DOCUMENT RESUME

ED 374 729 HE 027 735

AUTHOR Pascarella, Ernest; And Others
TITLE Is Differential Exposure to College Linked to the Development of Critical Thinking?
INSTITUTION Illinois Univ., Chicago. Coll. of Education.; National Center on Postsecondary Teaching, Learning, and Assessment, University Park, PA.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE [94]
CONTRACT R117G10037
NOTE 33p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS College Credits; College Freshmen; College Outcomes Assessment; Colleges; College Students; *Critical Thinking; Higher Education; Intellectual Development; Outcomes of Education; *Student Development; *Thinking Skills; Two Year Colleges; *Two Year College Students; *Undergraduate Study
IDENTIFIERS *National Study of Student Learning

ABSTRACT

This study, part of the National Study of Student Learning, investigated the influence of differential exposure to postsecondary education, particularly the impact of type of institution, number of credit hours, and other factors on gains in critical thinking skills. the sample was 2,092 first-year students attending 13 four-year and 4 two-year institutions from around the nation. The findings from the four-year college sample suggest that amount of exposure to postsecondary education, operationalized as number of semester hours taken, had a modest, positive effect on end-of-first-year critical thinking. Moreover, this effect persisted even in the presence of controls for precollege critical thinking skill and academic motivation, the average critical thinking of the first-year class at the institution attended, gender, race, age, work responsibilities, and types of courses taken during the first year of college. The findings for the two-year sample were also that level of exposure to postsecondary education had a significant, positive, linear effect on critical thinking at the end of the first year that persisted even in the presence of the same statistical controls. The two-year full-time college students derived the largest critical thinking benefits from their college exposure. (Contains 38 references.) (JB)

IS DIFFERENTIAL EXPOSURE TO COLLEGE LINKED TO THE DEVELCPMENT OF CRITICAL THINKING?*

Ernest Pascarella
Louise Bohr
Amaury Nora
University of Illinois

Patrick Terenzini
Pennsylvania State University

Mailing Address:
Ernest Pascarella
College of Education (M/C 147)
University of Illinois
1040 W. Harrison Street
Chicago, Illinois 60607-7133

*This investigation was conducted as part of the National Study of Student Learning (NSSL) at the University of Illinois at Chicago. NSSL is supported by Grant No.: R11G10037 from the U.S. Department of Education to the National Center on Postsecondary Teaching, Learning, and Assessment (NCTLA). The first author also received support for his work on this article as the University of Illinois Foundation James F. Towey University Scholar.

Abstract

This study investigated the influence on critical thinking of differential exposure to postsecondary education. The sample was 2092 first-year students attending 13 four-year and 4 two-year institutions from around the country. In the presence of controls for precollege critical thinking and academic motivation, the average critical thinking of first-year students at the institution attended, gender, race, age, and kinds of courses taken, the number of semester hours for which the student was enrolled had modest but significant positive effects on end-of-first-year critical thinking for both the two- and four-year college sample. In the two-year, but not the four-year, sample the relationship between semester hours and critical thinking deviated significantly from linearity. Students attending a two-year college full-time still derived the largest critical thinking benefits. However, the lowest levels of critical thinking accrued to those enrolled between 7-20 semester hours. Students enrolled for 6 or less hours actually had somewhat higher end-of-first-year critical thinking.

A substantial body of inquiry has focused on the extent to which college attendance fosters student learning (e.g. Astin, 1993; Bowen, 1977; Pascarella, 1985; Pascarella & Terenzini, 1991). The findings of this inquiry suggest two major conclusions. First, students appear to make statistically significant and, in some cases, substantial gains during college on standardized measures of specific content knowledge and academic skills such as those developed by the American College Testing Program or the Educational Testing Service (e.g., Dumont & Troelstrup, 1981; Harris, 1970; Harris & Hurst, 1972; Lenning, Munday, & Maxey, 1969; Pace, 1979; Pascarella & Terenzini, 1991). Second, individuals who are exposed to postsecondary education make significant gains in vocabulary knowledge and mathematical skills and demonstrate a greater knowledge of public affairs, history, science, and government than individuals whose formal education ends with secondary school. These differences remain statistically reliable even after variations salient background characteristics (e.g., academic aptitude, socioeconomic origins, age, race) between college and non-college individuals are taken into account (e.g., Hyman, Wright, & Reed, 1975; Wolfle, 1980, 1983, 1987; Robertshaw & Wolfle, 1982).

