doubt their abilities to do well (Pintrich, 2003). However, Wolters & Pintrich (1998) found that task value is the only significant predictor of cognitive strategy use and regulatory strategy use.

Pintrich and his colleagues, in a series of studies, have shown that students who adopted an intrinsic goal for learning were more likely to report using deeper processing strategies like elaboration as well as more metacognitive and self-regulatory strategies (Pintrich, Marx, & Boyle, 1993). However, results remain unclear for students approaching tasks with a focus on extrinsic rewards (Patrick, Ryan, & Pintrich, 1999).

Garcia & Pintrich (1992) conducted one of the few studies that introduced motivation and learning strategies into the critical thinking research. They used five scales from the 1988 version of Motivated Strategies for Learning Questionnaire (MSLQ): intrinsic goal orientation; rehearsal strategies; elaboration strategies; metacognitive self-regulatory strategies; and critical thinking. They found that intrinsic goal orientation is positively related to critical thinking. However, disciplinary differences exists in that intrinsic goal orientation is a significant predictor of critical thinking for biology and social science students, but not for English students. Elaboration and metacognitive self-regulatory strategies at the end of the semester were positively related to critical thinking. Their model explained 54 percent of the variance in posttest critical thinking. If pretest critical thinking was included, the R-square increased to 65

percent. However, Fleming, Garcia, & Morning (1995) found that achievement motivation was negatively correlated with abilities to do thematic analysis, a critical thinking measure in the study. The subjects for the study were 78 African-American and Hispanic engineering students.

Terenzini et al. (1995) found that after controlling for prior critical thinking skills, the variables that are significantly related to gains in critical thinking include hours spent studying, parents' education and number of non-assigned books read. These variables mapped the motivation, student characteristics, and learning strategies categories. However, reporting the hours spent studying is inadequate for characterizing student motivation. Individuals may have spent the same amount of time in achievement behavior, but their goal orientation has a dramatic effect on subsequent cognitions, attributions, motivation and affect (Ames, 1992).

Facion (1990) emphasized self-regulatory aspect of critical thinking. Self-regulation also tend to be required for distance learning students (Blocher et al., 2002). As online learners works in a learning environment where time and place for study lie in their own responsibility, students' ability to self-monitor, self-regulate their learning, and garner resources and peer support is vitally important. It is hypothesized that cognitive strategies like elaboration and organization will enhance critical thinking.

Literature on distance education also pointed toward motivation and learning strategies as a contributor to learning. Dill (2003) examined student perceptions of online course factors that enhance and hinder the development of critical thinking. A reinforcing factor of learning was that students must be self-directed, motivated and take more responsibility in their learning (p.142-143). Bullen (1998) reviewed literature to conclude

that motivational orientation of the student, part of the dispositional characteristics of the students, is a key factor to consider for learning outcome modeling. Fredericksen et al. (2000) also found student motivation for taking courses appears to play an important role in perceived learning. Students who reported that they were taking courses because they were not offered on campus reported significantly lower levels of learning than students who were taking courses because of family responsibilities or because of a conflict with their personal schedule. Shih & Gamon (2001) found that motivation, measured by task value, intrinsic motivation and extrinsic motivation etc., is the only significant predictor of achievement. Dill (2003) concluded from an online focus group of 17 students and found that time management was often referenced as a factor that hinders the development of critical thinking skills. Examples included "difficulties in managing time, balancing course requirements with personal/family requirements, and taking time to go online to check for questions and formulate and post responses"(p.142).

Other factors came into play, too. Bures, Abrami, & Amundsen (2000) argued technology was one of the factors contributing to student acceptance of computer conferencing. Blocher et al (2002) reasoned that online learners needed to feel comfortable with technology and that they have the adequate technical skills to engage in Web-based courses. Research on these contentions seems inconclusive. Kuh & Vesper (1999) found the gains in computer familiarity mediate gains in college through interactions with other gains. Similarly Hanson (1988) found that more variation in critical thinking performance was explained by computer ability than mathematical ability. However, Flowers, Pascarella, & Pierson (2000) found neither computer use nor email use had any significant effects on any of end-of-first-year cognitive outcomes for

the four-year college sample while computer use had modest but significant positive effects on a composite cognitive development measure. In the same study, high computer use in two-year colleges tended to neutralize the negative effects of email use on end-of-first-year composite cognitive development. For 4-year colleges, email use had positive effects on cognitive development as student precollege cognitive development increased.

In the distance learning mode, Bures et al. (2000) found that previous experience is not significantly related to success expectations and outcome expectations, although the insignificance might be due to the fact previous experience was not a valid construct (alpha only .395); the construct's operational definition asks how many math, computer, and CMC courses taken by the students. This study also found that computer anxiety is negatively related to success expectations but not related to outcome expectations. Computer attitudes are related to both success and outcome expectations. Shih & Gamon (2001) also found that achievement is not related overall attitude to web-based instruction. (Dill, 2003) found that inconsistent themes of prerequisite knowledge. Although students complained lack of computer knowledge as hindering the development of critical thinking skills, another theme emerged as that no factor hindered.

As shown above, motivation and learning strategies are important predictors of achievement, and possibly critical thinking. However, there is not much done in this area. Bures et al (2000) also argued that there is "a paucity of literature that focuses on the relationship between students' motivational characteristics and their acceptance of CC". Most research in distance education from 1990-1999 was descriptive and case studies (Berge & Mrozowski, 2001). Common research questions examined pedagogy, design

issues, interactivity and active learning, and learner characteristics. It is not clear how these different aspects interrelate and affect learning outcomes such as critical thinking.

Similarly, not enough attention has been given to how students are motivated and cognitively engaged in critical thinking in online discussions. Given that online discussion is an ideal environment for improving critical thinking, and there is scattered research on motivation and learning strategies, crucial factors to participation and higher-order learning online, it is important to examine the paths and relationships of those factors and discover how much impact these variables have on student self-reported growth in critical thinking.

Other Variables that Affect Critical Thinking

Other variables influenced student gains in critical thinking, too.

In the Terenzini study (Terenzini et al., 1995), prior critical thinking skills made a big difference in whether other variables were significant factors or not in predicting the gains in critical thinking. McMillan (1987), after his review of research on critical thinking, also warned that students' precollege level of critical thinking should be controlled for. Pascarella (1989) also showed that control of precollege critical thinking produced a small and insignificant effect on end-of-first-year critical thinking skills.

Tsui's (1998b) review of literature revealed that inconsistencies exist regarding the effects of race, parent education and gender on gains in critical thinking. Student characteristics came to be a strong predictor of gains in critical thinking (Terenzini et al., 1995). These characteristics include parental education, race/ethnicity, gender, total family income and degree aspirations. Kuh & Vesper (1999), however, found there is only a small but significant socio-economic status (SES) effect on the gains to think

analytically. SES was the sum of the variables that measure who pays for college, how much student works on a job and parental education. Criner (1992) found no correlation between parental education and critical thinking (Tsui, 1998b). Whereas Fleming et al. (1995) investigated the critical thinking skills as measured by scores in thematic analysis and analysis of arguments of 79 engineering minority students at three institutions. They found the SES effect varied across the institutions: higher critical thinking was negatively correlated with lower SES at one institution while nonsignificant at other two institutions. Cheung, Rudowicz, Lang, Yue, & Kwan (2001) found that SES, in particular, students who came from the bourgeois or upper class family, reported higher scores in critical thinking as compared with students of lower classes. The difference was still significant after controlling for educational and learning characteristics. Pascarella, (1999), however, reported no correlation between SES and critical thinking score in Waston-Glaser Critical Thinking Assessment (WGCTA).

The effect of race on critical thinking gains is inconclusive, too. Gadzella (1999) reported a negative effect of being African-American in the gains in critical thinking as measured by WGCTA. Flowers & Pascarella (2003) found race had a negative direct effect on critical thinking (CAAP) in the end of first year after controlling for background characteristics, institutional characteristics, academic experiences and social experiences. In addition, Flowers and Pascarella (2003) found there were conditional effects of race. Race had a differential effect on first-year critical thinking depending on the precollege thinking and also on the number of arts and humanities courses taken. The effect of precollege critical thinking is more pronounced for white students than African American students, although both effects are positive. In addition, the number of arts and

humanities courses taken in the first year impacted African American students negatively while positively impacting that of the White students. Meanwhile, there was precollege critical thinking X race interaction. (Kucharczyk, 2004) investigated factors that accounted for the cognitive development of 2-year public college students and race was a significant predictor of critical thinking as measured by CAAP.

The same inconsistency exists on the effects of gender. Kuhn (1991) found no significant gender differences in her analysis of responses of 169 subjects' argumentative reasoning. Tsui (1998a) also reported no differences by gender in self-reported gains to think critically four years after college entry. Similarly, Facione & Facione (American Philosophical Association, 1990; 1994; 1997) found race, number of credits completed, sex and age did not affect critical thinking skills as measured by CCTST for nursing students. However, Li et al. (1999) found gender had a small but significant on reported gains in critical thinking. Females had a disadvantage in reported gains than males. Even more so, Flowers, Osterlind, Pascarella & Pierson (2001) did find, after controlling for student ACT score, race, cumulative grade point average, total postsecondary credits taken, and average institutional ACT score, men had a bigger advantage in cognitive development measured by CBASE scores than women by attending college. Men had between .74 and .91 of a standard deviation advantage on the CBASE score over their freshmen counterparts while the same range for women .50 and .61 over their freshmen counterparts. However, the results of Kitchener and King (1994) showed that there were more men at higher stages of reflective judgment than women in their 10 year of study, using Reflective Judgment Interview (Hofer & Pintrich, 1997). The effect, though, was speculated to be a result of educational attainment, granted that men were more likely to

have attended postsecondary education during the period. Regarding 14 other studies employing the instrument, however, the effects of gender was not conclusive: 7 studies found no gender differences while 6 of the other 7 reported higher scores for men.

Finally, the effects of major were inconclusive, too. Tsui (1998a) found being education and non-tech majors was negatively correlated to self-reported growth in critical thinking while (Li et al., 1999; Terenzini et al., 1995) showed no significant effect of major. Garcia & Pintrich (1992), however, suggested major had a mediating effect on critical thinking via motivation.

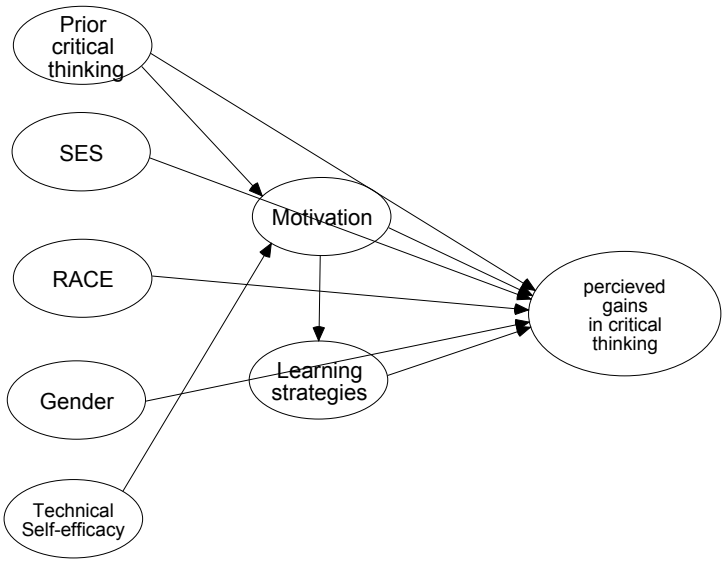
Few studies on online courses examined the effects of race, gender, and major. Hong (2002) discussed the results of a study about the effects of student and instructional variables on satisfaction and achievement in a Web-based course. Results indicated that gender, age, learning styles, time spent on the course, and perceptions of student-student interactions, course activities, and asynchronous Web-based conferences were not related to satisfaction and learning outcomes. Using a path analysis model, Murray-Harvey (1993) examined the interrelationships between study approaches, learning styles and locus of control on academic achievement. The study concluded with metacognitive ability being the best predictor of achievement and no significant contribution from gender, and age and approaches to learning. This finding conflicted with the Terenzini et al (1995) finding that time spent on the course is related to the gains in critical thinking. It also contradicts the finding that student-student interactions are important to promoting critical thinking reported by Smith (1978, 1981). These inconsistencies make it necessary for more research to be conducted. These variables will be used as control variables in the model.

Moreover, most studies establish only correlations between motivation, learning strategies and learning outcomes. One methodological focus on critical thinking is use of step-wise regressions. This approach could not deal with the correlations among variables and constructs such as motivation and learning strategies. What remains to be seen is interrelations among motivation, learning strategies and perceived gains in critical thinking online, controlling for other intervening variables such as prior critical thinking skills and student demographics.

