International Journal of Teaching and Learning in Higher Education 2012, Volume 24, Number 1, 16-30
http://www.isetl.org/ijtlhe/ ISSN 1812-9129

The Impact of Faculty Teaching Practices on the Development of Students' Critical Thinking Skills

Woo-jeong Shim
University of Michigan

Kelley Walczak
University of Wisconsin – Parkside

Colleges and universities recognize that one of the primary goals of higher education is to promote students' ability to think critically. Using data from the Wabash National Study of Liberal Arts Education (WNS), this study examined the relationship between faculty teaching practices and the development of students' critical thinking skills, specifically the differences between students' self-report and the direct assessment (i.e., CAAP) of critical thinking. The results from multinomial logistic regression and OLS regression analyses showed that asking challenging questions increased both students' self-reported and the directly measured critical thinking abilities. Interpreting abstract concepts as well as giving well-organized presentation increased students' self-reported gains in critical thinking; however, these same practices did not significantly impact their CAAP scores. Inconsistent with previous literature, class presentations as well as group discussions decreased either students' self-reported or directly assessed critical thinking abilities. These findings can guide faculty teaching practices to foster critical thinking for first-year college students.

Colleges and universities have long recognized that one of the primary goals of higher education is to promote students' ability to think critically (Astin, 1993; Gellin, 2003; McMillan, 1987). Critical thinking is a widely used term that includes skills in identifying, analyzing, synthesizing, and evaluating information to make informed decisions, and the disposition to apply these skills (Ennis, 1993; Giancarlo & Facione, 2001; Halpern, 1993; Paul, 1993). Although there is considerable debate over the definition and the elements of critical thinking, critical thinking has been listed as a top priority for undergraduate teaching and learning (Astin, 1993; Gellin, 2003; McMillan, 1987). Despite the sustained interests in fostering critical thinking in higher education, there is evidence that college graduates lack critical thinking and problem solving skills needed in today's workplaces (U.S. Department of Education, 2006). This discrepancy may be addressed, in part, by the fact that those teaching critical thinking at the college level do not fully understand how to effectively teach these skills and are unable to transfer critical thinking knowledge into their classrooms (Paul, Elder, & Bartell, 1997).

Literature Review

Instructional Practices Facilitating Critical Thinking Skills

Previous research has demonstrated how particular formal and informal instructional practices facilitate the development of critical thinking skills among undergraduates. These practices include such broad categories as active learning (Astin, 1993; Kuh, Pace, & Vesper, 1997; Pascarella & Terenzini, 1991), teacher clarity and feedback (Cabrera, Colbeck, & Terenzini, 2001; McKeachie, 1990), faculty interactions in and out of the classroom (Pascarella & Terenzini, 1991; Terenzini, Springer, Pascarella, & Nora, 1995), and collaborative learning (Pascarella & Terenzini, 1991; Terenzini et al., 1995). However, research on specific instructor-driven instructional practices that affect students' critical thinking is limited. One of these rare attempts to study the effect of classroom instruction on critical thinking development was conducted by Smith (1977). Using direct measures for assessing critical thinking, Smith found three kinds of instructor-influenced classroom interactions to be consistently and positively related to gains in critical thinking: the extent to which faculty members encouraged, praised, or used student ideas; the amount and cognitive level of student participation in class; and the amount of interaction among students in a course. Following this attempt, Terenzini et al. (1995) also conducted one of the few studies on growth in critical thinking ability that simultaneously examined the effects of instructional methods, particularly student relationships with faculty and instructor effectiveness in different types of courses. However, after controlling for precollege critical thinking ability, none of these variables was significant.

Course assignments and exams are commonly used to foster students' ability to think critically. If instructors can engage students in coursework by using appropriate instructional methods, students will improve their critical thinking skills. In other words, what students do for courses matters more than how instructors teach courses. In his monumental study exploring student involvement in higher education, Astin (1993) found assignments such as giving class presentations and critiquing papers were positively related to students' self-reported growth in critical thinking. Using the data derived from the Cooperative Institutional Research Program (CIRP) 1989 follow-up

survey, Tsui (1999) investigated the effect of instructional techniques on students' self-reported growth in critical thinking. She found that self-assessed growth in critical thinking is positively related to such instructional factors as having a paper critiqued by an instructor, conducting independent research, working on a group project, giving a class presentation, and taking essay exams; negatively related to this outcome was taking multiple-choice exams. Based on these findings, her conclusion was that the characteristics of the instructional methods that are effective for critical thinking development are asking students to construct responses or answers to a question, problem, or challenge rather than merely to memorize, recognize, and select correct answers from among provided possible responses. More recently, Tsui (2002) conducted a qualitative case study of four higher education institutions to explore the contextual factors that could affect students' growth in critical thinking. Through interviews and class observations, she found that the amount of writing and the nature of the writing assignment seemed to matter, such that assignments demanding more analysis and less description were conducive to promoting critical thinking. Furthermore, feedback on one's writing may further facilitate critical thinking, especially if it involves rewriting an assignment. According to Tsui (2002), rewriting challenged students to utilize others' feedback to refine their own, thus requiring an additional step and facilitating critical thinking.

Coupled with rare efforts that empirically examine the effect of particular instructional methods and course assignments on critical thinking, some theoretical and argumentative writings suggest specific teaching methods to foster higher order thinking skills based on authors' teaching experiences. For example, Mills (1998) suggested provocation as a method to foster higher order thinking in classroom environment. Citing his own experience of teaching philosophy using this method as an example, he argues the use of challenging questions and statements can promote students' active participation and learning, which can result in the development of abstract thinking. Owens (2007) argued for the importance of students' self-critique in class for promoting higher order thinking abilities such as thinking critically, analyzing arguments, and reflecting on one's own assumptions. Although Mills and Owen highlight specific teaching strategies to foster critical thinking, past research has rarely attempted to test the effect of provocation or self-critique on the development of critical thinking.

To summarize, several course-related activities or tasks have been identified as significant factors in promoting critical thinking: giving a class presentation, conducting a group project, writing assignment and exams, and conducting independent research, as well as the nature of the task or assignment. In other words, assignments or tasks that require more thinking or analyzing rather than retrieving or describing (i.e., assignments higher on Bloom's Taxonomy of the Cognitive Domain [Anderson, 2001; Bloom, Englehart, Furst, Hill, & Krathwohl, 1956]) are effective for enhancing critical thinking. Despite these recent attempts to unveil the nature of tasks or assignments that are specifically helpful for the development of critical thinking, the studies that examined the effects of instructor-driven teaching practices (e.g., Socratic methods, pushing students to apply concepts learned) are still rare.