The acquisition of verbal, quantitative, and subject matter competence, while a central mission of postsecondary institutions, has not been the only way in which colleges have sought to influence students' intellectual growth. A major aim of American postsecondary education has been to improve students'

ability to think critically. While there are various definitions of critical thinking, a constituent set of intellectual skills would appear to involve all or some of the following: identifying central issues or assumptions in an argument, making correct inferences from data, deducing conclusions from information or data provided, interpreting whether conclusions are warranted on the basis of data given, and evaluating the validity of an argument (Brabeck & Wood, 1990 ; Furedy & Furedy, 1985; McMillan, 1987; Pascarella & Terenzini, 1991). One needs only to examine recent catalogues or bulletins of undergraduate institutions to see "critical thinking" or a closely related term employed to define one of the essential outcomes of an undergraduate education. Moreover, as pointed out by McMillan (1987), two influential national reports published in the mid 1980s, Integrity in the College Curriculum (Association of American Colleges, 1985) and Involvement in Learning (National Institute of Education, 1984), have stressed the enhancement of critical thinking as one of the indispensable impacts of an undergraduate education.

Not surprisingly, the assessment of changes or growth in critical thinking during college has been the focus of considerable research (e.g., Dressell and Mayhew, 1954; Keely, Browne, & Kreutzer, 1986; Lehmann, 1963, 1968; Mentkowski & Strait, 1983; Pascarella, 1989; Steele, 1986; Winter, McClelland & Stewart, 1981). A comprehensive and carefully conducted synthesis of the research by McMillan (1987) reviewed 27 studies.

One major conclusion of this review was that students do, in fact, make statistically significant, and in some cases substantial, gains in their ability to think and reason critically during college. Of course a major problem with such a conclusion is that in accounting for these gains it is extremely difficult, if not impossible, to separate the unique impact due to college from the impact of potentially confounding influences such as maturation (Pascarella, 1985, 1987).

A small body of research has attempted to estimate the unique or net impact of exposure to postsecondary education on critical thinking. Most of this research uses cross-sectional designs that compare the critical thinking of a cohort of freshmen with a separate cohort of seniors or upper-classmen, while statistically controlling for academic aptitude or precollege academic achievement. With the exception of Mentkowski and Strait (1983), the weight of evidence in this research suggests that seniors or upper-classmen have significantly better critical thinking skills than freshmen, even after controls are made for academic aptitude or precollege achievement (Keely, Browne & Kreutzer, 1982; Steele, 1986; Whitla, 1978). It is not clear, however, that such cross-sectional studies adequately control for the confounding effects of maturation. Pascarella (1989) reports the results of the only longitudinal study that addresses the net impact of college attendance on critical thinking. In the presence of controls for such factors as precollege critical thinking, academic aptitude,

secondary school grades, family socioeconomic status, and educational aspirations, a sample of 30 students who attended college had significantly higher critical thinking scores after one year than a sample of 17 students whose formal education ended with secondary school.

Taken in the context of the evidence from cross-sectional studies, the longitudinal findings reported by Pascarella (1989) suggest that postsecondary education may well have a positive influence on critical thinking. Yet, apart from the problems inherent in cross-sectional studies, the longitudinal study conducted by Pascarella is also limited. First, the study may have quite limited generalizability. The sample was extremely small (N=47), selective (average ACT score greater than 25), and was drawn from five secondary schools in a single metropolitan area. Second, the small sample size afforded very limited statistical power to detect the presence of conditional (or interaction) effects. That is, do the effects on critical thinking of differential exposure to college vary in magnitude for different kinds of students (e.g., students differing in age, race, gender, precollege critical thinking level)? Finally, all of the existing research on the net effects of college on critical thinking has been conducted on four-year college samples. Little or no inquiry has focused on the extent to which differential exposure to postsecondary education influences critical thinking for two-year as well as four-year college students.

The present study sought to address these problems in the existing research in a longitudinal and multiinstitutional investigation of the impact of differential exposure to postsecondary education on first-year critical thinking. Specifically, the study had two objectives. First, it attempted to assess the extent to which the number of credit hours taken during the first year of college was differentially related to first-year critical thinking for students in two-year and four-year colleges. Second, it assessed the extent to which the effects on first-year critical thinking of differential exposure to college (i.e., number of credit hours taken) differed in magnitude for different kinds of students.