In view of the research literature discussed in this chapter on critical thinking in both classroom research and online education, motivation and learning strategies, I constructed a conceptual framework for the study (Figure 2.1). In this framework, student background characteristics such as SES (including parental education, family total income), race/ethnicity, sex, major, and prior critical thinking skills all directly influence gains in critical thinking. These input variables are important control variables to any learning outcome. Prior critical thinking and technical self-efficacy affect how much interest and value they attach to the tasks in the courses, therefore both influence the motivation variables. How students are motivated may incline them to choose from the repertoire of learning strategies in their command, consequently motivation variables are expected to affect learning strategies. Motivation, meanwhile, exerts a direct influence on the perceived gains in critical thinking, too. Finally, perceived gains in critical thinking are influenced by the learning strategies, because the former depends on the effectiveness of the latter.

Figure 2.1 shows the conceptual framework for the study:

Figure 2.1 Conceptual Model



To summarize, this study proposes to investigate:

1) To what extent do students report gains in critical thinking in online courses?

2) Do the data support the hypothesized model?

   i. What factors in the model have dominating influence on self-reported gains in critical thinking?

   ii. Do the effects of the motivation and learning strategies differ by race, gender and major?

Chapter 3

Methodology

The purpose of this study is to test the proposed model for gains in critical thinking (GCT). In particular, it examines the inter-relationships between GCT, motivation, learning strategies and a number of student-related factors. The variables included in the model are student race, gender, major, prior critical thinking ability, technical self-efficacy, motivation and learning strategies. These variables are subjected to a structural equation model (SEM) with GCT as the outcome variable with a view to discovering the determinants of gains in critical thinking.

Research Design

The research design for this study is longitudinal and pre-experimental. Collecting data via pretest/posttest survey, the study examines the same set of students over the course of a semester in terms of perceived gains in critical thinking while monitoring their initial perception of critical thinking ability at the beginning of the semester. The quantitative design uses a structural equation model to assess the fit of the proposed model and estimate the structural path coefficients among the latent variables. The data are collected online using Perseus Solution 6, a survey software that combines creation of surveys, administration and storage of responses. Information collected includes race, SES, gender, technical self-efficacy, prior critical thinking, pre- course MLSQ, and end-of-course gains in critical thinking.

Course Description and Subjects

The three courses examined in this study present a nice challenge for examining the relationships among motivation, learning strategies and critical thinking. On one hand, watching art performances is enjoyable as a recreational activity. On the other hand, the courses require students to discuss and critique the performances based on reasoning. The situation poses challenges in instructional design and effectiveness of online course delivery. Are learners motivated to discuss art issues with a critical mind? Can learners execute rational learning strategies to expand their understanding of something as subjective and elusive as art? Can critical thinking be developed online when you don't see the faces of people you are exchanging reasoning with? Do learners achieve development of critical thinking regardless of race, gender and major? These are the questions the study tries to understand.

IA5, IA100, IA100-W are three general education courses at Penn State taught by the same instructor. These courses used to be offered in a face-to-face setting. Due to budgetary constraints, the courses were reformatted for online delivery starting in 1992. Students live on campus. They are traditional age students. These courses are likely to be their only online course in the semester. These characteristics are both similar and different from the literature on online students as a whole; similar in that more are women and white; different in that the most studies report online students are older (Diaz, 2000), live at home, have full-time jobs and may take the whole degree online. Therefore some of the variables found to be significant in affecting student learning in those situations are not necessarily applicable. For example, social interaction in online courses for the latter is a significant portion of the online discussions. Sometimes the instructors

have to intervene to keep the social interactions from derailing the intellectual discussions. However, in a traditional age group, students have other opportunities (courses, campus events, faculty contact etc) to feel part of a community. Therefore online social interaction is not usually a variable that affects this group. The three courses used to have a non-content-related forum for students to socialize online, but it was abandoned due to lack of participation in the forum. Therefore, measures of social interaction are not included in the hypothesized model.

The three courses are similar in course structure and assignments. All of them combine theatre performances with background information and weekly critical opinion papers in helping students to "develop an understanding of the performing arts, develop an understanding of the performing arts, gain background in the experience of concert going, and aid in the development of critical responses to a variety of different arts experiences." (Course Website, 2005). The courses are not intended as art appreciation in nature but to encourage critical thinking about performing art events and evaluations of those experiences.

Introduction to critical thinking is given during week one and two. The instructor defines critical thinking as a process of drawing valid conclusions about performing arts events. There are six performing arts events and five critical thinking concepts, all of which explicitly deal with disciplinary elements in art critiquing. For example, one critical concept is "the Shock of the New". This concept stated that newness is the norm in art. What is regarded as new today will become old or vanish over time. New things are disturbing as well as powerful. They tend to shake people out of their smug

expectations. Therefore, evaluating an artistic experience should focus on "what is gained, what is lost, and at what cost?"

There are also background materials on the website for each event, the content of which is evaluated through weekly online quizzes and students can submit their responses as many times as they want. As a result, student performance on the quizzes doesn't vary much and are not considered for either a variable in the model. All communications between students and the instructor and among students take place on course websites. Each week the instructor introduces the topic for discussion through a commentary (which is a screen or more long). At the end of the commentary he raises some questions for opinion papers. The opinion papers should be posted on the discussion board and a position is taken based on the issues and ideas that arise from the instructor commentaries associated with each performance. In addition, students are required to post a response paper to one position paper of their peers. The response paper can challenge the position paper or support it with additional information. Examples of critical opinion papers and tips on writing them were provided on the website, too.

The population of this study consisted of all students in the three courses (N=328) for the spring semester, 2005. Students who take more than one of the three courses (N=7) are asked to base their responses on only one of the three courses.

Data Collection

Online surveys are both methodologically and financially appealing to researchers. An online survey is easy to administer and impervious to data entry errors. Respondents can take the survey at the convenience of their preferred time and location. Research also shows there is no significant difference between the responses of web and

paper surveys (Carini, Hayek, Kuh, Kennedy, & Ouimet, 2003). Previous studies on this course showed that over 40% of students would be likely to take the survey. Consequently conducting the survey online seems appropriate for this study.

I conducted a pilot study to test the response rate, details of which appear in a later section of the chapter. The Penn State Institutional Review Board (IRB) for the study was approved in February 2005. A copy of the approval is attached in Appendix A. Data collection for this study took place in the spring semester of 2005. I emailed students enrolled in IA005, IA100, and IA100W on Feb 3 (the 4th week), requesting their participation in a research study on the relationships among motivation, learning strategies and critical thinking in online learning. They were reminded that they could print a copy of the email invitation (see Appendix A) as an implied informed consent form and were told that they would take two surveys during the course. The instructor sent a message in the same week encouraging students to respond. A reminder email was sent to nonrespondents on February 10.

The first survey consisted of nine categories of questions. The questions requested information in the following areas, a) demographic information such as gender, race, major, semesters enrolled in college courses, total family income, and parental education b) technical self-efficacy, c) prior critical thinking, d) motivation and e) learning strategies. The second survey was emailed to students on April 20. The questions requested information on the end-of-course gains in critical thinking.

Instruments

Appendix B includes the first survey sent to students. Items on technical self-efficacy and prior critical thinking skills are explained here, as I developed the items for

these two constructs. The development of these items was intended to map the particular course content for this study. Eventually four items were included for technical self-efficacy and 16 items were included for prior critical thinking[1].

The structure of the courses required students to post their position papers on the discussion board. As a result, students needed to log on to the discussion board and cut and paste their writing onto the assigned threads from a Word or other document-editing program. Students also needed to be able to start a new thread or respond to a thread started by other students. In light of these elements, the researcher has included four items to measure the perceived competence in technical self-efficacy: using Internet, searching for information on the web, using discussion board and transferring a document online from an offline source. A typical item in this scale reads: please rate your competence in using discussion boards on a scale of 1 to 7, 1=lowest 7=highest.

As detailed in the measurement section, critical thinking in this study gauges student perceptions of their abilities to provide evidence, examine evidence, explore alternative explanations for an artistic phenomenon and draw valid conclusions. Consistent with the definition of critical thinking in the three courses, 16 items are used to measure the four areas of critical thinking, each dimension of critical thinking being measured by four items. A typical item for this scale reads: please rate your current ability to examine the strengths and weakness of evidence on a scale from 1 to 7 (1=lowest, 7=highest). These constructs were pilot-tested, the results of which were detailed in the pilot study section, showed that they are very reliable as well as valid.

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[1] Although MLSQ (Garcia & Pintrich, 1995) includes a section on critical thinking, that subscale is inadequate for measuring gains in critical thinking. It measures "students's use of strategies to apply previous knowledge to new situations or make critical evaluations of ideas". This subscale is too general for the course.

MSLQ is a self-report instrument designed to assess college students' motivational orientation and their use of different learning strategies for a college course (Teresa & Pintrich, 1995). It is based on a general social-cognitive view of motivation and learning strategies, with the student represented as an active processor of information whose beliefs and cognitions are important mediators of instructional output and task characteristics.

Different components of MSLQ can be used independently or as a whole (Garcia & Pintrich, 1995). Researchers can decide to use all or use only part of the instrument. For this study, the MLSQ was modified to match the online courses. Specifically, because no exams were given, the subscale on test anxiety was deleted. The subsection on rehearsal was deleted because it was not a skill student would employ for this course, as assessment was not conducted using multiple-choice questions. The critical thinking section was deleted, too (c.f. footnote 1). The section on Help Seeking was deleted because of its low reliability. The peer learning subscale was not used, as the course does not involve group projects.

The wording of some MSLQ items is not appropriate for online courses. Therefore these items were deleted or modified. For example, item 33 in the original MSLQ reads, "During class time, I often miss important points because I'm thinking of other things". There is no class time for online courses and materials, notes, and discussions are there for view anytime anyplace, so this item was deleted. So is it with item 79, which reads "If I get confused taking notes in class, I make sure I sort it out afterwards". Item 73 reads, "I attend this class regularly". The modified item reads, "I

participate in online discussions regularly". Table 3.1 shows the comparison of the modified and deleted items.

Table 3.1 Modified MSLQ Items

Item	Changes
During class time, I often miss important points because I'm thinking of other things	Deleted
When I study for this course, I go through the readings and my class notes and try to find the most important ideas.	When I study for this course, I go through the readings and try to find the most important ideas.
When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.	When I study for this class, I pull together information from different sources, such as readings, instructor commentaries and discussions.
When studying for this course, I go over my class notes and make an outline of important concepts.	When studying for this course, I make an outline of important concepts.
When I study for this course, I write brief summaries of the main ideas from the readings and my class notes.	When I study for this course, I write brief summaries of the main ideas from the readings.
I try to understand the material in this class by making connections between the readings and the concepts from the lectures.	I try to understand the material in this class by making connections between the readings and the concepts.
I attend this class regularly	I participate in the discussions regularly
I'm certain I can understand the most difficult material presented in the readings for this course. I am confident I can understand the most complex material presented by the instructor in this course.	Combined I am confident I can understand the most difficult and complex material presented in this course.
If I get confused taking notes in class, I make sure I sort it out afterwards.	Deleted
I rarely find time to review my notes or readings before an exam	Deleted
I try to apply ideas from course readings in other class activities such as lecture and discussion.	I try to apply ideas from course readings in discussions.

Items in MSLQ are scored on a 7-point Likert scale, from 1 (not at all true of me) to 7 (very true of me). Part of Table 3.4 shows the various scales of motivation and learning strategies measured in my study. The motivation section assesses students' goals and value beliefs for a course, and their beliefs about their skills to succeed in a course. The learning strategy section contains items on students' use of different cognitive and metacognitive strategies and management of different learning resources.

Two MLSQ subscales assess perceptions of self-efficacy and control beliefs for learning. Self-efficacy contains both expectancy for success and judgments of one's ability to accomplish a task and confidence in one's skills to perform a task. Control beliefs for learning refer to students' beliefs that outcomes are contingent upon one's own effort, rather than external factors such as the teacher or luck. Three subscales in the MSLQ measure value beliefs: intrinsic goal orientation (a focus on learning and mastery); extrinsic goal orientation (a focus on grades and approval from others); and task value beliefs (judgments of how interesting, useful, and important the course content is to the student).

There are three general types of scales in the learning strategies: cognitive; metacognitive; and resource management. Cognitive strategies include students' use of strategies for the information processing from texts and lectures. Two subscales are used in this study, elaboration strategies (e.g., paraphrasing, summarizing) and organization strategies (e.g., outlining, creating tables). The second general category is metacognitive control categories, which is measured by one large subscale concerning the use of strategies that help students control and regulate their own cognition. This subscale

includes planning (setting goals), monitoring (of one's comprehension), and regulating (e.g., adjusting reading speed depending on the task).