Defining and Measuring Critical Thinking Skills

Teaching critical thinking skills to college students is complicated partly due to the disagreement over the definition and components of critical thinking (e.g., see Ennis' [1962] 12 specific "aspects"; Facione's [1990] 5 "dispositions"; Paul, Binker, Jensen, and Kreklau's [1990] 35 "dimensions"; and Clark and Biddle's [1993] 4 "processes"). Authors who have developed the definition and the assessment of critical thinking touched on slightly different aspects of thinking abilities and highlighted one aspect more than the others. For example, Ennis (1962) emphasizes the element of making informed decisions whereas Facione and Facione (1992) highlight the disposition to continuously use critical thinking skills. Recently, authors have tried to define the concept of critical thinking by discriminating it from other similar constructs such as problem solving, reflective evaluation and creative thinking. Problem solving is most frequently confused with critical thinking because both constructs focused on solving the problems at hand via analytical thinking and reasoning. Bailin, Case, Coombs, and Daniels (1999) describe problem solving and decision making as arenas in which critical thinking should take place rather than as other kinds of thinking to be contrasted with critical thinking. In other words, critical thinking encompasses the process of solving problem and making decisions with specific skills and dispositions. Although Marzano et al. (1988) claim that creative thinking and critical thinking are similar and overlapping constructs, Paul (1993) differentiates creative thinking from critical thinking, but highlights that both constructs are not mutually exclusive, and share some skills and abilities. Ennis (1993), however, clearly states that critical thinking does not encompass creative thinking. According to Ennis (1993), creative thinking is generating new ideas or arguments, whereas critical thinking is analyzing or reasoning the pre-existing arguments, and forming informed decisions or views based on this reasoning.

As varied the constructs of critical thinking are, so are the measures for critical thinking. Disagreement in the construct of critical thinking generates several competing measures for critical thinking. To date, the most common measures of critical thinking are skills tests such as the California Critical Thinking Skills Test (Facione, 1990), the Collegiate Assessment of Academic Proficienty (CAAP; ACT, 2000), and Watson-Glaser Critical Thinking Assessment (Watson & Glaser, 1952). Facione and Facione (1992) developed an additional measure for measuring critical thinking dispositions and attitudes called the California Critical Thinking Dispositions Inventory (CCTDI). Although these tests share some common features, they differ in terms of theoretical bases and may measure slightly different constructs. Although some authors argue the advantage and accuracy of using direct measures of critical thinking, others use self-report measures because they are more efficient. Self-report has become a widely used method for gathering information about college students, particularly their attitudes and behaviors. In addition, self-report measures generally allow researchers to gather information from larger samples (Astin, 1993).

Researchers generally agree that self-report measures are valid within certain limits, but caution against using self-report singularly and universally (Gonyea, 2005). These cautions are evident for measures of academic development (Gonyea, 2005; Kuh, 2001; Pike, 1995, 1996). For example, Pike (1995) and Astin (1993) found self-report measures to be an acceptable proxy for academic development when self-report measures and direct assessment measure the same constructs, but self-reports cannot replace direct assessment measures entirely. Previous literature has also reported mixed results of the relationship between students' self-reports and direct measures of critical thinking. Some studies reported moderate correlations (Pascarella & Terenzini, 1991; Tsui, 1999), while Bowman and Seifert (2010) found that small or virtually zero correlations between students' self-reports and direct assessments of critical thinking skills.

Although students' self-reports can indicate cognitive growth, it is possible that students' self-reports and direct assessment measure different aspects of critical thinking abilities and skills. The former might be related to students' satisfaction with collegiate experiences and students' own perception of their developmental levels, whereas the latter might represent an attempted standardized measurement of students' ability levels across disciplines or institutions. This possible discrepancy in the measures of critical thinking, in turn, highlight the necessity of comparing the outcomes derived from different types of measures in order to improve the quality of teaching critical thinking.

The purpose of this study is to investigate the effects of various instructor-driven teaching practices on the development of students' critical thinking ability. While exploring the effectiveness of specific teaching practices, we will also compare students' self-reported measures of critical thinking and direct measures of critical thinking in order to generate practical implications for teaching and learning.

The lack of research on classroom instruction as well as very vague definitions of instructional practices in previous studies brings renewed attention to the topic. In other words, past research has not yet fully addressed the impact of specific instructional methods on students' critical thinking. Furthermore, what has been published cannot answer why particular assignments and tasks are more effective than others. Therefore, this study will contribute to research on critical thinking by specifying various instructor-driven teaching practices and course-related task characteristics to improve critical thinking, which will generate practical implications for professional development. Based on the review of the existing literature and the unknowns it brought to light, this study asks:

- What instructional practices and assignments promoted growth in self-reported critical thinking abilities in first-year college students?
- What instructional practices and assignments predict first-year college students' direct measured gains in critical thinking?
- How do self-report and objective measures of gains in critical thinking compare?

Methods

Data Source

The data for this study were derived from the Wabash National Study of Liberal Arts Education (WNS). King, Kendall Brown, Lindsay, and Van Hecke (2007) synthesized the literature on liberal arts education and developed a model of liberal arts outcomes that embraced seven general dimensions: effective reasoning and problem solving, well-being, inclination to inquire and lifelong learning, intercultural effectiveness, leadership, moral character, and integration of learning. For this specific study, we focused on the outcome of effective reasoning and problem solving which was measured by both students' self-reports of their gains in critical thinking and direct assessment of critical thinking.

The institutions selected for the WNS represent differences in college and universities nationwide on a variety of characteristics including institutional type and control, size, location, and patterns of student

residence. As a result, the sample has a total of 19 four-year and two-year colleges and universities, from which incoming first-year students were selected for participation either randomly (for larger institutions) or entirely (for smaller institutions). The data were collected at the beginning and the end of students' first year, primarily asking their first year experiences at college.

The initial data collection was conducted in the early fall of 2006 with 4,501 students. The data collection included a WNS precollege survey that sought information about student demographic characteristics, high school experiences, educational degree plans, and the like. Students also completed a series of instruments that measured liberal arts outcomes. Effective reasoning and problem solving, which is conceptualized as "the capacity to make reflective judgments; think critically and independently; and analyze, synthesize, and evaluate information in order to make decisions and solve problems" (King et al., 2007, p. 5), was measured through the critical thinking module from the Collegiate Assessment of Academic Proficiency (CAAP).

The Time 2 data collection was conducted in spring 2007, resulting in a participation of 3,081 students with returning rate of 68.5%. For the Time 2 data collection, two types of data were collected; the first was from questionnaire instruments that collected extensive information on students' experience of college. Two complementary instruments were used: the National Survey of Student Engagement (NSSE; Kuh, 2001) and the WNS Student Experiences Survey (WSES). These instruments were designed to capture student engagement in, or exposure to, empirically vetted good practices in undergraduate education. In addition, as a part of NSSE, students were asked to indicate to what extent they perceived that these practices facilitated their learning and development. The second type of data collected consisted of posttest measures of the instruments measuring dimensions of intellectual and personal development using instruments noted above.