METHOD

Initial Institutional Sample

The sample was selected from incoming freshman students at 18 four-year and 5 two-year colleges and universities located in 16 different states throughout the country. Institutions were selected from the National Center on Education Statistics IPEDS data base to represent differences in colleges and universities nationwide on a variety of characteristics, including institutional type and control (e.g., private and public research universities, private liberal arts colleges, public and private comprehensive universities, two-year colleges, historically black colleges), size, location, commuter versus residential, and the ethnic distribution of the undergraduate student body. In

aggregate, the student population of those 23 schools approximated the national population of undergraduates by ethnicity and gender.

Initial Student Sample and Instruments

The individuals in the overall sample were 2685 first-year students who participated in the National Study of Student Learning (NSSL), a large longitudinal investigation of the factors that influence learning and cognitive development in college. The research was sponsored by the federally-funded National Center on Postsecondary Teaching, Learning, and Assessment. The initial sample was, as far as possible, selected randomly from the incoming freshman class at each participating institution. The students in the sample were informed that they would be participating in a national longitudinal study of student learning and that they would receive a stipend for their participation. They were also informed that the information they provided would be kept confidential and would never become part of their institutional record.

An initial data collection was conducted in the Fall of 1992. The data collection lasted approximately three hours and students were paid a stipend of $25 by the National Center on Postsecondary Teaching, Learning, and Assessment. Students were reminded that the information they provided would be kept in the strictest confidence and that all that was expected of them was that they give an honest effort on tests and a candid response to

all questionnaire items. The data collected included a precollege survey that gathered information on student demographic characteristics and background, as well as aspirations, expectations of college, and a series of items assessing their orientation toward learning. Participants also completed Form 88A of the Collegiate Assessment of Academic Proficiency (CAAP). The CAAP was developed by the American College Testing Program (ACT) specifically to assess selected general skills typically acquired by students during the first two years of college (ACT, 1990). The total CAAP consists of five 40-minute, multiple-choice test modules, one of which, critical thinking, is the focus of this study.

The critical thinking test is a 32-item instrument that measures the ability to clarify, analyze, evaluate, and extend arguments. The test consists of four passages that are designed to be representative of the kinds of issues commonly encountered in a postsecondary curriculum. A passage typically presents a series of subarguments that support a more general conclusion. Each passage presents one or more arguments and uses a variety of formats, including case studies, debates, dialogues, overlapping positions, statistical arguments, experimental results, or editorials. Each passage is accompanied by a set of multiple choice items. The KR-20 reliability coefficients for the critical thinking test ranged from .81 to .82 (ACT, 1990). In pilot testing various instruments for use in the National Study of Student Learning on a sample of 30 college students, the

critical thinking test of the CAAP was found to correlate .75 with the total score on the Watson-Glaser Critical Thinking Appraisal. The Watson-Glaser Critical Thinking Appraisal is, by far, the most commonly employed objective measure of critical thinking (McMillan, 1987).

Each of the 23 institutions was given a target sample size relative in magnitude to the respective sizes of the freshman class at each institution. The overall target sample for the fall 1992 data collection at the 23 institutions was 5,000. The overall obtained sample size, (i.e., those students actually tested) for the Fall 1992 data collection was 3,840, or a response rate of 76.8%.

A follow-up testing of the sample took place in the spring of 1993. This data collection required about 3 1/2 hours and included an extensive set of measures of the students' freshman-year experience, including number of credit hours taken, and Form 88B of the Collegiate Assessment of Academic Proficiency. Students were paid a second stipend of $35 by the National Center on Postsecondary Teaching, Learning, and Assessment for their participation in the follow-up data collection. Of the original sample of 3,840 students who participated in the Fall, 1992 testing, 2,685 participated in the Spring, 1993 data collection, for a follow-up response rate of 69.92%.

Given the high response rates at both testings it is not particularly surprising that the sample was reasonably representative of the population from which it was drawn.

However, to adjust for potential response bias by gender, ethnicity, and institution, a sample weighting algorithm was developed. Specifically, within each individual institution participants in the follow-up data collection were weighted up to the institution's freshman population by gender (male or female) and ethnicity (white, black, hispanic, other). Thus, for example, if institution A had 100 black men in its freshman class and 25 black men in the sample, each black male in the sample was given a sample weight of 4.00. An analogous weight was computed for participants falling within each gender x ethnicity cell within each institution. The effect of applying sample weights in this manner was to adjust, not only for response bias by gender and ethnicity, but also for response bias (i.e., differential response rate) by institution.