The third general strategy category is resource management, which includes four subscales on students' regulatory strategies for controlling other resources besides their cognition. These strategies include managing one's time and study environment (e.g., using one's time well, having an appropriate place to study), as well as regulation of one's effort (e.g., persisting in the face of difficult or boring tasks.

The modified instrument takes approximately 20-30 minutes to finish. It contains 54 items, 23 items on Motivation and 31 items on Learning Strategies.

Table 3.2 shows that reliabilities of the MSLQ scales range from .62 to .90. The validity of MSLQ shows only marginal fit (Table 3.3). The reason might be that there are too many variables in the model. McClendon (1996) showed that MSLQ "measures what it purports to measure especially for motivation". In the results section, I also present the reliability of the MLSQ for the sample in my study.

Table 3.2 Reliability of MSLQ (Garcia & Pintrich, 1995)

Scale	alpha
Motivation	
Intrinsic Goal Orientation	.74
Extrinsic Goal Orientation	.62
Task Value	.90
Control of Learning Beliefs	.68
Self-Efficacy for Learning and Performance	.93
Learning Strategies Scales	
Elaboration	.75
Organization	.64
Metacognitive Self-Regulation	.79
Time and Study Environment Management	.76
Effort Regulation	.69

Table 3.3 CFA Validity of MSLQ (Pintrich, Smith, Garcia, & McKeachie, 1991)

Scales	χ^2/df	GFI	RMR	CN
Motivation Scales	3.49	.77	.07	122
Learning Strategies	2.26	.78	.08	180

Table 3.4 lists the variables and how they are measured in the current study. As shown in Table 3.4, the reliabilities of MLSQ scales range from .58 to .89, slightly less than but comparable to those reported by Garcia & Pintrich (1995). This suggests that the

modified MLSQ is a reliable instrument to measure the motivation and learning strategies of the online students in the current study.

The reliabilities of prior critical thinking and gains in critical thinking are very good, ranging from .82 to .95, suggesting that the scales are reliable. Similarly, technical self-efficacy has a reliability of .83.

Table 3.4 also reports the factor loadings of items on a factor. The values given in that column reflect the strength of the given item to measure a corresponding factor.

Table 3.4 Variables and Measures

Variables	Item#/Description	Items/Values	Alpha	Factor Loadings
	From Survey 1(Appendix B)			
Prior Critical Thinking				
Providing Evidence	3a1, 3a3, 3a7, 3a15	1=lowest,7=highest	.850	.928
Exploring Alternatives	3a4, 3a6, 3a10, 3a14	1=lowest,7=highest	.815	.887
Examining Evidence	3a2, 3a9, 3a12, 3a13	1=lowest,7=highest	.817	.903
Drawing Conclusions	3a5, 3a8, 3a11, 3a16	1=lowest,7=highest	.849	.924
Social Economic Status	3 items		.664	
	10, total family income	1=under $25,000 2=$25,000---$49,999 …7=above $200,000		
	11a, mother's education	1=less than high school …7=doctorate		
	11b, father's education	1=less than high school …7=doctorate		
Race	7	0=white, 1=nonwhite		
Gender	6	0=male, 1=female		
Major	9	0=SMET, 1=humanities & soc sci		
Technical Self-efficacy	2a-2d (4 items), measuring competence in using Web & discussion board	1=lowest, 7=highest	.827	
Motivation				
Intrinsic Goal Orientation	5a1, 5b4, 5b8 (3 items),	1=not at all true of me,	.720	.681

	Goals like challenge, curiosity, and mastery	7=very true of me		
Extrinsic Goal Orientation	5a6, 5b1, 5b3, 5c6 (4 items), Goals like grades, rewards, competition with others.	1=not at all true of me, 7=very true of me	.584	
Task Value	5a3, 5a8, 5b5, 5c1, 5c3, 5c4 How interesting, important, useful a learning task is.	1=not at all true of me, 7=very true of me	.883	.87
Control of Learning Beliefs	5a2, 5a7, 5b6, 5c2, Beliefs that efforts will result in positive outcomes.	1=not at all true of me, 7=very true of me	.761	.583
Self-efficacy for Learning & Performance	5a2, 5a7, 5b6, 5c2, appraisal of ability to master a task and succeed.	1=not at all true of me, 7=very true of me	.888	.475
Learning Strategies				
Elaboration	5e3, 5f1, 5f3, 5f5, 5f6, 5g6 Paraphrasing, summarizing, and note-taking etc.	1=not at all true of me, 7=very true of me	.780	.823
Organization	5d1, 5d6, 5e1, 5f2, Clustering, outlining, and selecting main ideas	1=not at all true of me, 7=very true of me	.811	.757
Time and Study Environment Management	5d2, 5d7, 5e2, 5f4, 5f7, 5g1, 5g4, regulation of time and location for study.	1=not at all true of me, 7=very true of me	.694	.536
Effort Management	5d4, 5e8, 5f8, 5g4, control of Effort & attn despite distractions & boring tasks	1=not at all true of me, 7=very true of me	.606	
Self-regulation	5d3, 5d5, 5d8, 5e4, 5e5, 5e6 5e7, 5g3, 5g5, 5g7, planning, monitoring and regulating	1=not at all true of me, 7=very true of me	.826	.881

Gains in Critical Thinking	From Survey 2 (Appendix C)			
Gains in Providing Evidence	3a1, 3a3, 3a7, 3a15	1=lowest,7=highest	.890	.920
Gains in Exploring Alternatives	3a4, 3a6, 3a10, 3a14	1=lowest,7=highest	.903	.915
Gains in Examining Evidence	3a2, 3a9, 3a12, 3a13	1=lowest,7=highest	.893	.948
Gains in Drawing Conclusions	3a5, 3a8, 3a11, 3a16	1=lowest,7=highest	.906	.949

Data Analysis

The application of Structural Equation Modeling (SEM) in educational research has gained popularity over the past few decades. SEM grows out of and serves purposes similar to multiple regression but in a more powerful way which takes into account the modeling of interactions, correlated independents, measurement error, correlated error terms, multiple latent independents each measured by multiple indicators, and one or more latent dependents also each with multiple indicators (Garson, 2004). SEM is useful for dealing with relationships between latent variables, namely variables that cannot be directly measured (Long, 1983).

In this study, variables such as motivation, learning strategies, technical self-efficacy and perceived gains in critical thinking are latent variables measured by survey instruments. Therefore, SEM is appropriate for estimating the parameters and testing the models, as done in testing the validity of the MSLQ and the relationships between motivation and self-regulated learning (Garcia & Pintrich, 1991; 1995). More importantly, structural equation modeling can account for measurement error, an advantage not found with other statistical methodology. When researchers get engrossed in estimating parameters without controlling for measurement error, it leads to biased findings.

Available programs to run SEM include AMOS, LISREL, EQS, and Mplus. Specifically, the purpose is to test the applicability of MSLQ in online courses. Mplus will be used to test the fit of hypothesized model and make parameter estimates. This program is one of the few statistical packages that accommodate categorical variables in the SEM model. It was developed by Muthen & Muthen.

Mplus uses Full Information Likelihood (FIML) handling of missing data, an appropriate and modern method of missing data handling that utilizes all available

data points, even for cases with some missing responses. FIML use all available data to generate maximum likelihood-based sufficient statistics. If the missing at random (MAR) assumption can be met, maximum likelihood-based methods can generate a vector of means and a covariance matrix among the variables in a database that is superior to the vector of means and covariance matrix produced by commonly-used missing data handling methods such as listwise deletion, pairwise deletion, and mean substitution. Multiple imputation is similar to the maximum likelihood method, except that multiple imputation generates actual raw data values suitable for filling in gaps in an existing database. Typically, five to ten databases are created in this fashion. The investigator than analyzes these data matrices using an appropriate statistical analysis method, treating these databases as if they were based on complete case data. The results from these analyses are then combined into a single summary finding.

The analytical plan for this study includes first, percentage of students who reported gains in end-of-semester critical thinking and descriptive statistics on given the gains by race, gender and major. Correlations with other variables will be presented, too.

Second, a confirmatory factor analysis will be conducted to assess the validity of the construct of critical thinking and the fit of model. In other words, the test determines the validity of the hypothesized relationship between latent variables and their indictors, allowing only correlated latent factors while not making any assumptions about the directions between the latent factors.

Thirdly, the overall fit of the hypothesized model will be assessed according to the standards of the field. This is a critical step before venturing parameter estimates (Diamantopoulos & Siguaw, 2000). McDonald & Ringo Ho (2002) reviewed 41 SEM studies and found that the most common global fit indices used included comparative

fit index (CFI), the root mean square error of approximation (RMSEA), Goodness-of-fit index (GFI), the Tucker-Lewis index (TLI) and the normed fit index (NFI). Most investigators reported at least two such measures. RMSEA of less than .05 means a good fit while less than .08 is an acceptable fit. If an index is scaled up to unity for perfect fit (URFI/CFI, GFI, etc.) the value of this index has to be greater than .90. McDonald & Ringo Ho (2002) also suggested giving tables of correlations, variances and discrepancies.

Finally, parameters between latent variables and gains in critical thinking will be estimated. The significance and magnitude of the estimates will reveal what factors significantly influence the gains.

Pilot Study

A pilot study (for details and results of the pilot study, please refer to Zhang (2005)) was conducted in the fall semester of 2004. The purpose of the pilot study was to test the reliability and validity of prior critical thinking and technical self-efficacy, the reliability of MSLQ in the sample population, and get a sense of the response rate.

The pilot study was conducted through two surveys. The first survey, given in the second week of Fall 2004, collected information on race, gender, technical self-efficacy and prior critical thinking. The second survey was given in the 14th week of Fall 2004. It collected information on the end-of-course critical thinking as well time 2 motivation and learning strategies.

Several factors contributed to the choice to administer two surveys. First, prior critical thinking was measured in the beginning of the course to have high validity. If prior critical thinking and gains in critical thinking were both measured at the end of course, students might have trouble recalling their prior critical thinking at the

beginning of the course due to the passage of time. Secondly, a satisfactory response rate is more likely to happen, as MSLQ contained 54 items. If all the information were collected at the end of the course, the survey would get too long and response rate might suffer.

Table 3.5 reports the demographic information for the pilot study first survey. Ninety-five out of 230 students responded.

Table 3.5 Demographic Makeup of INART 005_Fall 2004

Variable		N	Percent
Gender	M	28	29.5
	F	67	70.5
Race	White	78	82.1
	Nonwhite	17	17.9
First online course*	Yes	80	84.2
	No	15	15.8

* Whether it is the first time for the student to take an online course

The second pilot survey was collected from December 3 to December 18, 2004. Fifty-eight out of 230 students responded to the second survey. The low response rate might be a result of poor timing, as the survey was administered during the finals and pre-holiday season. The length of the survey might also have played a role in the low response rate.

Although four areas of skills are included in our definition of critical thinking, each cannot be separated from one another. It is hard to draw conclusions without evaluating the evidence, for example. In fact, Ennis (1993) contended that components of critical thinking are interdependent. In addition, Research (American Philosophical Association, 1990) has particularly warned that critical thinking as measured in CCTT is not a multi-dimensional factor. Consequently, CFA for PCT tested whether the summed values for the four skills all load on one factor called prior

critical thinking. Table 3.6 shows the fit statistics of the prior critical thinking in the pilot study:

Table 3.6 Fit Statistics of Prior Critical Thinking in the Pilot Study

Concept	χ^2/df (p value)	CFI	TLI	RMSEA
Prior Critical Thinking	1.135 (.3178)	.999	.998	.038

These fit statistics showed that prior critical thinking as measured by the four composites has good fit.

Table 3.7 shows the reliability of the constructs in the pilot study. The reliability coefficients of the constructs range from .627 to .959. These numbers are good enough for proceeding to the next step.

Table 3.7 Reliabilities of Constructs in the Pilot Study

Concept	Items making up the concept	Alpha
Prior Critical Thinking(PCT)	provide(sum of pct1, 3, 7, 15) explore(sum of pct4, 6, 10, 14) examine(sum of pct2, 9, 12, 13) conclude(sum of pct5, 8, 11, 16)	.959
Technical Self-Efficacy (TSE)	tse1, tse2, tse3, tse4	.875
SES	income, moed, faed	.654
Motivation		
Intrinsic Goal Orientation (IGO)	igo1-igo3	.744
Task Value (TV)	tv1-tv6	.866
Control of Learning Beliefs (CONTROL)	control1-control4	.841
Self-efficacy for learning & Performance (SE)	se1-se6	.907
Extrinsic Goal Orientation (EGO)	ego1-ego4	.667
Learning strategies		
Organization (ORG)	org1-org4	.803
Elaboration (ELAB)	elab1-elab6	.765
Time & Study Environment Management (EVRN)	evrn1-evrn7	.672
Effort Management (EFFORT)	effort1-effort6	.627
Self-Regulation (REG)	reg1-reg10	.756
Gains in Critical Thinking (GCT)	G_prov (sum of gct1, 3, 7, 15) G_exp (sum of gct4, 6, 10, 14) G_exa (sum of gct2, 9, 12, 13) G_con (sum of gct5, 8, 11, 16)	.945

Based on the results in this pilot study, some changes were made in the data collection procedures. These changes are described as follows. Considering the low

response rate for the MLSQ of the pilot study and the poor timing of the second survey, some changes were made, which included:

1) Students were offered two extra points for completing both surveys
2) The first survey collected demographics, prior critical thinking, technical self-efficacy and the MSLQ. The MSLQ was collected in the beginning of the course when students were still fresh and not distracted by the stress with finals.
3) The second survey only collected student perceptions of gains in critical thinking at end of the course.