For the purpose of present study, we excluded students attending two-year institutions (n = 128) because of the diversity of educational goals for students at two-year institutions. We also selected out cases with missing values either on independent or dependent variables; this resulted in an analytic sample of 1,181 students from 17 institutions. A description of our analytical sample is presented in Appendix A.

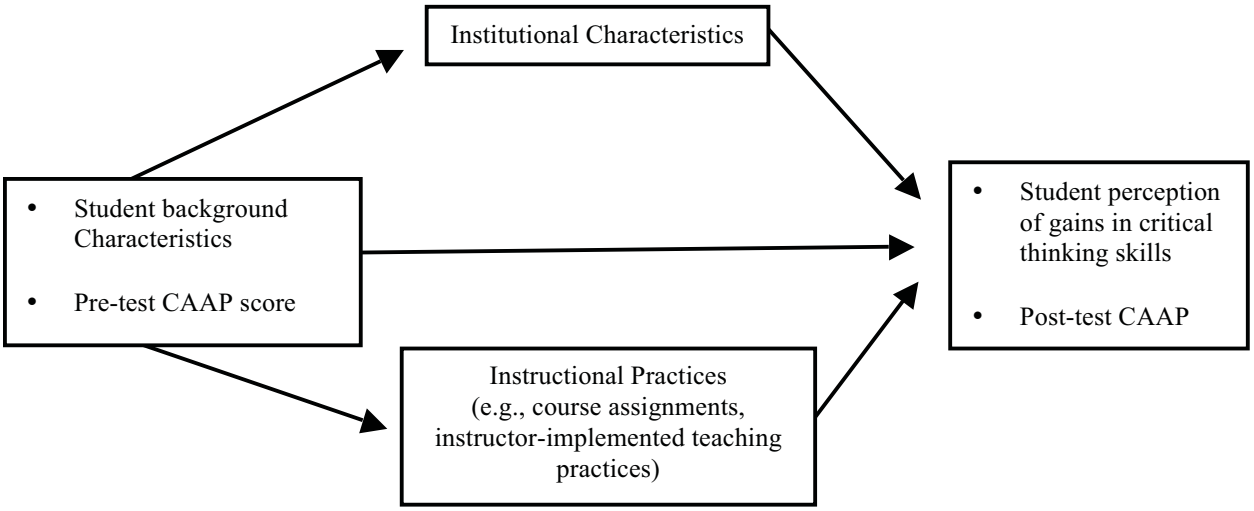
Variables

The dependent variables were two measures that assessed students' development in critical thinking: students' self-reported gains in and direct assessment of students' critical thinking abilities. Self-reported gains were measured by asking students the extent to which each teaching practice (e.g., making a class presentation, completing a writing assignment) contributed to the development of students' critical thinking abilities. The critical thinking module from the CAAP was used to assess students' development in critical thinking abilities and skills. The critical thinking test is a 40-minute, 32-item instrument designed to measured students' ability to clarify, analyze, evaluate, and extend arguments (ACT, 2008). The test consisted of four passages in a variety of formats (e.g., case studies, debates, dialogues, experimental results, statistical arguments, editorials). Each passage contained a series of arguments that support a general conclusion and a set of multiple-choice test items. Scores are calculated from these items and scaled using an algorithm devised by ACT to minimize measurement errors. The internal consistency reliabilities for the CAAP critical thinking test are around .85 (ACT, 2008). In addition, Pascarella, Bohr, Nora, & Terenzini (1995) reported that in pilot testing for the National Study of Student Learning with a sample of 30 college students, the critical thinking test of CAAP correlates .75 with the total score of Watson-Glaser Critical Thinking Appraisal, one of the most widely used critical thinking skills assessments.

Students' development in critical thinking abilities was modeled as a function of individual characteristics, institutional characteristics and instructional practices (see Figure 1). Because our major focus was on the impact of instructional practices on students' development in critical thinking abilities, we controlled for individual and institutional variables that potentially confound the results. With regard to individual characteristic variables, we included gender, race/ethnicity, parental educational attainment measured with years of education, parental income, precollege academic ability, and academic motivation. Precollege academic ability was measured with either students' ACT or Time 1 CAAP test scores. These two measures are highly correlated with each other ($r = .78$), so we used only one of them for our analyses in order to avoid multicollinearity. We used ACT score as a control for estimating self-reported gains, and precollege CAAP scores as a control for modeling the post-test CAAP test scores.

In order to control for institutional characteristics, we included institutional type based on their Carnegie classification, and average class size. With regard to institutional type, regional or research universities were compared to liberal arts colleges. Average class size of each institution was a dummy-coded variable that compared large classes (average class size > 20) to small classes (average class size ≤ 20). The distinction between large and small classes was made based on

Figure 1
Conceptual Model Guiding Effects of Instructional Practices on Critical Thinking



previous literature that defined small classes as classes with less than 20 students (Glass & Smith, 1979).

Finally, instructional practice variables consisted of a set of classroom instruction variables, frequencies of different types of class-related tasks, and the characteristics of these course-related tasks. All of these measures on instructional practices were derived either from the WNS student survey or the NSSE survey to measure students' perception of how often these instructional practices were implemented during their courses. For example, students were asked to respond to a question like, "In your experience at your institution during the current school year, about how often have you received prompt written or oral feedback from faculty on your academic performance (Faculty feedback)" with 4 or 5 point Likert-type scales. A more detailed description of each variable is presented in the Appendix B.

Analytical Models

Students' self-reported gains in critical thinking abilities were analyzed using the multinomial logistic regression (MNLR) technique due to the multinomial nature of the dependent variable. Students' self-reported gains in the WNS were measured with 4-point Likert scale (1: very little to 4: very much). Measures with Likert scales are often conceived of as continuous outcomes, and analyzed with least squares regression technique. However, ordinary least squares (OLS) technique could produce biased estimation because Likert measures are not actually continuous, but ordinal categories. Ordered logistic regression is suggested as a technique which produces accurate estimation in case of ordinal categorical measures (Peel, Goode, & Moutinho, 1998). However, ordered logistic regression was not appropriate for the present study due to the violation of the parallel regression assumptions (Long, 1997). Consequently, we adopted multinomial logistic regression analysis, and examined differences among students who reported different levels of growth in critical thinking during their first year at college. For the present analysis, two response categories at the lower end were combined into "minimum" gains as Wald Tests for combining alternatives indicated that "very little" and "some" were indistinguishable from each other, c2(24, N = 1181) = 23.169, p = .510. Subsequently, "quite a few" and "very much" response categories were renamed respectively as "medium" and "maximum," then the utilities of choosing either of these categories were compared to the utilities of selecting "minimum" response choice. The mathematical representation of the MNLR analytic model was:

$$U_{ji} = \mathbf{X}_{1i}\beta_{1j} + \mathbf{X}_{2i}\beta_{2j} + \mathbf{X}_{3i}\beta_{3j} + e_{ji}$$

where subscript j denoted the choice (e.g., minimum, medium, or maximum) and subscript i denoted the individual case. All the **X**s on the right-hand side of the equation denoted each set of variables. $\mathbf{X}_1$ indicated a set of individual variables, $\mathbf{X}_2$ denoted a set of institutional characteristics, and $\mathbf{X}_3$ represented instructional practice variables. In addition, although we never observed utility, we inferred from the choices people made how they rank some of these alternatives. Thus, if an individual reported maximum growth in

critical thinking, it must have been the case that the utility of selecting that response category exceeded the utilities of either choosing "minimum" or "medium" response category. In other words, a student chose the response that maximized the utility gained from that choice.

Students' CAAP test scores were analyzed using the ordinary least squares (OLS) regression technique because the CAAP score is a continuous measure. Our OLS model for CAAP scores is mathematically represented as follows:

$$\mathbf{y}_{CAAP} = \mathbf{X}_{1i}\beta_1 + \mathbf{X}_{2i}\beta_2 + \mathbf{X}_{3i}\beta_3 + e_i$$

Because the study aims to explore the impacts of instructional practices on students' development while controlling potential confounding variables, as well as to compare different measures on critical thinking, we entered all the independent variables into the regression at the same time and focused more on comparing OLS with MNLR results.

Results

Students' Self-Reported Gains in Critical Thinking

The results of multinomial logistic model (MNLM) on students' self-reported growth in critical thinking are presented in Table 1; this reports the odds ratios that compare the probabilities of either "maximum" or "medium" response categories to those of the "minimum" gains. None of demographic variables (e.g., gender, race/ethnicity) were significantly associated with students' self-reported growth of critical thinking skills. Among other background and institutional variables, students in research universities were approximately twice as likely to report maximum growth rather than minimum growth, compared to students in liberal arts colleges, odds ratio = 2.182. In other words, twice as many students in research universities thought that they gained a lot of critical thinking abilities during their first year than did students at liberal arts colleges.

Among the five faculty-initiated instructional practices, the frequency of faculty asking challenging questions in class had a substantial influence on students' self-reported growth in critical thinking. To illustrate, for a one unit increase in the frequency of faculty asking students challenging questions, the odds of students' self-reporting maximum and medium growth increased by 98.0% and 44.9% respectively, as compared to the odds of students' reporting minimum gains. In other words, the more students were asked challenging questions, the more likely they were to report medium or maximum gains rather than minimum gains. This may imply that students' level of self-report growth in critical thinking abilities can be increased by the frequent use of challenging questions.

Being in classes with faculty who frequently interpreted abstract concepts for students as well as giving well-organized presentation distinguished the students who reported maximum growth from those reporting minimum growth, but not from those reporting medium growth. Thus, these practices can be said to contribute to only maximizing the students' self-reported growth in critical thinking abilities. To illustrate, the frequency of faculty explaining abstract concepts in class significantly increased the odds of students reporting maximum gains in critical thinking as compared to minimum growth response by 60.2%. We also found that as faculty more frequently gave well-organized presentations of materials in class, the odds of students reporting maximum growth in critical thinking ability increased by 47.7% in comparison to the odds of students choosing the minimum growth response category.

Some variables representing course-related task characteristics had significant impacts on students' perceived growth in critical thinking. Frequent use of course-related tasks that required students to integrate the ideas from multiple sources contributed to an increase in odds of students responding either with the maximum or medium response category compared to the odds of minimum growth. In fact, for a one unit increase in the frequency of this type of task, the odds of students' reporting either medium or maximum growth in critical thinking ability became larger than the odds of minimum growth response by 42.5% and 129.7% respectively.

Only two course-related task characteristics differentiated students reporting maximum growth from those reporting minimum growth. More frequent assignments that required students to compare and contrast topics or ideas from a course increased the odds of students' reporting maximum growth by 45.4%, as compared to the odds of students reporting minimal growth in critical thinking. In addition, for a unit increase in the frequency of faculty feedback on students' assignments or academic performance, the odds of maximum response increased by 71.3% over the odds of students' self-reporting minimum growth in critical thinking. These results indicate that instructors can maximize students' perceived gains in critical thinking by giving more assignments or exams that require students to compare and contrast diverse perspectives as well as by providing more frequent feedback on these assignments.

By contrast, frequency of giving presentations was significant but negatively associated with students' self-reported gains in critical thinking abilities. As the frequency of this assignment increased, the odds of students reporting maximum gains decreased by 35.6%

Table 1
MNLM Results of Students' Self-Reported Growth in Critical Thinking (odds ratios)

Outcome: Self-reported growth in critical thinking	Medium vs. Minimum	Maximum vs. Minimum
Controls: Background Characteristics		
Gender (Female)	1.250	1.210
Race/Ethnicity (Non-white)	1.493	1.631
Mother's education	0.993	1.021
Father's education	1.066	1.025
Parental income	1.013	1.006
Academic motivation	0.967	1.062
Precollege academic ability (ACT)	0.988	0.995
Controls: Institutional Variables		
Research university[1]	1.547	**2.182** *
Regional university[1]	0.746	0.643
Large class size (> 15)	0.850	0.625
Variable of Interest: Faculty-Initiated Instructional Practices		
Asking challenging question	**1.449** *	**1.980** ***
Asking students to apply concepts	1.089	1.158
Asking students to defend point of view	1.021	1.115
Interpreting abstract concepts	1.158	**1.602** **
Well-organized presentation	1.034	**1.477** *
Variable of Interest: Course-Related Tasks		
Writing	1.181	1.013
Problem solving	1.108	1.162
Class presentation[2]	0.807	**0.644** *
Group project[2]	0.982	0.852
Variable of Interest: Task Characteristics		
Application of concepts	0.960	1.029
Compare & contrast	1.275	**1.454** **
Defend point of view	0.962	1.235
Integrate ideas[2]	**1.425** *	**2.297** ***
Faculty feedback[2]	1.132	**1.713** ***
Number of Cases	1,181.0	
Log likelihood	-947.37673	
Log likelihood ratio χ^2	374.33 ***	
Pseudo R^2	0.165	

Note. *** p < .001; ** p < .01; * p < .05
[1] Compared to liberal arts university
[2] Items are derived from NSSE survey; all the others are from WNS student survey

compared to the odds of reporting minimum gains. In other words, students who more frequently gave and listened to class presentations tended to perceive less growth in critical thinking. This result contradicted previous studies which highlight the importance of active learning pedagogies, such as giving class presentations and engaging in small group discussions as promoting students' critical thinking skills (e.g., Pascarella & Terenzini, 1991; Tsui, 1999).