Final Sample

Because the question in the follow-up instrument asking students to indicate the number of credit hours taken during the first year of college was on a scale that best fit the semester system, there was a concern that it might not provide the same sensitivity of measurement for institutions on a different academic calendar (e.g., the quarter or trimester system). Consequently, rather than risk this as a potentially uncontrolled factor in our findings we confined our analyses to students from those institutions in the sample that were on the semester system. This provided a final sample of 2076 students from 17

two- and four-year colleges located in 15 different states throughout the country. The four-year college sample was 1860 students attending 13 four-year institutions, while the two-year college sample consisted of 216 students at four two-year colleges.

Variables and Analytical Model

The dependent variable in the study was the Spring 1993 score on the CAAP critical thinking test. The independent variable of interest was exposure to postsecondary education operationalized as the number of semester hours taken during the first year of college. This was a self-reported item on the Spring 1993 follow-up questionnaire that was coded: 1 = "6 or fewer," 2 = "7-11 hours," 3 = "12-15 hours," 4 = "16-20 hours," 5 = "21-24 hours," and 6 = "more than 24 hours." It was highly likely that the sample correlation between exposure to postsecondary education and Spring 1993 critical thinking was spuriously inflated by the presence of other causal influences. Consequently, in order to obtain a more accurate estimate of the net impact of exposure to postsecondary education on first-year critical thinking, it was necessary to include as many of these other causal influences as possible in the analytic model. In selecting these other causal influences for inclusion in the analytic model we were guided by the existing body of evidence on the factors independently influencing learning and cognitive development during college (e.g., Astin, 1968, 1977, 1993; Astin

& Panos, 1969; Kuh, 1993; Pascarella & Terenzini, 1991). The other causal influences in the model were operationalized as follows:

1. Individual Fall, 1992 (precollege) CAAP critical thinking scores.

2. Gender: coded 2 = female, 1 = male.

3. Ethnicity: coded 2 = non-white, 1 = white.

4. Fall, 1992 (precollege) academic motivation: an eight-item, Likert-type scale (5 = strongly agree to 1 = strongly disagree) with an internal consistency reliability of .65. The scale items were developed specifically for the NSSL, and were based on existing research on academic motivation (e.g., Ball, 1977). Examples of constituent items are: "I am willing to work hard in a course to learn the material, even if it won't lead to a higher grade," "When I do well on a test it is usually because I was well prepared, not because the test was easy," "In high school I frequently did more reading in a class than was required simply because it interested me," and "In high school I frequently talked to my teachers outside of class about ideas presented during class."

5. Age: age in years in Fall, 1992.

6. Work Responsibilities: average number of hours per week worked on- or off-campus during the first year of college: coded 1 = "none" to 9 = "more than 35 hours." (taken from the follow-up questionnaire).

7-11. Number of courses taken during the first year of

college in five different areas: natural science (e.g., biology, chemistry, engineering, geology, physics); arts and humanities (e.g., art history, composition, English literature, foreign languages, philosophy, classics); social sciences (e.g., economics, psychology, history, sociology, political science, social work); mathematics (e.g., algebra, calculus, statistics, computer science, geometry, matrix algebra); and technical or pre-professional (e.g., business, education, physical education, nursing, physical therapy, drafting). Respondents were given 61 different courses across the five broad areas to select from, and were asked to indicate how many of each of the 61 courses they had taken during their first year of college (coded from 0 to 5). This information was taken from he follow-up questionnaire.

Because the existing body of evidence suggests that institutional context can play a role in shaping the impact of college in indirect, if not direct, ways, we also included one institutional-level variable in the analytic model. This was:

12. The average level of critical thinking in each institution's first-year class: this was estimated by the average precollege (Fall, 1992) CAAP critical thinking score for the sample of first-year students at each of the 17 institutions. Each individual student in the sample was then given the mean of his or her institution on the CAAP critical thinking test.

The first stage in the analysis sought to estimate the net impact of exposure to postsecondary education on end-of-first year critical thinking. Thus, using ordinary least squares, end-

of-first-year critical thinking (i.e., Spring, 1993 CAAP critical thinking score) was regressed on all 12 potentially confounding influences plus number of semester hours taken during the first year of college. Separate analyses were conducted for students attending two- and four-year colleges.

In the second stage of the analyses we tested for the presence of conditional effects (Pedhazur, 1982). A series of cross-product terms was computed between hours enrolled during the first year of college and each of the other 12 variables in the model. These were then added to the regression model employed in the first stage of the analyses (i.e., the main-effects model). A statistically significant increase in explained variance in critical thinking attributable to the cross-product terms (over and above the main-effects model) indicates that the net effects on critical thinking of exposure to postsecondary education vary in magnitude for students at different levels on the other variables in the prediction model. Once again, separate analyses were conducted for the two- and four-year college samples.