Chapter 4

Results

First part of this section includes a description of the response rates of the surveys and demographic information on the subjects. In addition, descriptive statistics is reported for self-perceived gains by group. A correlation matrix of the continuous variables is presented to give a rough idea of the relationships among those variables. More importantly, information on validity and reliability for PCT and GCT are reported to establish the usefulness of the instrument. Finally, assessment results of the hypothesized model are reported and parameter estimates are presented.

Response Rate

The response rate for the first survey for Spring 2005 was much better than the pilot study. 241 students out of 328 students responded in the first survey while 260 did in the second survey. First data from the two surveys were merged and matching of cases for the two surveys was performed. Then, the following cases are deleted: 1) those who one of the two surveys was missing, 2) those whose responses in both surveys were contradictory (for example, some students reported taking one course in survey one while reported taking another course in survey two). After the deletion, the final sample consisted of 216 cases, which represented 67 percent of the student population in this study.

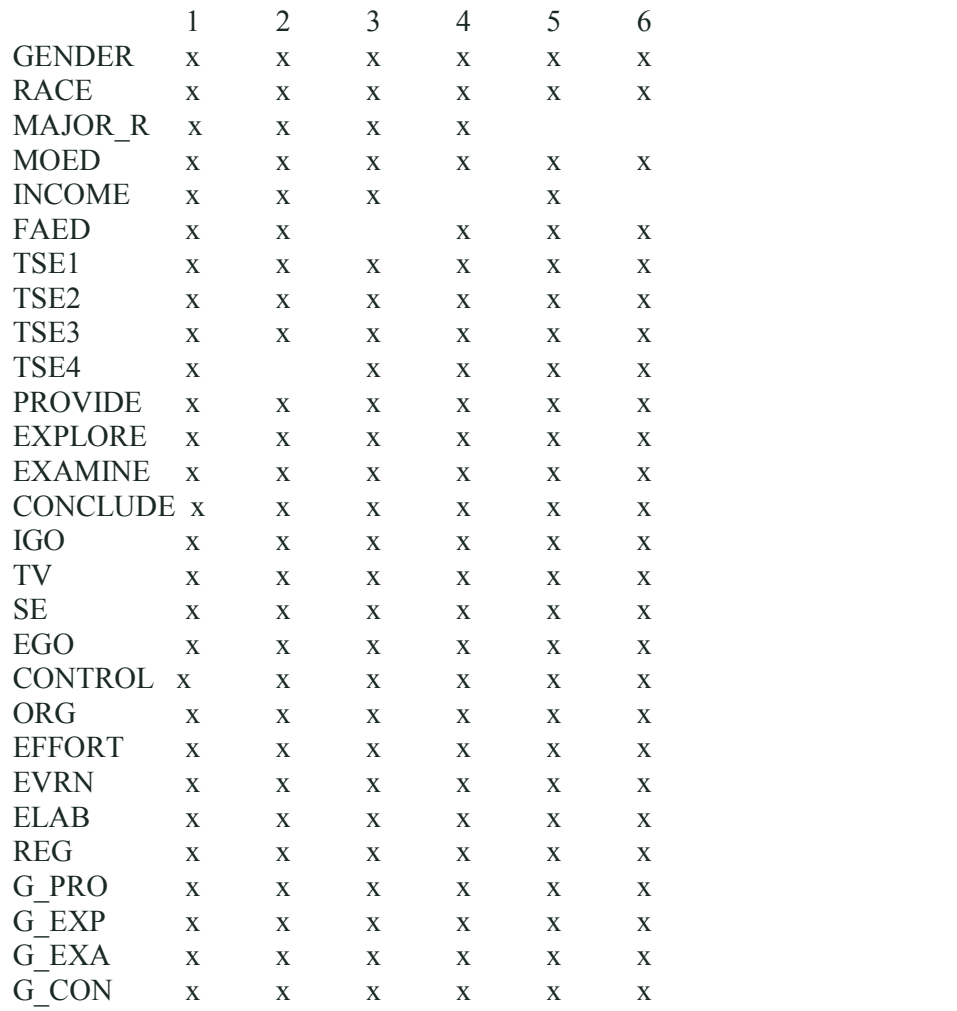
Data screening

It is very important to review the data before conducting the analysis. Purposes for data review include: 1) accuracy of data; 2) making decisions about missing data; 3) check for the presence of outliers; 4) check for normality.

Data recoding took place as follows. The new variable major_r became a binary variable with 0 indicating students majoring science, engineering, math, technology, premed and nursing while 1 has the combined categories of social sciences and humanities. Several cases have undeclared majors and these responses are coded “missing”. Four sum values were obtained for the prior critical thinking, resulting in ‘provide’, ‘examine’, ‘explore’ and ‘conclude’ for the PCT. Each is the summation of the individual scores in the four items meant to measure providing evidence, exploring alternative explanations, examining evidence and drawing valid conclusions. Similarly, four sum values were obtained for the gains in critical thinking (GCT), resulting in g_pro, g_exp, g_exa, and g_con for GCT. Each of these sums is the summation of the individual scores in the four items meant to measure perceived gains in providing evidence, exploring alternative explanations, examining evidence and drawing valid conclusions.

Frequency distributions and descriptive statistics are generated for all data used in this study. Frequency distributions were reviewed to make sure all data contained possible values for the variables. Perseus automatically records a value of “0” for students who fail to submit a response; therefore frequency distributions are reviewed to see if “0” are possible values for a variable. For example, all possible values for perceived competence in using discussion board is 1 to 7. A “0” in the data is missing instead of an actual response. Two methods were used to check for missing data: the missing data patterns and the distribution of the data patterns. The following figure shows the missing data patterns.

Figure 4.1 Missing Data Patterns



	1	2	3	4	5	6
GENDER	x	x	x	x	x	x
RACE	x	x	x	x	x	x
MAJOR_R	x	x	x	x		
MOED	x	x	x	x	x	x
INCOME	x	x	x		x	
FAED	x	x		x	x	x
TSE1	x	x	x	x	x	x
TSE2	x	x	x	x	x	x
TSE3	x	x	x	x	x	x
TSE4	x		x	x	x	x
PROVIDE	x	x	x	x	x	x
EXPLORE	x	x	x	x	x	x
EXAMINE	x	x	x	x	x	x
CONCLUDE	x	x	x	x	x	x
IGO	x	x	x	x	x	x
TV	x	x	x	x	x	x
SE	x	x	x	x	x	x
EGO	x	x	x	x	x	x
CONTROL	x	x	x	x	x	x
ORG	x	x	x	x	x	x
EFFORT	x	x	x	x	x	x
EVRN	x	x	x	x	x	x
ELAB	x	x	x	x	x	x
REG	x	x	x	x	x	x
G_PRO	x	x	x	x	x	x
G_EXP	x	x	x	x	x	x
G_EXA	x	x	x	x	x	x
G_CON	x	x	x	x	x	x

Table 4.1 Frequencies of Missing Data Patterns

Pattern	Frequency	Pattern	Frequency	Pattern	Frequency
1	199	3	1	5	6
2	1	4	8	6	1

Figure 4.1 showed that there were 6 missing data patterns: complete cases, missing technical self-efficacy item 4; missing father's education; missing total family income; missing major and missing both major and total family income. Thus most of the data (92 percent) have complete information on all variables. Even for missing cases, all of them only have missing observation on one variable except one case that

is missing in both major and total family income. Only a small portion of cases (3.7 percent) lacked information on total family income, which is understandable. The other noteworthy missing variable (3.2 percent) is major. The cases that are missing from the sample on the major variable actually are not missing but are cases where respondents have reported they don't have a declared major and are coded as missing, as mentioned earlier in this section. Overall, the missing data patterns and distributions showed the data has complete coverage in most cases. In addition, the data seems to be missing at random.

Data imputation is an alternative way to treat missing data. Usually it is used when listwise deletions reduce sample size substantially. However, to make comparisons between the results of the study with or without data imputation, one dataset was imputed for the sample data. The results from the imputed dataset showed similar fit statistics and parameter estimates as those before the imputation, with the differences in parameter estimates in the third decimal places. For example, the direct effect of learning strategies on GCT is .487 for the sample data whereas the estimate for the same parameter is .482 in the imputed data. Therefore, results are only reported for the sample data without imputation.

Table 4.2 shows the demographic breakup. 36.6 percent of the participants were male and 63.4 percent were female. The racial makeup of the group is 81% white and 19% nonwhite. 72.7 percent of the participants majored in social sciences or humanities while 27.3 percent of the participants majored in science, math, engineering and technology. The SMET group also included students majoring in nursing and premed. The majority of the participants (71.2 percent) had no online course experience before taking the courses under study. The mean age of the sample

is 20.85 years. The mean self-reported GPA is 3.31. The mean number of semesters enrolled in college courses is 6.49 semesters.

Table 4.2 Demographic Makeup of INART 005_Spring 2005

Variable		N	Percent
Gender	M	79	36.6
	F	137	63.4
Race	White	175	81.0
	Nonwhite	41	19.0
Major	SMET	57	27.3
	Social sciences & humanities	152	72.7
First online course	Yes	153	71.2
	No	62	28.8

Thus, the demographics of Spring 2005 respondents did not differ significantly from that of the pilot study. It is presumed that the samples are representative of the students in the courses. It is consistent with the overall undergraduate population by race but not by sex (Pennsylvania State University, 2005). Females are overrepresented by 17 percent.

Normality plots were reviewed to see if the variables are normally distributed. The normal plots of all the variables do not deviate from strongly from a straight line, therefore suggesting the variables follow a normal distribution. No transformation of the data is needed.

Descriptive Statistics

Table 4.3 Mean Gains in Critical Thinking

Item	Mean	SD	Rating 5 or higher(%)
Quoting sources	4.52	1.53	52.56
Contemplating complexities	4.90	1.27	61.79
Supporting with reasoning	4.97	1.23	69.93
Examining sides	5.01	1.30	68.84
Making informed decisions	4.95	1.23	65.58
Looking from multiple angles	5.14	1.41	72.30
Gathering justifications	4.75	1.35	57.67
Drawing valid conclusions	4.94	1.30	64.19
Assessing credibility of sources	4.70	1.27	59.81
Exploring alternative explanations	4.84	1.32	61.79
Making inferences	4.94	1.35	69.16
Distinguishing evidence from assertions	4.81	1.39	64.02
Examining evidence	4.83	1.38	62.33
Formulating interpretations	4.88	1.30	66.51
Locating sources	4.72	1.38	57.67
Assessing the logic btw evidence and conclusion	4.82	1.38	60.47

Table 4.3 shows the means of perceived gains in each category of critical thinking as a result of taking the online courses. The means of the perceived gains leaned more towards the high end. Most students felt that their gains in the 16 aspects of critical thinking were close to 5 on a scale of 7. It is remarkable more than 60% of the students reported making gains of 5 or higher in all 16 critical thinking areas except in quoting sources, gathering justifications, and locating sources. This shows that students felt that they have made significant learning gains in critical thinking as a result of taking the courses. Next, I present the means of perceived gains in critical thinking by group: race; gender; and major.

Tables 4.4-4.6 show that there seem to be differences in self-perceived gains in all the aspects of critical thinking across gender, race and major lines. Females tend to have higher self-perceived gains than their male counterparts. White students tend

to report higher gains in critical thinking than their non-white classmates. Students majoring in social sciences and humanities tend to have higher reported gains than students majoring in science, engineering, math and technology. However, MANOVA results showed that there are no overall race, gender or major effects on perceived gains in critical thinking. The results of these analyses are reported in detail below.