Students' Growth in Critical Thinking as Measured by CAAP

Table 2 presents the results of OLS regression on the direct assessment of students' gains in critical thinking skills. Unlike the findings of MNLR, a number of background and institutional variables significantly affected students' critical thinking ability. Among individual characteristics, academic motivation as well as pre-college critical thinking ability positively affected students' critical thinking ability. Students' pre-college critical thinking ability was the strongest factor predicting their critical thinking ability during their first year. Among institutional variables, there was a significant difference between students enrolled at regional universities and those in liberal arts colleges, with liberal arts college students scoring significantly higher on CAAP test than those enrolled at regional universities.

Of instructor-initiated teaching practices, asking challenging questions in class had a significant and positive impact on students' gains in critical thinking

Table 2
OLS Regression Results of Students' Post-Test Critical Thinking (CAAP)

	OLS Results		
Outcome: Post-Test Critical Thinking	B	β	S.E.
Controls: Background characteristics			
Gender (Female)	0.079	0.038	0.209
Race/Ethnicity (Non-white)	-0.440	-0.188	0.245
Mother's education	-0.018	-0.041	0.053
Father's education	0.016	0.042	0.047
Parental income	0.016	0.031	0.060
Academic motivation	**0.244** *	**0.240**	0.107
Pre-test critical thinking (pre-CAAP scores)	**0.754** ***	**0.794**	0.022
Controls: Institutional variables			
Research university[1]	0.624	0.286	0.356
Regional university[1]	**-0.573** *	**-0.227**	0.269
Large class size (> 15)	0.325	0.161	0.307
Variable of Interest: Instructional practices			
Asking challenging questions	**0.547** ***	**0.433**	0.150
Asking students to apply concepts	0.012	0.012	0.118
Asking students to defend point of view	0.120	0.128	0.118
Interpreting abstract concepts	0.271	0.217	0.145
Well-organized presentation	0.149	0.108	0.154
Variable of Interest: Course-related tasks			
Writing	0.220	0.188	0.132
Problem solving	-0.037	-0.041	0.092
Class presentation[2]	-0.115	-0.075	0.165
Group project[2]	**-0.377** **	**-0.287**	0.134
Variable of Interest: Task characteristics			
Application of concepts	-0.148	-0.156	0.106
Compare & contrast	-0.045	-0.042	0.131
Defend point of view	-0.131	-0.147	0.114
Integrate ideas[2]	-0.294	-0.217	0.150
Faculty Feedback[2]	-0.011	-0.009	0.131
Number of Cases	1,181.0		
F (24, 1156)	0.10 ***		
R^2	0.6215		
Adjusted R^2	0.6137		

Note. *** p < .001; ** p < .01; * p < .05
[1] Compared to liberal arts university
[2] Items are derived from NSSE survey; all the others are from WNS student survey.

even after controlling for pre-CAAP scores. In fact, for every unit increase in the frequency of instructors asking challenging questions in class, students' scores on the CAAP increased by .547 points *(*b = .547*, p ≤ .0005)*. In contrast with the MNLR results, other instructional practices were not significantly associated with students' development in critical thinking.

One type of course-related practices did seem to affect students' gains in critical thinking abilities. The frequency of group projects had a significant but negative impact on students' critical thinking skills. As the frequency of engaging in group projects increased, students' post-test scores on CAAP decreased (b = -.377, *p = .005)*. This result, similar to the case of MNLR, contradicted previous literature that indicated a positive impact of group work on critical thinking abilities (Pascarella et al., 1995; Tsui, 1999). None of the assignment characteristic variables were significant for CAAP test scores, which was inconsistent with the results from MNLR analysis.

Discussion

Our results provided several insights into the features of instructional practices that would foster first-year college students' critical thinking abilities. First, instructional techniques that not only provoke students to think differently (e.g., asking challenging questions), but also provide developmental supports (e.g., giving well-organized presentations, interpreting

abstract concepts) are needed to foster students' critical thinking abilities; this balance is consistent with Sanford's (1966) theory that both support and challenge are necessary for growth. Our results indicated that posing challenging questions in class improved students' self-reported as well as objectively measured critical thinking abilities. Teaching practices such as teachers' frequent explanations of abstract concepts to students, as well as well-organized presentations in class contributed to increasing self-report growth in critical thinking among college freshmen. These two teaching practices are slightly different from teachers' asking challenging questions in that the latter stimulates students to think creatively or differently, whereas explaining abstract concepts as well as giving well-organized presentations provides some support. Therefore, instructors should use these practices complementarily by provoking students through questioning that challenges students to view issues from different perspectives, and then providing explanations to help them understand abstract concepts. In other words, the development of critical thinking may require instructors to balance cognitive challenge with intellectual support, as Sanford (1966) suggested.

Second, our results indicated that course assignments requiring students to compare and contrast, and integrate ideas contributed to increasing students' critical thinking abilities. Tasks that require integration of ideas, as well as assignments specifying that students compare and contrast ideas, require students to gather multiple ideas or perspectives, organize them by themes, and highlight the differences and commonalities among different ideas (Barber, 2008). This suggests that the development of critical thinking may entail thinking and analyzing multiple ideas instead of retrieving and recognizing correct answers, which is consistent with what Tsui (2002) found in her study. Consequently, instructors need to focus on the characteristics of tasks (e.g., whether tasks require compare and contrast) rather than types of tasks (e.g., writing, class presentation) and to incorporate analytic components into each class assignment in order to foster students' critical thinking.

Third, our findings demonstrated that student-implemented course practices such as class presentations and group projects did not promote but hindered the development of first-year students' critical thinking abilities. These results are inconsistent with previous studies that indicated the positive effects of these two instructional practices (Astin, 1993; Tsui, 1999). Our findings are likely reflective of first-year students' developmental orientation; that is, first-year students are often externally-defined and rely on authority figures to help them understand the world around them and seek approval from others (Baxter Magolda, 2001). For these externally-defined students, the act of hearing other students present in class places students in the role of expert and therefore contradicts an externally-defined epistemological belief. They would prefer to learn directly from an instructor rather than from a peer. In a similar vein, externally-defined students in the group situations may be reluctant to challenge each other and share ideas with peers for fear of disrupting the group and potentially receiving negative feedback from others. The positive effect of faculty giving feedback on students' critical thinking abilities may also reflect first-year students' reliance on authority figures for learning critical thinking abilities. In sum, instructors who teach first-year students may benefit from attending to students' developmental orientations and restructuring student-implemented course practices (e.g., class presentation) to meet their developmental capacity.