Weighted sample estimates, adjusted to the actual sample sizes to obtain correct standard errors, were used in all analyses. Because of its large size (N=1876) a critical alpha level of .01 was used in all four-year college analyses. A critical alpha level of .05 was used for all two-year college analyses because of the smaller sample size (N=216).

RESULTS

Table 1 summarizes the parameter estimates for the net effects of hours of enrollment on first-year critical thinking. The "b" column is the unstandardized regression coefficient, the "Beta" column is the standardized regression coefficient, and the "t" column indicates whether or not the regression coefficients are significantly greater than zero. As the table shows, in the presence of controls for all other variables in the equations, semester hours enrolled during the first year of college had a statistically significant, positive, net effect on end-of-first-year critical thinking for both the two-year and four-year college samples. The linear direct effect on critical thinking of hours enrolled was somewhat more pronounced at four-year than at two-year colleges. Using the unstandardized regression coefficients for between-sample comparisons (Pascarella & Terenzini, 1991), it can be seen that effect of hours enrolled at four-year institutions (.458) was about 1.56 times as large as the corresponding effect at two-year institutions (.294). This difference in the magnitude of between-sample regression coefficients was, however, not statistically significant.

Place Table 1 About Here

The unstandardized linear regression coefficients can also be used to estimate the average net increase in critical thinking associated with each individual increase in the six categories of

semester hours taken. For the four-year sample each increase in semester-hours taken was associated with a net increase of .458 of point in end-of-first year critical thinking. Thus, on average, students attending college full-time (24 semester hours or more) had a 2.29 point net advantage (.458 x 5) in critical thinking over students enrolled in college for only 6 or fewer semester hours. Dividing 2.29 by the standard deviation of end-of-first-year critical thinking (5.59) converts to an estimated effect size advantage of .41 of a standard deviation or 15.9 percentile points. (Glass, McGaw & Smith, 1981; Light & Pillemer, 1982). (That is, if four-year college students enrolled for 6 or fewer semester hours are at the 50th percentile in critical thinking at the end of the first year of college, students enrolled for 24 hours or more are performing at about the 66th percentile.) For the two-year college sample students attending college full-time had 1.47 point net advantage in critical thinking over students enrolled in college for 6 or fewer semester hours. This converted to an estimated effect size advantage of .24 of a standard deviation or 9.5 percentile points. Thus, if two-year college students enrolled for 6 or fewer semester hours are performing at the 50th percentile in end-of-first-year critical thinking, students enrolled for 24 semester hours or more are performing at about the 60th percentile.

The second stage of the data analyses sought to determine if the effects on critical thinking of hours enr lled were general or conditional. The addition of the sets of cross-product terms to the main-effects model was associated with non-significant

increases in explained variance in critical thinking for both the two- and four-year samples. This suggests that the linear estimates of the effects of semester hours enrolled on first-year critical thinking are similar in magnitude for two- and four-year college students at different levels of the other variables in the prediction equations shown in Table 1 (e.g., precollege critical thinking and academic motivation, gender, race, age, work responsibilities, kinds of coursework taken).

ADDITIONAL ANALYSES

We suspected that the net relationship between semester hours enrolled and end-of-first-year critical thinking might not be adequately described by the linear regression coefficients shown in Table 1. Consequently, we tested for the presence of a significant curvilinear relationship by adding a quadratic term $(\text{hours enrolled})^2$ to the 13-variable linear equations (Pedhazur, 1982). The addition of the quadratic term was not associated with a significant R^2 increase in the four-year college sample (t-ratio for the quadratic term = 1.26, $p > .05$). Thus we concluded that the linear regression coefficient alone adequately described the net effect of semester hours enrolled on critical thinking for the four-year college sample.

The addition of the quadratic term in the two-year college sample was associated with a significant R^2 increase (t-ratio for the quadratic term = 2.51, $p < .05$). This evidence indicated

that the net impact of semester hours enrolled on critical thinking was not adequately described by the linear regression coefficient. Using the regression equation in Table 2, the net curvilinear relationship between semester hours enrolled and end-of-first-year critical thinking was plotted for the two-year college sample. This curvilinear relationship is shown in Figure 1. As Figure 1 indicates, two-year college students attending full-time (more than 24 semester hours) did substantially better than all their counterparts who were enrolled for fewer hours. However, the lowest levels of critical thinking were shown by students enrolled for between 12-15 hours during the first year of college. Students enrolled for six or fewer semester hours actually showed somewhat greater critical thinking development than then counterparts enrolled for between 7 and 20 hours.