Table 4.4 Descriptive Results across the Total Sample by Sex

	Mean (Standard Deviation)		
Variables	Male N=79	Female N=137	Total Sample N=216
Gains in providing evidence (4.94)	18.46 (4.57)	19.09 (5.14)	18.86
Gains in exploring alt explanations (4.87)	19.19 (4.39)	19.95 (5.13)	19.67
Gains in examining evidence (4.80)	18.69 (4.32)	19.25 (5.06)	19.05
Gains in drawing conclusions (4.83)	19.22 (4.57)	19.76 (4.99)	19.56

Regarding the differences in Table 4.4, MANOVA results showed that there is not a significant difference between male and female students in the mean gains in the four critical thinking areas (wilks' lamda =.990, F=.05, df=(4, 210), p=.737). This suggests that there seems no overall gender effect on perceived gains in critical thinking.

Table 4.5 Descriptive Results across the Total Sample by Race

	Mean (Standard Deviation)		
Variables	White N=175	Nonwhite N=41	Total Sample N=216
Gains in providing evidence	19.09 (5.04)	17.90 (4.44)	18.86 (4.94)
Gains in exploring alt explanations	19.89 (4.93)	18.75 (4.56)	19.67 (4.87)
Gains in examining evidence	19.26 (4.86)	18.14 (4.44)	19.05 (4.80)
Gains in drawing conclusions	19.81 (4.86)	18.51 (4.68)	19.56 (4.83)

Regarding the differences in Table 4.5, MANOVA results showed that there is not a significant difference between white and nonwhite students in the mean gains in the four critical thinking areas (wilks' lamda =.986, F=.076, df=(4, 210), p=.552). This suggests that there seems no overall race effect on perceived gains in critical thinking.

Table 4.6 Descriptive Results across the Total Sample by Major

	Mean (Standard Deviation)		
Variables	SMET N=57	Humanities & Soc Sci N=152	Total Sample N=241
Gains in providing evidence (4.94)	18.14 (4.04)	19.21 (5.23)	18.86
Gains in exploring alt explanations (4.87)	19.42 (4.57)	19.89 (4.99)	19.67
Gains in examining evidence (4.80)	18.47 (4.28)	19.34 (4.96)	19.05
Gains in drawing conclusions (4.83)	18.89 (4.49)	19.89 (4.96)	19.56

Regarding the differences in Table 4.6, MANOVA results showed that there is not a significant difference between SMET majors and majors in humanities and social sciences in the mean gains in the four critical thinking areas (wilks' lamda =.980, F=1.06, df=(4, 203), p=.378). This suggests that there seems no overall major effect on perceived gains in critical thinking.

Overall, the greatest gains were perceived in exploring the alternative explanations, followed by gains in drawing valid conclusions, examining evidence and lastly providing evidence. However the extent of differences among these separate gains seems not that great. This suggests that the gains in all these aspects are correlated. The correlation matrix presented in the next section will show the close relationship among them more clearly. It remains to be seen if these differences will hold when other factors are entered into the equation.

A MANOVA test is also performed to see if there were significant differences among students in the three courses regarding the four dimensions of critical thinking. The result fails to show such a difference (wilks' lamda =.975, F=66, df=(8, 418), p=.729). Consequently, it was concluded that gains in critical thinking do not differ significantly by course.

Tables 4.7a-4.7b showed the correlation matrix of the continuous variables used in this study. Several observations can be made from the matrix. First, prior critical thinking is positively and significantly correlated with gains in critical thinking. However, the strength of correlations is low to modest, ranging from .15 to .30. Second, technical self-efficacy is modestly correlated with prior critical thinking and motivation, but not significantly correlated either with learning strategies and gains in critical thinking. Third, motivation is moderately correlated with prior critical thinking and learning strategies but only modestly correlated with gains in critical thinking. Finally, learning strategies were more correlated with prior critical thinking than with gains in critical thinking. So far the proposed interrelationships seemed to hold. For correlations among latent factors please refer to appendix D.

Table 4.7a Matrix of All Significant Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	income															
2	mother edu	.28**														
3	father edu	.40**	.52**													
4	tech self-efficacy1		-.18**													
5	tech self-efficacy2				.70**											
6	tech self-efficacy3	-.18**		-.14*	.60**	.53**										
7	tech self-efficacy4	-.15*			.45**	.41**	.57**									
8	providing evidence				.27**	.35**	.44**	.24**								
9	exp alt explanations				.24**	.32**	.37**	.19**	.83**							
10	examining evidence				.31**	.35**	.39**	.29**	.84**	.78**						
11	drawing conclusions				.29**	.36**	.41**	.23**	.85**	.83**	.84**					
12	gains in providing evidence								.23**	.26**	.23**	.24**				
13	gains in exp alt explanations								.17*	.25**	.15*	.21**	.83**			
14	gains in examining evidence								.15*	.15**	.14*	.20**	.88**	.87**		
15	gains in drawing conclusions								.21**	.23**	.19**	.27**	.87**	.87**	.90**	
16	intrinsic goal orientation						16*		.29**	.29**	.30**	.27**	.18**	.16*	.14*	.15**
17	task value								.39**	.37**	.36**	.37**	.17*	.16*	.15*	.19**
18	control of learning					.16*			.42**	.37**	.40**	.39*	.27**	.20**	.21**	.26**
19	self-efficacy					.28**		.14*	.44**	.41**	.43**	.47**	.17*		.15*	.18**
20	extrinsic goal orientation												.29**	.22**	.22**	.27**
21	organization								.24**	.24**	.20**	.20**	.32**	.31**	.28**	.30**
22	elabaration					.15**			.45**	.44**	.43**	.44**	.32**	.26**	.24**	.27**.
23	effort management					.15*			.20**	.22**	.22**	.27**	.24**	.17*	.17*	.23**
24	time&study envrment management								.21**	.18**	.20**	.20**	.25**	.22**	.22**	.26**
25	self-regulation								.35**	.37**	.34**	.38**	.34**	.28**	.26**	.33**

**=sig @.01 *=sig @.05

Table 4.7 b Matrix of All Significant Correlations (cont'd)

		16	17	18	19	20	21	22	23	24	25
16	intrinsic goal orientation										
17	task value	.62**									
18	control of learning	.32**	.52**								
19	self-efficacy	.36**	.39**	.64**							
20	extrinsic goal orientation	.19*	.29**	.23**	.28**						
21	organization	.40**	.49**	.22**		.33**					
22	elaboration	.45**	.58**	.42**	.30**	.26**	.62**				
23	effort management	.23**	.29**	.39**	.39**			.34**			
24	time&study evrn management	.22**	.31**	.31**		.20**	.44**	.47**	.41**		
25	self-regulation	.51**	.61**	.41**	.30**	.30**	.68**	.71**	.32**	.45**	

**=sig @.01 *=sig @.05

Construct validity

The validity of prior critical thinking was put to test in the spring sample. Confirmatory factor analysis was run on Mplus 3.12 to test the validity of the constructs. Confirmatory factor analysis (CFA) is designed to test statistically whether the sample data is consistent with the imposed constraints between latent factors and indictors (Long, 1983). For example, 16 items were used to measure the construct of prior critical thinking. This means 16 items are expected to load on the factor of critical thinking. Because the 16 items tap into four dimensions, namely providing evidence, examining evidence, exploring alternatives and drawing inclusions, confirmatory factor analysis in this case really tests whether the four dimensions load on the factor of prior critical thinking.

Table 4.8 CFA Fit of PCT (N=241)

Concept	χ^2/df (p value)	CFI	TLI	RMSEA
Prior Critical Thinking	1.204 (.2965)	1.000	.999	.029

Table 4.8 shows the CFA statistics of the construct Prior Critical Thinking. χ^2 /df ratio gives a sense of how the data is deviated from the hypothesized data. A ratio of less than three is considered an acceptable ratio. Comparative Fit Index (CFI) and Tucker Lewis Index (TLI) are indices of goodness of fit. The closer these indices are to one, the better the fit. The Root Mean Square Error of Approximation (RMSEA) measures how close the data is reflecting the reality. The closer the index is to zero, the better. Usually a value below .06 indicates acceptable fit. As table 4.8 shows the prior critical thinking as measured by the four composite scales are well-supported by the data.

Another way to look at the validity of a construct is to check the magnitude of factor loadings and the standard errors of the estimates of the factor loadings (Diamantopoulos & Siguaw, 2000). Table 4.9 shows the unstandardized regression weights of the four composites.

Table 4.9 Unstandardized Factor Loadings of PCT

	Estimates	S.E.	Estimate/S.E.
Prior Critical Thinking BY			
Providing evidence	1.000	---	---
Exploring alt explanations	.935	.042	22.103
Examining evidence	.934	.041	22.863
Examining evidence	.981	.039	24.846

Unstandardized factor loadings show the change in the indictor from a unit change in the latent construct when holding other variables constant. As Table 4.9 shows the factor loadings are significant, with Estimate/S.E. ratio far greater than 2.

Two other constructs developed by the researcher were also put to the CFA test. The results are presented in table 4.10. The results indicate that both gains in critical thinking and technical self-efficacy are valid measures.

Table 4.10 CFA Fit of Other Variables (N=216)

Concept	χ^2/df (p value)	CFI	TLI	RMSEA	SRMR
Gains in Critical Thinking	.77 (.46)	1.00	1.00	.000	.003
Technical Self-Efficacy	.105(.746)	1.00	1.01	.00	.002

Reliability

Reliability indicates the extent of consistency for an instrument, regardless of what it is purported to measure. Internal consistency reliability is an indicator of how well different items measure the same construct (Litwin, 2003). Usually it appears in

terms of Cronbach alpha. The closer alpha is close to 1, the higher the reliability. Table 4.4 shows the reliability coefficients for the constructs for the spring sample (N=241). SAS 9.0 was used to get the alpha values.

Table 4.11 Reliability of Constructs in the Spring Sample (N=241)

Scales	Number of items	Cronbach alpha
Technical self-efficacy (TSE)	4	.817
SES	3	.667
Prior critical thinking (PCT)	4 composites	.950
Motivation	5 composites 4 composites	.758 .787 (w/o EGO)
Task value (TV)	6	.887
Self-efficacy (SE)	6	.883
Control of Learning (Control)	4	.750
Intrinsic Goal Orientation (IGO)	3	.733
Extrinsic Goal Orientation (EGO)	4	.614
Learning Strategies	5 composites 4 composites	.794 .828 (w/o effort)
Organization (org)	4	.801
Elaboration (elab)	6	.770
Time and Environment Management (evrn)	7	.689
Regulated learning (Reg)	9	.851
Effort management (Effort)	4	.61
Gains in critical thinking (GCT)	4 composites	.964

Table 4.11 shows generally that the constructs and variables suggest strong to very strong reliability. In particular, PCT and GCT were very reliable measures for the concepts with alphas in the upper .9 range. However, the table also suggested two concepts, extrinsic goal orientation (EGO) and effort management (effort) were not good measures, thus dragging down the reliability index for motivation and learning strategies. As a result, the researcher also ran the reliability statistics without the two concepts. The reliability without them is presented below the original. Alpha for motivation without extrinsic goal orientation jumped to .787, close to strong reliability while alpha for learning strategies without effort management have climbed to .828, suggesting strong reliability.

Structural Equation Model (SEM) Results

As the validity and reliability of variables were not challenged, analysis of the data proceeds to the SEM model fit. Model fit refers to the extent the hypothesized model is consistent with the data. In SEM analysis the closer the estimated covariance matrix gets to the sample/data covariance matrix, the better the model fits. The test of the model was examined using Mplus 3.12 (the latest version) using maximum likelihood function. Table 4.12 gave the fit indices for the model.

Table 4.12 CFA Fit of Models (N=216)

Model	χ^2/df (p value)	CFI	TLI	RMSEA	SRMR
Initial model	2.02 (.0000)	.906	.893	.069	.067
Final model	1.576(.0000)	.957	.950	.052	.062

The initial model shows a marginal fit. The Chi Square statistic is significant at .001 level, TLI is close to .90, and RMSEA and SRMR are greater than .06, indicating a marginal fit.

For a better fit, modifications of the original model were attempted. Modifications of the model are necessary but require theoretical support (Loehlin, 2004; Long, 1983). In addition, the fewer modifications, the better. Modifications of the initial model were informed by the modification indices provided by Mplus. The indices suggested that if the errors between self-efficacy and control of learning, and the errors between technical self-efficacy item 1 (tse1) and technical self-efficacy item 2 (tse2) were allowed to correlate, the chi-square value would drop by 60 and 59 respectively. Theoretically the modifications were reasonable. Responses to using Internet (tse1) and searching information on the Internet (tse2) are highly correlated,

therefore the measurement error for tse1 are necessarily correlated with that for tse2. Similarly, the same logic applies to the correlation between the measurement error for responses to control of learning and that for self-efficacy. Therefore, the errors for these two pairs of constructs were allowed to correlate.

In addition, as noted in the reliability section, extrinsic goal orientation (ego) has a low correlation with the construct motivation (.366); effort has a low correlation with the construct learning strategies (.386). Therefore, both constructs were dropped from the final model.