Finally, we found some discrepancies between students' self-report and direct assessment of critical thinking. For example, frequent use of interpreting abstract concepts had a significant, positive effect on students' self-reported gain; however, this was not a significant predictor for the increase of CAAP scores. One possible explanation for these discrepancies is that the direct measure of gains in critical thinking and student self-reports of gains in critical thinking measure different constructs. For the direct measure, the developers of CAAP defined critical thinking, whereas each student defined critical thinking for self-report measures. Given the breadth of critical thinking definitions within the literature, we expect student interpretations of critical thinking to be just as varied. Although this variation is problematic, the different definitions may also encompass a broader critical thinking skill set than the CAAP. Therefore, the student-identified teaching practices may promote critical thinking skills beyond what the CAAP measures, such as creativity (Marzano et al., 1988) or reflective thinking (Aretz, Bolen, & Devereux, 1997).

In addition to variation in the critical thinking construct, student self-reports might also reflect student satisfaction and student engagement (Bowman & Seifert, 2010). As Astin (1993) reported, when students believed they were learning, they were more satisfied and more engaged with their educational experiences. Increased satisfaction and particularly engagement in learning complemented the pedagogical methods employed by faculty to improve critical thinking skills because students already held faculty and faculty teaching practices in high regard. On the other hand, students who were dissatisfied with their college experience were less likely to report experiences as having a positive impact on their development (Bowman & Seifert,2010). Future research may include measures of student satisfaction in order to better understand the nature of self-report and direct assessments on the development of critical thinking.

Limitations

The WNS dataset has several limitations that should be kept in mind when interpreting the findings. First, although the overall sample includes a broad range of different kinds of postsecondary institutions from 11 different states, the fact that institutions were not selected randomly and that the liberal arts colleges were purposely over-sampled means that one cannot necessarily generalize the results to the population of all four-year institutions in the United States.

A second limitation is the fact that not all students who participated in the first (precollege) data collection participated in the second (follow-up) data collection. The 68.5% persistence rate in the WNS from the first to second data collections is consistent with other large longitudinal studies requiring a substantial amount of participation in terms of time and intellectual effort (e.g., see the National Study of Student Learning, Pascarella, Edison, Nora, Hagedorn, & Terenzini, 1998). However, attrition from the first to second data collections is a major, if perhaps unavoidable, limitation of the study. In other words, we cannot guarantee that those students who dropped out of study after the first data collection would have responded in the same way as their counterparts who persisted in the study from the first to second waves.

Finally, although we cautiously selected instructional methods variables that best captured our conceptual model describing the effects of course practices on students' critical thinking abilities, the use of secondary data sources can limit the investigation of our intended conceptual model. There could be other instructional methods commonly practiced in colleges to promote the ability of critical thinking other than those measured in the first-year of the WNS. Consequently, findings should be regarded as a partial explanation that addresses the effect of instructional practices on students' growth in critical thinking during only their first year at college.

Implications and Conclusion

A number of implications for educational research and practice can be drawn from this study. First, the findings provide practical implications for professional training of future faculty members and graduate teaching assistants. Instructors and teaching assistants need to learn how to organize the class presentations, formulate and ask challenging questions in class, give clear explanations about abstract concepts, and encourage students to apply course concepts for effectively teaching critical thinking abilities. Although these teaching practices could be effective across fields of study, the actual implementation should tailor to the characteristics of each field. For example, probing on underlying assumptions of an argument would be a challenging question in humanities while encouraging students to integrate multiple theorems for a problem at hand would be challenging in engineering. For this reason, professional training would reflect the context and the characteristics of each disciplinary field.

Second, with regard to course design, instructors should pay more attention to determining why certain assignments or exams are important. This study demonstrates that assignments or exams are only effective in promoting critical thinking because of specific characteristics of those assignments or exams. Thus, when instructors design a course, they need to determine the specifics and the core elements of each assignment. Furthermore, these assignments should incorporate the element of extracting diverse ideas from multiple sources to foster critical thinking.

Lastly, if institutions are truly committed to the development of students' critical thinking abilities, they need to research environmental factors that either facilitate or hinder the development of students' critical thinking skills. From the findings of this study, students' self-reports as well as direct assessments of critical thinking differed across different types of institutions. Students in research universities tended to report maximum growth in critical thinking rather than minimum compared to students in liberal arts colleges. In a similar vein, students in regional universities scored significantly lower on CAAP compared to those in liberal arts colleges. Combined together, these findings suggest that educational practices in research universities or liberal arts colleges work more effectively than in regional universities. These institutional differences may result from different practices implemented in each institution or from differential effects of similar practices on students attending each institution. Whatever the case would be, institutions need to research best practices on campus and examine why these practices work in their context. These best practices, once compiled, could be used for professional development purposes.

This research provides insight into future areas of research. As noted above, the relationships between self-report measures and direct measures may change over time. Future research should include comparisons between self-report and direct measures of gains in critical thinking at the end of college. In addition, comparisons between self-report measures in the first year and direct measures at the end of college might provide insight into whether there is a time lapse between what practices students experienced as enhancing critical thinking in the first year and what practices actually improve CAAP scores at the end of college. In addition, future studies could use multiple items to measure students' self-reported gains in

critical thinking ability in order to improve measurement validity and reliability.

Since self-report results largely depend on student interpretations, qualitative and mixed methods research would provide deeper understanding of the topic. For example, student interviews could explore the basis of student interpretations of the critical thinking construct, as well as gain deeper understanding of the exact faculty teaching practices that students identify as important. Interviews could also assess the types of challenging questions faculty ask, as well why the student believed these questions developed critical thinking skills. In addition, mixed methods research may help explain the contradictory findings about types of assignments by providing insight into how students perceive group work and class presentations.

Overall, these findings highlight the importance of faculty-driven teaching practices in class, such as asking challenging questions or encouraging students to apply course concepts to real-world situations. In addition, by using specified measures that better capture the actual instructional methods used in college classrooms, these findings give a more clear and detailed explanation of the kinds of teaching practices that make a difference in promoting critical thinking. The identification of characteristics of course-related tasks that can increase students' perceived gains in critical thinking is another important finding of the present study. The study found that it is not the type of tasks (e.g., writing reports, class presentation), but rather the task demands (e.g., assignments asking compare and contrast, assignment asking application of concepts) that help students improve their critical thinking. Although instructional practices and certain assignments can promote students' critical thinking, contextual factors such as institutional type may differently shape the effectiveness of these instructional methods. Thus, colleges and universities need to pay more attention to environmental factors that can either facilitate or hinder students' development of critical thinking.

References

ACT. (2000). *CAAP: Technical handbook.* Iowa City, IA: ACT.