Place Table 2 and Figure 1 About Here

CONCLUSIONS

The vast majority of research on critical thinking has focused almost exclusively on the gains made by college students. A literature review uncovered only one, somewhat limited, longitudinal study that attempted to assess the unique or net effect of college attendance on critical thinking. The present longitudinal study sought to determine the net effect of differential exposure to postsecondary education on the first-

year critical thinking of 2092 students attending 13 four-year and 4 two-year colleges from 15 states around the country.

The findings from the four-year college sample suggest that amount of exposure to postsecondary education, operationalized as number of semester hours taken, had a modest, positive effect on end-of-first-year critical thinking. Moreover, this positive effect persisted even in the presence of controls for precollege critical thinking and academic motivation, the average critical thinking of the first-year class at the institution attended, gender,race, age, work responsibilities, and types of courses taken during the first year of college. The findings also suggest that the positive effect on critical thinking of exposure to postsecondary education for four-year college students is general rather than conditional. That is, it appears to be similar in magnitude for students with different precollege, ascribed, and other characteristics (e.g., precollege critical thinking and academic motivation, race, gender, age, work responsibilities, and kinds of courses taken). Exposure to postsecondary education also appears to have the same net effect on individual student critical thinking irrespective of the average level of critical thinking of the students at the institution attended.

It is interesting to compare the findings of this investigation with those of previous longitudinal assessments of the net effects of college on critical thinking. In Pascarella's (1989) study 30 students who attended college full time had a net

advantage after one year of .44 of a standard deviation, or 17 percentile points, in critical thinking (as measured by the Watson-Glaser Critical Thinking Appraisal) over 17 similar students who did not attend college. The present study found that students attending a four-year college full-time (more than 24 semester hours) had a net advantage after one academic year of .41 of a standard deviation, or 15.9 percentile points, in critical thinking (as measured by the Critical Thinking Test of the Collegiate Assessment of Academic Proficiency) over similar students enrolled for six hours or less during the first year of college. Thus, our four-year college findings, based on a much larger multiinstitutional sample, with a different operational definition of exposure to college, and using a different measure of critical thinking, are quite consistent, if not totally replicatory, of the single existing longitudinal study on the topic. For four-year college students college attendance appears not only to have a net, positive, impact on the development of critical thinking, but the more a student is exposed to the academic experience of college the larger the net positive impact on his or her growth in critical thinking.

The findings for the two-year college sample are in some ways consistent with those from the four-year sample, but in other ways different. As with the four-year sample, level of exposure to postsecondary education had a significant, positive, linear effect on end-of-first-year critical thinking that persisted even in the presence of the same statistical controls.

Similarly, as with the four-year sample, the positive effect on critical thinking of level of exposure to postsecondary education was general rather than conditional. That is, it appeared to be similar in magnitude for students differing on such characteristics as precollege critical thinking and academic motivation, gender, race, age, work responsibilities and kinds of courses taken. The major difference between the two- and four-year college findings was that, in the former, the net relationship between level of exposure to postsecondary education and first-year critical thinking showed a significant deviation from linearity. Consistent with the four-year findings, students attending a two-year college full-time (more than 24 semester hours) clearly derived the largest critical thinking benefits. However, the lowest level of critical thinking was demonstrated by students enrolled for between 7 and 20 hours, with somewhat larger benefits accruing to those enrolled for less than 6 semester hours. The explanation for this curvilinear effect is not readily apparent. It may simply be an anomaly in our data manifest because of the rather small two-year college sample (N=216). Nevertheless, such a finding suggests the importance of testing for the presence of non-linear relationships in estimating the impact of level of exposure to postsecondary education on the outcomes of the collegiate experience.