As Table 4.12 shows, the chisq/df ratio is still significant, but it has dropped substantially. Although the χ^2 /df value is significant at .0000 level, rejecting the model is not sound on account of chi-square's sensitivity to sample size. A moderate sample could blow up a tiny departure from the hypothesized model to a significant chi-square value. In light of this, other indices of model fit are more appropriate. The combined picture of other fit indices (CFI=.955, TLI=.948, RMSEA=.051, SRMR=.063) showed a good fit of the final model in the sample.

In summary, the assessment of our model revealed good evidence of validity and reliability for the operationalization of the latent variables. Therefore the estimates of the parameters proceeded.

Table 4.13. Direct, Indirect, and Total Effects on Gains in Critical Thinking

	Standardized Effects								
	Motivation			Learning Strategies			Gains in Critical Thinking		
Demographics & Mediating Variables	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Race	---	---	---	---	---	---	-.10	---	-.10
Gender	---	---	---	---	---	---	.00	---	.00
Major	---	---	---	---	---	---	.02	---	.02
Prior Critical Thinking	.62**	---	.62**	---	.49**	.49*	.15*	.10	.25**
Tech Self-efficacy	-.19**	---	-.19**	---	---	---	-.07	.04	-.03
Motivation	---	---	---	.79**	---	.79**	-.23	.39**	.16
Learning Strategies	---	---	---	---	---	---	.49**	---	49**

** sig <01 * sig < .05

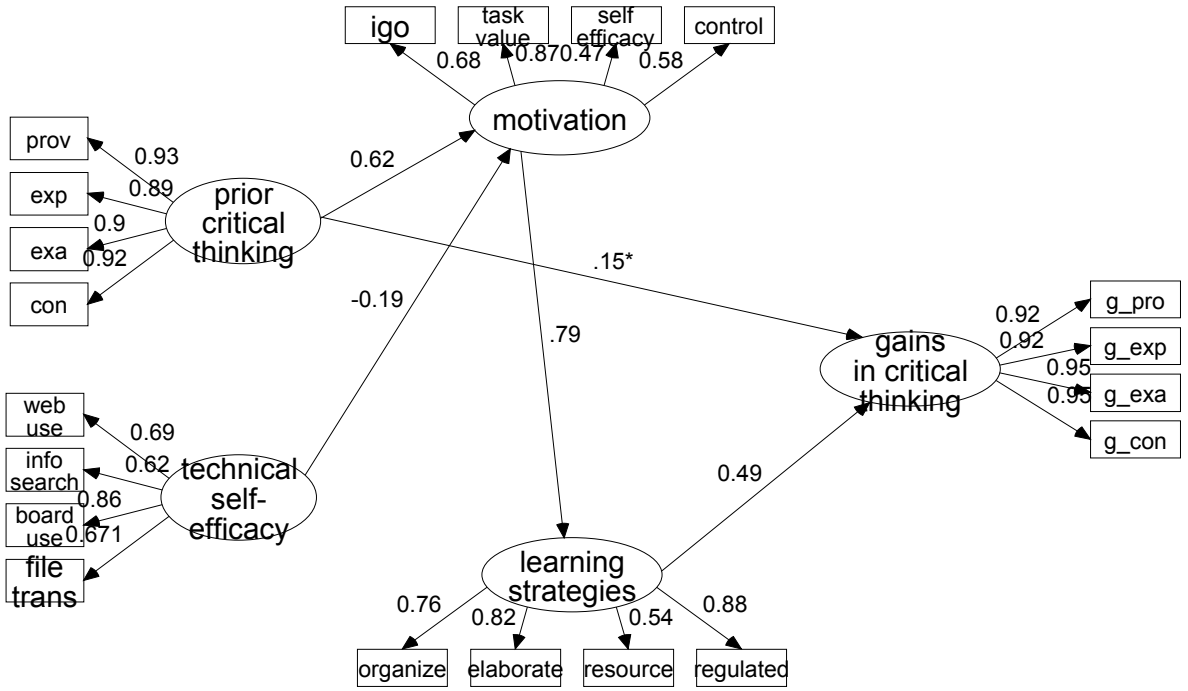


Figure 4. Structural Equation Model of Gains in Critical Thinking (Mplus 3.12 standardized estimates)

Notes: the model above only shows significant relationships. Insignificant relationships are left out.

* significant at .10, all others at .05 or .01

Table 4.13 and Figure 4 present the results of the parameter estimation. Figure 4 showed the parameter estimates of relating variables to their latent constructs consisting of prior critical thinking, technical self-efficacy, motivation, learning strategies, and gains in critical thinking. The arrows from a latent factor to its indicator serve as factor loadings. For example, the arrow from Motivation to Task Value with .87 attached on the arrow means that, of all the four indicators for motivation, task value measures motivation best. On the other hand, the arrows from one latent factor to another indicate regression weights. For example, a change in one standardized unit in motivation will lead to .79 standardized unit changes in learning strategies.

Overall, learning strategies is the only construct directly influencing the self-reported gains in critical thinking (.49). The more students tend to use organization, elaboration, time and resources management and self-regulated learning, the higher the reported gains. In particular, self-regulated learning contributes the most to the learning strategy construct (.88). Another strong contributor for the construct is elaboration (.82), followed closely by organization (.76). The weakest contributor is the resource management.

The second largest determinant of GCT is PCT, with a total significant effect of .25. Although the direct effect of PCT on GCT (.15) is not significant at .05, it is significant at .10. In addition, it has a significant indirect effect on GCT via motivation and learning strategies (.10). Students with higher self-reported prior critical thinking tend to report higher gains at the end of the semester. An additional effect on motivation comes from students' perception of critical thinking ability at the beginning of the course. Higher precourse abilities have a significant positive effect on their motivation.

Motivation is best measured by task value (.87) and intrinsic goal motivation (.69). Motivation (-.23) does not have a significant direct effect on the gains in critical thinking. However, its total effect on GCT (.16) is significant at .10. This total effect is the third largest of all the variables. More importantly, it exerts a strong indirect effect (.39) via learning strategies. Students reporting a higher sense of task value, self-efficacy, and control of learning and having a higher intrinsic goal orientation tend to use deeper learning strategies, which in turn contribute to a higher sense of gains in critical thinking.

Students' level of technical competence is best measured by perceived ability in using discussion board (.87). It makes sense, as the courses require student to use the discussion board frequently. TSE had a negligible total effect on GCT. However, technical self-efficacy had a significant slight negative effect (-.19) on motivation. It suggests that students with a higher technical self-efficacy tended to have lower motivation.

Effects of other student characteristics on the gains in critical thinking were modeled, too. Although differences in gains between white and non-white groups, between male and female students, and between SMET and other majors seem to exist the differences disappeared when other variables were factored into the model. The effects of race, gender and major had no significant effects on the gains in critical thinking.

The entire model explained 17.2 percent of the variance in GCT.

Chapter 5

Discussions and Conclusions

This chapter begins with a brief overview of the rationale and significance of the study and method. The bulk of this section discusses the major findings of the study in relation to the literature. Implications of the findings are embedded in the discussions of the findings, too. The third section addresses the limitations and policy implications. The chapter closes with concluding remarks.

Significance of the study

This study makes contributions to the following areas. First, it integrates research on motivation, online learning and critical thinking. How online learners are motivated and develop critical thinking has not been extensively explored in the past. In addition, learning strategies have not been examined in relation to critical thinking in online education. Considering the online environment where students need more self-regulation and motivation, it is absolutely necessary to bridge the gap in this area.

Secondly, the motivation aspects of the I-E-O model will illuminate course design implications for instructors. Tsui (2002) declared “research can and should assist faculty in their efforts to nurture students' abilitites to think critically. As yet, however, little substantiated knowledge on effective pedagogy comes from research on critical thinking". Effective assessment of factors determining critical thinking in online courses would help faculty to tailor course design and tasks to maximizing students learning.

In the areas of gains in student learning, faculty would be able to determine what particular instructional strategies or course activities are linked with student growth (Sankaran & Bui, 2001) In general, knowledge of student learning strategies and motivational levels can be helpful to the instructor. The course may be designed

to better fit with the students' learning methods and motivational traits. This is particularly important to the design of online courses, which are, at least if not more, hindered by the lack of visual cues from students.

Further, administrators can implement appropriate programs to improve student learning skills particularly for students with low motivation. Weinstein and Mayer (1986) called for the development of effective ways to teach students to handle the "barrage of information coming from the environment" (p315). It should become a major goal of the educational system whose importance cannot be too emphasized in the present times. Understanding the relationships among motivation, learning strategies and critical thinking might be the first step toward that goal.

This study proposes a single-level SEM model and tests it to explain the impact of motivation, learning strategies and other student characteristics on gains in critical thinking of learners in three online courses. Fostering critical thinking is important to the goals of higher education. Research in the past has focused more on the overall effects of collegiate experiences on the gains of critical thinking, or the pedagogical effects. In addition studies have used commercialized tests, whose financial and time restrictions can limit the sample size and cause attrition of subjects. Past studies have not examined thoroughly the effect of motivation and learning strategies on critical thinking, especially in the online setting. Another limitation in other studies is the frequent use of single item to measure critical thinking, thus making it difficult to cover the complex facets of the construct and leaving no room for measuring the quality of the item. In contrast, this study uses a multi-item measurement of critical thinking.

This study is important in that it incorporated motivation and learning strategies into the study of gains in critical thinking while controlling for the effects of

student characteristics such as race, gender, major and their pre-course perceptions in technical self-efficacy and critical thinking. In terms of measuring perceived gains in critical thinking, this study tests the feasibility of multi-item measurement of critical thinking, correcting the single item bias found in some studies (Li et al., 1999; Tsui, 1998a). This study also adopts a statistically powerful technique SEM to model the relationships among control variable, mediation variables and dependent variables.

Development of Critical Thinking online

In this section, findings from this study are discussed in light of related studies on critical thinking and academic achievement. This study finds that a large majority of students in online courses report making significant gains in critical thinking as measured by these scales: providing evidence, exploring alternative explanations, examining evidence, and drawing valid conclusions. It offers evidence through a moderately large sample that these dimensions of critical thinking can be and is being developed online. The critical thinking instrument used in this study is shown to be valid as well as reliable. Therefore the findings reported in this study are applicable where appropriate. The length and format of the instrument also lend itself to ease of use.

Learning Strategies

Our study found students' use of learning strategies is the most important predictor of their end-of-semester gains in critical thinking. This finding offers support to previous research, which identified positive influences of self-regulation strategies on academic performance (Flowers & Pascarella, 2003; Garcia & Pintrich, 1992; Kuhn, 1999). Other research also suggested learning strategies are correlated highly to grades (Pintrich & De Groot, 1990; Zeegers, 2004). The three processes that self-regulation taps, planning, regulating, and monitoring, can activate the awareness

that facilitate the critical examination of information and reaching conclusions. Elaboration strategies (attempts to paraphrase, summarize, or draw analogies) are also important contributors. These strategies seem to bring students to provide the details and supportive evidence essential to critical thinking.

The finding also lends support to the theory that it is essential for students to monitor and regulate their learning in order for learning to take place. After all, students have a better sense of where they need to improve and correct. When equipped with the appropriate strategies, they are moving toward the right direction. The self-awareness portion of the process is the key; it is more efficient than instructor admonition or feedback.

In addition to self-regulation, learning strategies include elaboration, organization, and management of one's time and study environments. Although these scales are not strong indictors of learning strategies as self-regulation, they team up to determine how well students are prepared to deal with cognitive challenges such as gains in critical thinking. In order to improve critical thinking, students should also learn to develop these strategies.

Kucharczyk (2004) recalled from personal experience and information from other sources (e.g. faculty members, academic advisors, college administrators, conference presenters, higher education research) and confirmed the view that students need study skills development and assistance (p111). Student often made requests for study skills assistance and additional skills development. Among them was improving time management and improve concentration skills and/or memory skills. These skills are metacognitive skills that students probably are lacking or needs reinforcement.

This finding has significant curricular and retention policy implications. Freshmen seminar and orientations are the places students receive training in college survival skills. It is recommended that freshmen seminars and orientations focus on these metacognitive skills in the curriculum so that students can be aware of their learning strategies and expanding the repertoire of the learning strategies. In addition, instructors are well-advised to model efficient learning strategies and scaffold them in the assignments and projects if portions of the class lack the preparation in these aspects. Also instruction that embeds cognitive and metacognitive strategies have more likelihood to create success in learning (p90, cited in Olgren, 1998).