ACT. (2008). Collegiate assessment of academic proficiency. Retrieved from http://www.act.org/caap/

Anderson, L. W. (2001). *A Taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Aretz, A. J., Bolen, M. T., & Devereux, K. E. (1997). Critical thinking assessment of college students. *Journal of College Reading and Learning, 28*(1), 12-23.

Astin, A. W. (1993). *What matters in college: Four critical years revisited*. San Francisco, CA: Jossey-Bass.

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies, 31*(3), 285-302. doi:10.1080/002202799183133

Barber, J. (2008). *Integration of learning: Meaning making for undergraduates through connection, application, and synthesis* (Unpublished doctoral dissertation). University of Michigan, Ann Arbor, MI.

Baxter Magolda, M. B. (2001). *Making their own way: Narratives for transforming higher education to promote self-development*. Sterling, VA: Stylus Publishing.

Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals, handbook I: Cognitive domain.* New York: Longman.

Bowman, N. A., & Seifert, T. A. (2010). *Can students accurately assess what affects their learning and development in college?* Manuscript submitted for publication.

Boyer Commission on Educating Undergraduate in the Research University. (1998). *Reinventing undergraduate education: A blueprint for America's research universities*. Stony Brook, NY: State University of New York.

Cabrera, A. F., Colbeck, C. L., & Terenzini, P. T. (2001). Developing performance indicators for assessing classroom teaching practices and student learning: The case of engineering. *Research in Higher Education, 42*(3), 327-352. doi:10.1023/A:1018874023323

Clark, J. H., & Biddle, A. W. (Eds.). (1993). *Teaching critical thinking: Reports from across the curriculum*. Englewood Cliffs, NJ: Prentice Hall.

Ennis, R. H. (1962). A concept of critical thinking. *Harvard Educational Review, 32*(1), 81-111.

Ennis, R. H. (1993). Critical thinking assessment. *Theory into Practice, 32*(3), 179-186. doi:10.1080/00405849309543594

Facione, P. A. (1990). *California critical thinking skills test manual*. Millbrae, CA: California Academic Press.

Facione, P. A., & Facione, N. C. (1992). *The California critical thinking disposition inventory test manual*. Millbrae, CA: California Academic.

Gellin, A. (2003). The effect of undergraduate student involvement on critical thinking: A meta-analysis of the literature 1991-2000. *Journal of College Student Development, 44*(6), 746-762. doi:10.1353/csd.2003.0066

Giancarlo, C. A., & Facione, P. A. (2001). A look across four years at the disposition toward critical

thinking among undergraduate students. *Journal of General Education, 50*(1), 29-55. doi:10.1353/jge.2001.0004

Glass, G. V., & Smith, M. L. (1979). Meta-analysis of research on class size and achievement. *Educational Evaluation and Policy Analysis, 1*(1), 2-16. doi:10.2307/1164099

Gonyea, R. M. (2005). Self-reported data in institutional research: Review and recommendations. In P. D. Umbach (Ed.), *New directions for institutional research* (Vol. 127, pp. 73-89). San Francisco, CA: Jossey-Bass.

Halpern, D. F. (1993). Assessing the effectiveness of critical thinking instruction. *Journal of General Education, 50*(4), 270-286.

Hampton, S. E., & Reiser, R. A. (2004). Effects of a theory-based feedback and consultation process on instruction and learning in college classrooms. *Research in Higher Education, 45*(5), 497-527. doi:10.1023/B:RIHE.0000032326.00426.d5

King, P. M., Kendall Brown, M., Lindsay, N. K., & Van Hecke, J. R. (2007). Liberal arts student learning outcomes: An integrated approach. *About Campus, 12*(4), 2-9. doi:10.1002/abc.222

Kuh, G. D. (2001). Assessing what really matters to student learning: Inside the National Survey of Student Engagement. *Change: The Magazine of Higher Learning, 33*(3), 10-17, 66. doi:10.1080/00091380109601795

Kuh, G. D., Doughlas, K. B., Lund, J. P., & Ramin-Gyurnek, J. (1994). *Student learning outside the classroom: Transcending artificial boundaries*. Washington, DC: ASHE-ERIC Education Report No. 8.

Kuh, G. D., Pace, C. R., & Vesper, N. (1997). The development of process indicators to estimate student gains associated with good practices in undergraduate education. *Research in Higher Education, 38*(4), 435-454. doi:10.1023/A:1024962526492

Long, J. S. (1997). *Regression models for categorical and limited dependent variables*. Thousand Oaks, CA: Sage Publications.

Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C., & Suhor, C. (1988). *Dimensions of thinking: A framework for curriculum and instruction*. Alexandria, VA: Association for Supervision and Curriculum Development.

McKeachie, W. (1990). Research on college teaching: The historical background. *Journal of Educational Psychology, 82*(2), 189-200. doi:10.1037/0022-0663.82.2.189

McMillan, J. (1987). Enhancing college students' critical thinking: A review of studies. *Research in Higher Education, 26*, 3-29. doi:10.1007/BF00991931

Mills, J. (1998). Better teaching through provocation. *College Teaching, 46*(1), 21-15. doi:10.1080/87567559809596228

Owens, K. (2007). Classroom critiques: Transforming conformity into creativity. *Industry and Higher Education, 21*(5), 345-351. doi:10.5367/000000007782311786

Pascarella, E. T., Bohr, L., Nora, A., & Terenzini, P. T. (1995). Cognitive effects of 2-year and 4-year colleges: New evidence. *Educational Evaluation and Policy Analysis, 17*(1), 83-96. doi:10.2307/1164271

Pascarella, E. T., Edison, M. I., Nora, A., Hagedorn, L. S., & Terenzini, P. T. (1998). Does work inhibit cognitive development during college? *Educational Evaluation and Policy Analysis, 20*(2), 75-93. doi:10.2307/1164375

Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students: Findings and insights from twenty years of research*. San Francisco, CA: Jossey-Bass.

Paul, R. W. (1993). The logic of creative and critical thinking. *American Behavioral Scientist, 37*(1), 21-39. doi:10.1177/0002764293037001004

Paul, R. W., Binker, A., Jensen, K., & Kreklau, H. (1990). *Critical thinking handbook: A guide for remodeling lesson plans in language arts, social studies and science*. Rohnert Park, CA: Foundation for Critical Thinking.

Paul, R. W., Elder, L., & Bartell, T. (1997). *California teacher preparation for instruction in critical thinking: Research findings and policy recommendations*. Sacramento, CA: California Commission on Teacher Credentialing.