Perhaps the most confirmatory findings of the study with respect to the intellectual impact of college is that students attending either a two- or four-year institution full-time

achieved greater levels of critical thinking during the first year of college than students enrolled part-time. The causal mechanisms underlying this influence, however, may be a bit more subtle than merely variations in exposure to the academic experience of college. Evidence reviewed by Pascarella and Terenzini (1991) suggests that for such general cognitive outcomes as critical thinking the impact of any one academic or non-academic experience may not be as important as the student's total level of engagement in the academic and social systems of the institution. Thus, particularly in four-year institutions, full-time enrollment may be a partial proxy for the fact that students attending college full-time are also more likely than their non full-time counterparts to become involved in the mutually reinforcing academic and social experiences that foster intellectual development (e.g. informal interaction with faculty and peers, involvement in clubs, organizations, and cultural events, residing on campus, etc.). Of course this is not to say that exposure to the academic experience of college is unimportant. Although the effect was not as pronounced as in the four-year sample, full-time students in two-year institutions, where no one lived on-campus, still derived larger critical thinking benefits than those enrolled for fewer semester hours. This suggests that the academic experience itself may be a significant part of the impact.

LIMITATIONS

This investigation has several limitations that should be kept in mind when interpreting the findings. First, although the overall sample is multiinstitutional and consists of a broad range of two- and four-year institutions from around the country, the fact that the analyses were limited to 17 institutions on the semester system means that we cannot necessarily generalize the results to all two- and four-year institutions. Similarly, although attempts were made in the initial sampling design, and subsequent sample weighting, to make the sample as representative as possible at each institution, the time commitment and work required of each student participant undoubtedly led to some self-selection. We cannot be sure that those who were willing to participate in the study responded in the same way as would those who were invited but declined to participate in the study. Weighed against this, however, is the fact we found no significant conditional effects involving such factors as age, precollege critical thinking and academic motivation, work responsibilities or kinds of courses taken. Thus, even if the sample had some bias on these factors it did not appear to have an appreciable influence on the study results. Third, while we looked at one important measure of cognitive development in college (the ability to think critically), this is certainly not the only dimension along which students develop intellectually during the college years. Alternative conceptualizations or approaches to the assessment of cognitive development might have

produced findings different from those yielded by this investigation. Finally, this study is limited by the fact that it was only able to trace cognitive growth over the first year of college. We cannot be sure that the effects we observed would persist over subsequent years.

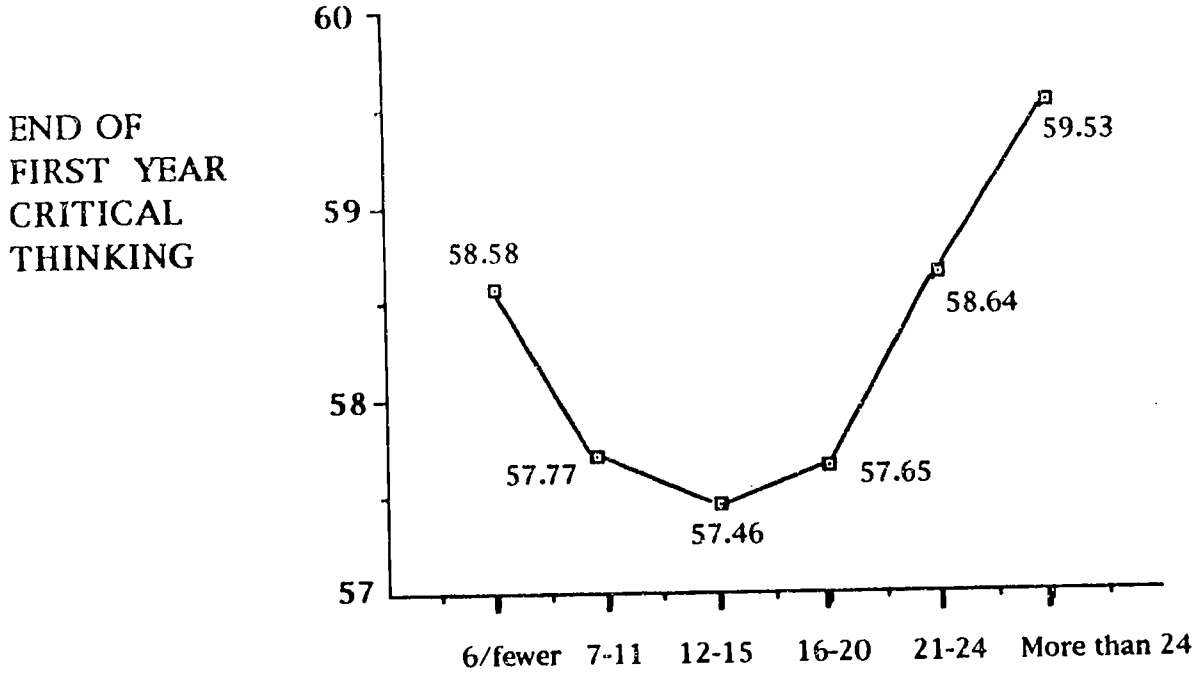
END OF
FIRST YEAR
CRITICAL
THINKING
60
59
58
57
58.58
57.77
57.46
57.65
58.64
59.53
6/fewer
7-11
12-15
16-20
21-24
More than 24
SEMESTER HOURS ENROLLED
DURING FIRST YEAR OF COLLEGE