It is puzzling that the scale of effort management was not a good measure of learning strategies for the samples in the study. This scale refers to the commitment to finishing one's goals despite distractions and difficulties (Pintrich et al., 1991). It has low correlation with other scales (.06, .34, .41, .32 respectively), therefore it was removed from the final model. It remains to be seen why this scale failed to correlate strongly with other scales in the learning strategies. Is it due to the particular sample in this study or this scale is not a good measure of online learners in general or the scale itself requires revision or the measure may be bimodal, characterizing not only those who are making great gains in CT but also those who are struggling? Further research on this scale is warranted.

Motivation

Overall, motivation had a moderate effect on GCT. However, motivation has an insignificant negative direct effect, which conflicts with the findings in the literature that motivation is positively related to achievement or grades (Dill, 2003; Paulsen & Gentry, 1995; Sankaran & Bui, 2001; Shih & Gamon, 2001). It is also inconsistent with the finding in the pilot study (Zhang, 2005), where motivation not

only had a significant effect on GCT but the effect is positive in direction. It might be that students with high motivation had higher expectations for the gains and it was a great disappointment to experience a lower gain at the end of the semester, leading them to report lower gains. Or it might be due to the fact that motivation exerted a strong direct effect on learning strategies, which defrayed its direct effect on GCT. Or the gains in critical thinking are so qualitatively different that motivation on achievement or grades don't apply? Further research is warranted to see if the finding in this study can be reproduced.

Despite the insignificance of the direct effect, motivation maintained a strong positive mediation on GCT through learning strategies. This means students who have strong motivation can seek and choose appropriate learning strategies to benefit their learning. In particular, task value students attach to the course seems to drive and direct their attention and efforts. This finding has significant implications for instructional design. Course website, structure, learning tasks can be managed to maximize student interest, importance and challenge for optimized engagement in the task. Olgren (1998), discussing the implications of learning strategies, suggested using orientation aids or activities that help learners to identify the value of the material and their intrinsic purposes for learning. Online course is not simply a transplant of lectures. For example, a diverse set of tasks can be implemented. In addition, instructors can instill the value of the tasks more effectively by bringing relevance and career applications into critical thinking. From the institutional point of view, institutional mission and goals can highlight the value of critical thinking so that students can see the streamlining of the value of critical thinking in their academic and social life. Also orientations and take-you-hand chat sessions can improve student

self-confidence to the effect that their purpose of enrolling is not just to get a grade but for the intrinsic value of accomplishing a task.

Technical Self-efficacy (TSE)

Research is not consistent in the effect of technical competence on achievement. Kuhl (1989) found that student familiarity with computers is positively correlated with their analytical gains while Flowers et al (2003) showed that usage of email had differential impacts on cognitive development for different students. This study indicates that TSE, strongly denoted by the competence in using discussion board, has an insignificant negative effect on GCT. Perhaps the more tech-savvy students are more unlikely to perceive gains in critical thinking. It might be these students already had a higher level of critical thinking, which is illustrated the strong factor correlation between prior critical thinking and technical self-efficacy (.47). The higher PCT may be accompanied with high expectation for gains, causing the possible disenchantment with end results. It also might be true that technically competent learners are not strongly motivated; their time may be better spent doing other useful stuff like online chat, games or downloading movies. Later studies could test this hypothesis by asking the kinds of online activities students engage in and the time spent on each of those activities.

Prior Critical Thinking

Among the control variables, PCT is the only one having significant total effect. This means other factors considered, students with higher PCT will be more likely to report higher GCT. Similarly students with lower PCT tend to report lower GCT at the end of the semester. From an instructor's point of view, it is a troubling situation. The learning environment of the course is reproducing the structure of

critical thinking performance. The lower-PCT group did not get much boost in their critical thinking from the course. However, literature is rare on studies focusing on this group. It would be hugely inspiring to see efforts in this direction.

On the other hand, this finding confirms the essentialness of controlling for this variable suggested by (McMillan, 1987). In agreement with the literature (Kucharczyk, 2004), this finding means that many studies not controlling for PCT such as (Li et al., 1999) are deficient and need to be interpreted with caution.

Background Variables

The effects of student characteristics such as race, gender, SES and major are all insignificant. This suggests that online education levels the playing field for diverse learners, and all learners are equally likely to benefit from this delivery mode. Details of the results are discussed as follows.

Although students majoring in SMET and non-SMET reported different gains in critical thinking, these differences disappeared when taking other variables in the model into account. This finding corroborated the findings in (Li et al., 1999; Terenzini et al., 1995) but conflicts with the findings in (Garcia & Pintrich, 1992; Tsui, 1998a). Garcia & Pintrich (1992) found that majoring in biology was negatively related to critical thinking measured by MSLQ while majoring in English has a significant positive effect after controlling for motivation, cognitive strategy use, and course perceptions. In addition, the effects of motivation, strategy use, and course perceptions on critical thinking differ among majors. For biology majors, IGO, rehearsal, elaboration, and self-regulation strategies are significantly correlated with critical thinking whereas for English majors only self-regulation strategies are strongly correlated. Tsui (1998a) found positive association between majoring in English and self-reported growth in critical thinking and negative association between

majoring in education, business, and other nontechnical fields. In addition the negative effects of majoring in English and non-technical fields persisted after controlling for other variables whereas the significant effects of majoring in English and business disappeared. The inconsistencies might be a result of the choice of measurement, statistical analysis and research methodology.

In this study, race had an insignificant effect on GCT. This finding is inconsistent with the findings in literature (Flowers & Pascarella, 2003; Gadzella et al., 1999; Kucharczyk, 2004; Zhang, 2005). These studies all reported that being a non-white has a significant disadvantage in making gains in critical thinking. In my pilot study, the results showed that race has a significant negative effect on GCT. However, the SEM for the pilot study was run with a limited sample size (n=58), meaning that the results from the pilot have to be interpreted with extreme caution, especially for a SEM analysis. Nevertheless, it might not be a great contradiction between the two. The direction of the effect is the same. In both studies the effect was negative. In addition, the standardized estimate is close to be significant at .10, which means that being non-white has a disadvantage in perceived gains. In this light, the finding from this study echoes the previous studies. The direction of this disadvantage has implications for course design. It might be effective for a different learning environment, assessment tasks in place for a better learning experience for different race/ethnicities. Further research is needed to test the hypothesis whether students of different races followed the same structural model.

SES has no significant influence on GCT, which is in contradiction to the findings in literature (Cheung et al., 2001; Fleming et al., 1995; Terenzini et al., 1995). The reason might be that there is limited variation for the variables defined in

the construct. Also the three items used for SES in the study don't have strong correlations with each other and the construct as a whole, mitigating the effect of SES.

Gender has the smallest insignificant standardized estimates on GCT. Again this finding was in agreement with (Kucharczyk, 2004; Terenzini et al., 1995; Tsui, 1998a) while conflicting with others (Flowers & Pascarella, 2003; Li et al., 1999).

Taken as a whole, none of the background student characteristics has a significant unique effect on perceived gains in critical thinking. Regardless of race, gender, and majors, students are equally likely to self-report gains in critical thinking. Is online course a democratic and egalitarian arena? The data from this study seems to suggest a positive response. However, further studies are needed to confirm the findings.

Limitations of the study

This study has a moderate sample size and is limited to students in three online courses of Penn State University main campus. Therefore its findings may be generalizable only to students sharing the characteristics of those in the study.

Another limitation of the study relates to the measurement of critical thinking. Although this study establishes validity by using multiple items for perceived gains in critical thinking and by conducting a confirmatory factor analysis, the study does not incorporate the actual measures of critical thinking such as scores of critical thinking tests or student writing samples. Self-perceived gains from the students are assumed to be valid measures, because they meet the conditions spelled out by Kuh (2005). However, future studies would be valuable if actual scores and other alternative measures for critical thinking could be used to supplement this instrument.

Our tested model used a diverse set of factors to explain the variation in self-perceived gains in critical thinking: student background variables, prior course critical thinking, technical self-efficacy, motivation, learning strategies. However, the model explained only 17.2 percent of the variance. It is presumed that factors important to the dependent variable are missing from our model. A big factor that we don't measure is the disposition to critical thinking. In addition, out-of-classroom experience, such as faculty interactions (Tsui, 1998a) was found having correlations with perceived gains in critical thinking. These measures are possible candidates for future models of gains in critical thinking.

My pilot study (Zhang, 2005) measured motivation and learning strategies at the end of the semester and the R^2 explained are much higher (55.3%). There is reason to believe that the timing of measurement is crucial as reported in Garcia & Pintrich (1992). Further studies could measure motivation and learning strategies at both times and arrive at an average of the two measures and compare the results. Studies have shown that numbers of courses taken in math, arts, and sciences, living on campus and out-of-class involvement might have affected gains in critical thinking. However, due to the already-too-long version of the survey used in the study, these variables were not included. Future research should consider the inclusion of them.

Future studies also should also incorporate qualitative methodology to reveal the complexities of the path from student prior achievement, motivation, learning strategies to the perceived gains in critical thinking. For example, motivation had a negative influence on GCT. It would be important to know why this is the case. Do course structure, course assignments or other instructional design factors lead to changes in their motivation during the course of the semester? Focus group interviews of students might help discover the intricacies surrounding the issue.

Concluding Remarks

This study examines the factors that are important in determining the perceived gains in critical thinking. In the process, an instrument of critical thinking is developed and tested. The instrument has shown satisfactory reliability and validity with respects to the measurement of the construct. The results suggest the instrument can be an alternative method to assessing critical thinking. The advantage the instrument has over other critical thinking assessment is its economy in time, ease of administration and easy scoring.

An important finding is the key role played by learning strategies. How students organize, monitor, and regulate their learning impacts their perceptions of learning gains. Faculty members and academic counselors might promote critical thinking further by implicitly or explicitly inculcating strategies for students to use.

Another important finding is student motivation in fostering critical thinking. Although motivation does not directly influence student perceptions, the mediation effect it exerts via learning strategies calls for additional studies. Faculty members would enhance the learning outcomes by creating a learning environment that is motivating and challenging. Instructional designers can come in to facilitate the process.

The strong path from prior critical thinking to motivation to learning strategies to gains in critical thinking is a meaningful and significant finding. Prior critical thinking and student ability provide an important foundation for subsequent learning. Learning can be developed through the selection of appropriate learning strategies such as outlining, paraphrasing, summarizing and monitoring learning environment and progress of learning. There is ample room from faculty and institutions to intervene in this process to make the learning take place.

Critical thinking in higher education is paramount today because of the overflow and ready access and distractions of information and because of the work and everyday life we face. A recent study has alerted the dangers of our info-crazy society: exposure to constant need for information or informania can lower intelligence twice as much as smoking marijuana (The Week, 2005). It is clear that the human brain has a loading ceiling and it needs to select and filter information going through. Without practice and learning of these skills in college, citizens cannot function well in work and daily situations. It is important that educational institutions including universities and colleges do a good job of preparing the students. This study has provided a CT measure and useful findings that may attract additional attention to this topic. The results of this study add further support to the concept that learning is a complex activity involving multiple factors. This research demonstrates that, although prior critical thinking affects gains in critical thinking, the dominating influence comes from learning strategies and motivation, which can be cultivated and trained. The finding indicated that there is much room for instructional design and faculty involvement. The study also raises concerns about certain scales in motivation and learning strategies, such as extrinsic goal orientation and management of time, study environment.

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Appendix A: Email Invitation to Students for Survey Participation

Dear Student:

I have been working with your instructor to improve the learning experience in INART 005 offered at Penn State.

Because of your experience in the course, I am requesting your assistance in completing two short, confidential online surveys, one at the beginning of this semester and the other at the end. The surveys will ask questions about your motivation, learning strategies, course experience and gains in critical thinking in your specified course. Filling out the both surveys will take a total of about 40 minutes.

You will get 2 extra points for your participation in this research study. If you don't want to take part in the research but would like to earn the credits, you have the option of writing a 450-word paper critiquing one performance.

If you are willing, please click the link below to take the first survey:
http://128.118.92.131/artsp/sp05_1.htm?18569

If the link is not highlighted, please cut and paste it into your web browser.

You must be 18 years of age or older to agree to participate in this study.

You may decline to answer any question that you do not wish to answer. Please be aware that no guarantees can be made that Internet data will not be viewed by individuals outside of the study. You are not under any obligation to take this survey and you may end your participation at any time. However, we hope you will do the survey because it will help improve this class for future students.

Whether you decide to take part in this study or not, your course grade will not be affected in any way. The instructor's evaluation of you will not be affected, either. Only the researchers will have access to the survey responses. The course instructor will not have access to the responses. While the researcher will know which students filled out the survey, the researchers will not be able to connect specific answers to specific students. The online survey software scrambles the answers so they cannot be linked to specific students. This means your responses are confidential. By agreeing to participate, you are also giving the researcher permission to use your course assignments and grades for research purposes, but be assured that your identity will not be revealed if the results of the study are presented or published.

There are no risks in participating in this research.