Peel, M. J., Goode, M. H., & Moutinho, L. A. (1998). Estimating consumer satisfaction: OLS versus ordered probability models. *International Journal of Commerce and Management*, *8*(2), 75-93. doi:10.1108/eb047369

Pike, G. R. (1995). The relationship between self reports of college experiences and achievement test scores. *Research in Higher Education, 36*(1), 1-21. doi:10.1007/BF02207764

Pike, G. R. (1996). Limitations of using students' self-reports of academic development as proxies for traditional achievement measures. *Research in Higher Education, 37*(1), 89-114. doi:10.1007/BF01680043

Ramsden, P. (1979). Student learning and perceptions of the academic environment. *Higher Education, 8*(4), 411-427. doi:10.1007/BF01680529

Sanford, N. (1966). *Self and society: Social change and individual development*. New York: Atherton Press.

Smith, D. G. (1977). College classroom interactions and critical thinking. *Journal of Educational*

Psychology, 69(2), 180-190. doi:10.1037/0022-0663.69.2.180

Terenzini, P. T., Springer, L., Pascarella, E. T., & Nora, A. (1995). Influences affecting the development of students' critical thinking skills. *Research in Higher Education, 36*(1), 23-40. doi:10.1007/BF02207765

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education, 68*(6), 599-623. doi:10.2307/2959965

Tsui, L. (1999). Courses and instruction affecting critical thinking. *Research in Higher Education, 40*(2), 185-200. doi:10.1023/A:1018734630124

Tsui, L. (2002). Fostering critical thinking through effective pedagogy: Evidence from four institutional case studies. *Journal of Higher Education, 73*(6), 740-763. doi:10.1353/jhe.2002.0056

U.S. Department of Education. (2006). *A test of leadership: Charting the future of U.S. higher education*. Washington, DC: U.S. Department of Education.

Umbach, P. D., & Wawrzynski, M. R. (2005). Faculty do matter: The role of college faculty. *Research in Higher Education, 46*(2), 153-184. doi:10.1007/s11162-004-1598-1

Watson, G., & Glaser, E. M. (1952). *Watson-Glaser critical thinking appraisal*. New York: Pearson Education.

Whitt, E. J., Edison, M. I., Pascarella, E. T., Nora, A., & Terenzini, P. T. (1999). Interactions with peers and objective and self-reported cognitive outcomes across 3 years of college. *Journal of College Student Development, 40*(1), 61-78.

WOO-JEONG SHIM is a doctoral candidate at the Center for the Study of Higher and Postsecondary Education in the University of Michigan. Her research interests are college student development, gender issues in education, and college teaching and learning.

KELLEY WALCZAK is director of College Access, Readiness, and Transition at the University of Wisconsin-Parkside. Her research interests are college student learning and development, identity development of college student athletes, and college access.

Acknowledgements

An earlier draft of this paper was presented at the Annual Meeting of the Association for the Study of Higher Education, Jacksonville, FL, on November 7, 2008. The authors express gratitude to Patricia M. King, Janet H. Lawrence, and Stephen L. DesJardins for their careful review and helpful comments on the earlier drafts of this paper. They also gratefully acknowledge the sponsorship of the Center of Inquiry in the Liberal Arts at Wabash College in support of this project.

Appendix A
Sample Characteristics

Variables		Percent	
Gender	Female	63 %	
	Male	37 %	
Race	Non-white	24 %	
	White	76 %	
Class size	Large class (≥ 20)	43 %	
	Small class	57 %	
Institutional type	Research	29 %	
	Regional	19 %	
	Liberal arts	52 %	
Variables		Mean	Standard Deviation
Mother's Education (in years)		15.32	2.25
Father's Education (in years)		15.69	2.64
Family income[1]		5.66	1.90
Precollege academic ability[2]		27.16	4.20
Academic motivation		.00	.98
Pre-test CAAP scores		64.13	5.02
Post-test CAAP scores		64.68 ***[4]	5.37
Self-report gains in critical thinking[3]		2.37	.67

[1] 1 if Less than $14,999; 2 if ~ $24,999; 3 if ~ $34,999; 4 if ~ $49,999; 5 if ~ $74,999; 6 if ~ $99,999; 7~ $199,999; 8 if ~ $299,999; 9 if $300,000 or more

[2] ACT score

[3] 1 = minimal growth, 2 = medium growth, 3 = maximal growth

[4] The difference between pre-test and post-test CAAP scores is statistically significant, $t(1180)=5.2762$, $p \leq .0005$

Appendix B
Variable Definitions and Coding Schemes

Variable	Description
Outcome	
Self-reported growth in the ability of critical thinking	"Extent to which the institution contributes to the development of students' critical and analytical thinking; "1 minimum, 2 medium, 3 maximum
CAAP	Scores computed and scaled using algorithm devised by ACT
Demographics	
Gender	1 if female, 0 otherwise
Race/ethnicity	1 if white, 0 otherwise
Mother's education / Father's education	11 if did not finish high school; 12 if High school graduate; 13 if Attended college but no degree; 14 if Vocational certificate or 2-year degrees; 16 if Bachelors or other 4-year degree; 18 if Masters; 19 if Law school; 20 if Doctorate
Family income	1 if Less than $14,999; 2 if ~ $24,999; 3 if ~ $34,999; 4 if ~ $49,999; 5 if ~ $74,999; 6 if ~ $99,999; 7~ $199,999; 8 if ~ $299,999; 9 if $300,000 or more
Precollege academic ability	Common high school achievement metric calculated either from SAT or ACT scores
Academic motivation	composite mean of four items measuring academic motivation (e.g., willingness to work hard to learn even if it won't lead to a higher grad)
Institutional Characteristics	
Research university	1 if research university, 0 otherwise
Regional university	1 if regional university, 0 otherwise
Liberal Arts university	reference category
Average class size	1 if larger than 15, 0 otherwise
Instructional practices in class	
Asking challenging questions	5 point scale: 1 = never, to 5 = very often
Asking students to apply	5 point scale: 1 = never, to 5 = very often
Asking students to defend point of view	5 point scale: 1 = never, to 5 = very often
Interpreting abstract concepts	5 point scale: 1 = never, to 5 = very often
Well-organized presentation	5 point scale: 1 = never, to 5 = very often
Assignment Types	
Writing	5 point scale: 1 = never, to 5 = very often
Problem solving	5 point scale: 1 = never, to 5 = very often
Class presentation	4 point scale: 1 = never, to 4 = very often
Group project	4 point scale: 1 = never, to 4 = very often
Assignment Characteristics	
Application	5 point scale: 1 = never, to 5 = very often
Compare & contrast	5 point scale: 1 = never, to 5 = very often
Defend point of view	5 point scale: 1 = never, to 5 = very often
Integration of ideas	4 point scale: 1 = never, to 4 = very often
Faculty Feedback	4 point scale: 1 = never, to 4 = very often

[1] Percent of students who respond with each response category
[2] Number of students who respond with each response category