You may ask any questions about the research procedures. You can call or email the following researchers:

Tao Zhang, Schreyer Institute for Teaching Excellence, 301 Rider II Building,

(814) 865-7848, tyz102@psu.edu

Fred Volkwein, 400 Rackley Building, 814-865-9739, volkwein@psu.edu

If you have questions about your rights as a research participant, contact Penn State's Office for Research Protections at (814) 865-1775.

Completion of the survey serves as your implied permission to participate in this study.

Please print a copy of this email for your record.

Thanks for your help in this.

RESEARCHER

Tao Zhang

This informed consent (IRB# 19011) was reviewed and approved by the Office for Research Protections at The Pennsylvania State University on 02/03/05. It will expire on 06/14/05

Appendix B Survey 1

INART Survey 1

Hi, guys, welcome to INART Survey 1. Thank you for agreeing to participate in the survey.

There are no right or wrong answers but do try your best to answer every question.

It takes approximately 20 minutes to finish this survey.

1. Is this your first time to take an online course?

- ☐ Yes
- ☐ No

2. Please rate your current competence in the following areas on a scale of 1 to 7 (1=lowest, 7=highest)

	1	2	3	4	5	6	7
using internet	☐	☐	☐	☐	☐	☐	☐
searching for information on the web	☐	☐	☐	☐	☐	☐	☐
using discussion board	☐	☐	☐	☐	☐	☐	☐
transferring files online from an offline source	☐	☐	☐	☐	☐	☐	☐

3a. Please rate your current abilities in the following areas on a scale of 1 to 7 (1=lowest, 7=highest)

	1	2	3	4	5	6	7
quoting different sources in discussing art issues	☐	☐	☐	☐	☐	☐	☐
contemplating the complexities of artistic issues	☐	☐	☐	☐	☐	☐	☐
supporting artistic views with logical reasoning	☐	☐	☐	☐	☐	☐	☐
examining differing sides of an artistic view	☐	☐	☐	☐	☐	☐	☐
making informed artistic decisions based on evidence	☐	☐	☐	☐	☐	☐	☐
looking at issues from multiple angles	☐	☐	☐	☐	☐	☐	☐
gathering justifications for artistic judgments	☐	☐	☐	☐	☐	☐	☐
drawing valid artistic conclusions from information available	☐	☐	☐	☐	☐	☐	☐

4. Which of the following courses are you taking this semester (select only one even you might be taking two of the following courses)?

- ☐ INART 005
- ☐ INART 100
- ☐ INART 100W

4a. What grade do you expect to get for the course specified in question 4?

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F

Motivatedlearning

5a-5g list statements related to your motivation and learning strategies for taking the INART course specified in Question 4.
If a statement is not at all true of you, click 1;
if the statement is very true of you, click 7;
if the statement is more or less true of you, find an appropriate number in between that best describes you.

5a. Motivation1

	1 =not at all true of me	**2**	**3**	**4**	**5**	**6**	**7 =very true of me**
In a class like this, I prefer course material that really challenges me so I can learn new things.	☐	☐	☐	☐	☐	☐	☐
If I study in appropriate ways, I will be able to learn the material in this course.	☐	☐	☐	☐	☐	☐	☐
I think I will be able to use what I learn in this course in other courses.	☐	☐	☐	☐	☐	☐	☐
I believe I will receive an excellent grade in this class.	☐	☐	☐	☐	☐	☐	☐
I'm certain I can understand the	☐	☐	☐	☐	☐	☐	☐

	1 =not at all true of me	2	3	4	5	6	7 =very true of me
most difficult material presented in this course.							
Getting a good grade in this class is the most satisfying thing for me right now.	☐	☐	☐	☐	☐	☐	☐
It is my own fault if I don't learn the material in this course.	☐	☐	☐	☐	☐	☐	☐
It is important for me to learn the course material in this class.	☐	☐	☐	☐	☐	☐	☐

5b. Motivation2

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	☐	☐	☐	☐	☐	☐	☐
I'm confident I can learn the basic concepts taught in this course.	☐	☐	☐	☐	☐	☐	☐
If I can, I want to get better grades in this class than most of the other students.	☐	☐	☐	☐	☐	☐	☐
In a class like this, I prefer course material that arouses my curiosity even if it is difficult to learn.	☐	☐	☐	☐	☐	☐	☐
I am very interested in the content area of this course.	☐	☐	☐	☐	☐	☐	☐
If I try hard enough, I will understand the course material.	☐	☐	☐	☐	☐	☐	☐
I'm confident I can do an excellent job on the assignments and tests in this course.	☐	☐	☐	☐	☐	☐	☐
The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	☐	☐	☐	☐	☐	☐	☐

5c. Motivation3

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
I think the course material in this class is useful for me to learn.	☐	☐	☐	☐	☐	☐	☐
If I don't understand the course material, it is because I didn't try hard enough.	☐	☐	☐	☐	☐	☐	☐
I like the subject matter of this course.	☐	☐	☐	☐	☐	☐	☐
Understanding the subject matter of this course is very important to me.	☐	☐	☐	☐	☐	☐	☐
I'm certain I can master the skills being taught in this class.	☐	☐	☐	☐	☐	☐	☐
I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.	☐	☐	☐	☐	☐	☐	☐
Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	☐	☐	☐	☐	☐	☐	☐

5d. Learningstrategies1

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
When I study the readings for this course, I outline the material to help me organize my thoughts.	☐	☐	☐	☐	☐	☐	☐
I usually study in a place where I can concentrate on my course work.	☐	☐	☐	☐	☐	☐	☐
When reading for this course, I make up questions to help focus my reading.	☐	☐	☐	☐	☐	☐	☐
I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.	☐	☐	☐	☐	☐	☐	☐
When I become confused about something I'm reading for this class, I go back and try to figure it out.	☐	☐	☐	☐	☐	☐	☐
When I study for this course, I go	☐	☐	☐	☐	☐	☐	☐

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
through the readings and/or my class notes and try to find the most important ideas.							
I make good use of my study time for this course.	☐	☐	☐	☐	☐	☐	☐
If course readings are difficult to understand, I change the way I read the materia							

5e. Learningstrategies2

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
I make simple charts, diagrams, or tables to help me organize course material.	☐	☐	☐	☐	☐	☐	☐
I find it hard to stick to a study schedule.	☐	☐	☐	☐	☐	☐	☐
When I study for this class, I pull together information from different sources, such as readings and discussions.	☐	☐	☐	☐	☐	☐	☐
Before I study new course material thoroughly, I often skim it to see how it is organized.	☐	☐	☐	☐	☐	☐	☐
I ask myself questions to make sure I understand the material I have been studying in this class.	☐	☐	☐	☐	☐	☐	☐
I try to change the way I study in order to fit the course requirements and the instructor's teaching style.	☐	☐	☐	☐	☐	☐	☐
I often find that I have been reading for this class but don't know what it was all about.	☐	☐	☐	☐	☐	☐	☐
When course work is difficult, I either give up or only study the easy parts.	☐	☐	☐	☐	☐	☐	☐

5g. Learningstrategies4

	1 =not at all true of me	2	3	4	5	6	7 = very true of me
I participate in online discussions regularly.	☐	☐	☐	☐	☐	☐	☐
Even when course materials are dull and uninteresting, I manage to keep working until I finish.	☐	☐	☐	☐	☐	☐	☐
When studying for this course I try to determine which concepts I don't understand well.	☐	☐	☐	☐	☐	☐	☐
I often find that I don't spend very much time on this course because of other activities.	☐	☐	☐	☐	☐	☐	☐
When I study for this class, I set goals for myself in order to direct my activities in each study period.	☐	☐	☐	☐	☐	☐	☐
I try to apply ideas from course readings in online discussions and assignments.	☐	☐	☐	☐	☐	☐	☐
I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.							

6. What is your gender?

☐ M

☐ F

7. What is your race?

☐ White

☐ Nonwhite

8. How many semesters, including this semester, have you been enrolled in college?

semester(s) _____

8a. What is your cumulative GPA?

GPA _____

9. What is your major?

Major

10. What is your family's total annual income approximately?

- ☐ under $ 25,000
- ☐ $ 25,000---$ 49,999
- ☐ $ 50,000---$ 74,999
- ☐ $75,000---$99,999
- ☐ $ 100,000---$149,999
- ☐ $150,000---$199,999
- ☐ Above $200,000

11. What is your parents' education?

	Less than high school	**High school**	**Less than 2 year associate degree**	**Two-year associate degree**	**Bachelor's degree**	**Masters degree**	**Doctorate**
Mother	☐	☐	☐	☐	☐	☐	☐
Father	☐	☐	☐	☐	☐	☐	☐

12. What's your Penn State account ID (for extra credit purposes only) ?

ID (e.g. tyz102)

Appendix C. Survey 2

INART Survey 2

Hi, guys, welcome to INART Survey 2. Thank you for agreeing to participate in the survey.

There are no right or wrong answers but do try your best to answer every question.

It takes approximately 20 minutes to finish this survey.

1. Which of the following courses are you taking this semester (if you are taking more than 1 of them just choose 1)?

- ☐ INART 005
- ☐ INART 100
- ☐ INART 100W

Note: The rest of the survey applies to the course you specified in question 1.

3a. Please rate your gains, as a result of taking this course, in the following areas on a scale of 1 to 7 (1=lowest, 7=highest)

	1	2	3	4	5	6	7
quoting different sources in discussing art issues	☐	☐	☐	☐	☐	☐	☐
contemplating the complexities of artistic issues	☐	☐	☐	☐	☐	☐	☐
supporting artistic views with logical reasoning	☐	☐	☐	☐	☐	☐	☐
examining differing sides of an artistic view	☐	☐	☐	☐	☐	☐	☐
making informed artistic decisions based on evidence	☐	☐	☐	☐	☐	☐	☐
looking at issues from multiple angles	☐	☐	☐	☐	☐	☐	☐

	1	2	3	4	5	6	7
gathering justifications for artistic judgments	☐	☐	☐	☐	☐	☐	☐
drawing valid artistic conclusions from information available	☐	☐	☐	☐	☐	☐	☐
assessing the credibility of different artistic sources	☐	☐	☐	☐	☐	☐	☐

	1	2	3	4	5	6	7
exploring alternative explanations for an artistic phenomenon	☐	☐	☐	☐	☐	☐	☐
making inferences based on evidence	☐	☐	☐	☐	☐	☐	☐
distinguishing evidence from assertions	☐	☐	☐	☐	☐	☐	☐

	1	2	3	4	5	6	7
analyzing the strengths and weaknesses of evidence	☐	☐	☐	☐	☐	☐	☐
formulating many possible interpretations for evidence	☐	☐	☐	☐	☐	☐	☐
locating various sources for making artistic statements	☐	☐	☐	☐	☐	☐	☐
critically assessing the logic that connects evidence and a conclusion	☐	☐	☐	☐	☐	☐	☐

Appendix D. Table of Factor Correlations

	PCT	TSE	SES	MOTIVE	Learning Strategies
TSE	.47*				
SES	-.04	-.17*			
MOTIVE	.55*	.15	.00		
Learning Strategies	.46*	.13	.05	.77*	
GCT	.29*	.12	.04	.30*	.41*

* significant at .05

VITA

Tao Zhang

Education

- Penn State University (2000-2005): PhD in Higher Education, M. S. in Applied Statistics
- Northwestern Polytechnic University (1990-1993): M.A. in Applied Linguistics
- Xi'an Foreign Languages Institute (1986-1990): B.A. in English

Professional Experience

- Curricular Design and Assessment Consultant, Schreyer Institute for Teaching Excellence, Penn State (Aug 2002---June 2005)
- Research Assistant, Center for the Study of Higher Education, Penn State (Aug 2000---Aug 2002)
- Resident Director, Tsinghua-UIUC Exchange Program, China (Aug 1999---Jan 2000)
- Lecturer, Tsinghua University, China (Apr 1993---July 2000)
- Visiting Scholar, University of Illinois at Urbana-Champaign (Sept 1997---Sept 1998)

Publications & Conference Presentations

- Zhang, T. (2005, Apr). Impact of motivation and learning strategies on gains in critical thinking of online learners. Paper presented at AERA, Montreal, Canada.

- Zhang, T. (2003, Apr). State policy for e-learning: Issues of quality assurance and academic transfer. Paper presented at AERA, Chicago.

- Johnson, D. K., Lane, J. L., Gray, G., Costanzo, F. & Zhang, T. (2003). Assessment of a problem-centered approach to putting the motion back in dynamics. Proceedings of the 2003 American Society for Engineering Education Annual Conference, Nashville, TN.

- Colbeck, C and Zhang, T. 2001. Critical issues in remedial education. Pennsylvania Department of Education

- Colbeck, C and Zhang, T. 2001. Critical issues in distance learning. Pennsylvania Department of Education