TABLE 1
PARAMETER ESTIMATES FOR EFFECTS OF SEMESTER HOURS ENROLLED ON END-OF FIRST-YEAR CRITICAL THINKING[a]

	Two-Year Colleges			Four-Year Colleges		
PREDICTOR	b	Beta	t	b	Beta	t
Precollege Critical Thinking	.504	.482	9.25***	.699	.660	35.28***
Average Critical Thinking of First-Year Class	.730	.295	4.59***	.098	.037	1.91
Precollege Academic Motivation	-.695	-.037	1.77	.036	.004	.26
Female	-.381	-.031	.77	.226	.020	1.25
Non-White	-.452	- .037	.60	-.764	-.068	3.63**
Age	.042	.038	.93	.047	.031	1.92
Work Responsibilities	.023	.010	.25	-.043	-.021	1.25
Number of Courses Taken in Arts and Humanities	.434	.130	2.60**	.048	.022	1.26
Number of Courses Taken in Natural Sciences and Engineering	.641	.125	3.00**	.092	.025	1.47
Number of Courses Taken in Social Sciences	-.126	-.033	.76	.102	.036	2.16
Number of Courses Taken in Mathematics and Statistics	-.772	-.189	4.29***	.018	.004	.22
Number of Courses Taken in Technical/Pre-Professional Areas	-.224	-.054	1.34	-.228	-.050	2.95**
Semester Hours Enrolled During the First Year of College	.294	.086	2.00*	.458	.113	6.80***
R^2	.712***			.572***		

[a]Means, standard deviations, and intercorrelations among all variables are available from the first author.

*p < .05
**p < .01
***p < .001

TABLE 2

REGRESSION EQUATION DESCRIBING THE CURVILINEAR EFFECT OF SEMESTER HOURS ENROLLED ON END-OF-FIRST-YEAR CRITICAL THINKING FOR TWO-YEAR COLLEGE STUDENTS

PREDICTOR	Unstandardized Regression Weight (b)
Precollege Critical Thinking	.483
Average Critical Thinking of First-Year Class	.715
Precollege Academic Motivation	-.739
Female	-.384
Non-White	-.572
Age	.052
Work Responsibilities	.017
Number of Courses Taken in Arts and Humanities	.505
Number of Courses Taken in Natural Sciences and Engineering	.652
Number of Courses Taken in Social Sciences	-.167
Number of Courses Taken in Mathematics and Statistics	-.713
Number of Courses Taken in Technical/Pre-Professional Areas	-.288
Semester Hours Enrolled During the First Year of College	-1.557
(Semester Hours Enrolled During the First Year of College)^2	.247
Constant	-7.628

References

American College Testing Program. (1990). Report on the technical charactristics of CAAP: Pilot Year 1: 1988-89. Iowa City, Iowa: Author.

Association of American Colleges (1985). Integrity in the college curriculum: A report to the academic community. Washington, D.C.: Association of American Colleges.

Astin, A. (1968). Undergraduate achievement and institutional "excellence". Science, 161, 661-668.

Astin, A. (1977) Four critical years. San Francisco: Jossey-Bass.

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

Astin, A. & Panos, R. (1969). The educational and vocational development of college students. Washington: American Council on Education.

Ball, S. (Ed.), (1977). Motivation in education. New York: Academic Press.

Bowen, W. (1977). Investment in learning: The individual and social value of American higher education. San Francisco: Jossey-Bass.

Brabeck, M. & Wood, P. (1990). Cross-sectional and longitudinal evidence for differences between well-structured and ill-structured problem solving abilities. In M. Commons, C. Armon, L. Kohlberg, F. Richards, T. Grotzer, and J. Sinnott (Eds.), Adult development 2: Models and methods in the study of adolescent and adult thought. New York: Praeger.

Dressel, P. & Mayhew, L. (1954). General education: Exploration in evaluation. Westport, Conn: Greenwood Press.

Dumont, R. & Troelstrup, R. (1981). Measures and predictors of educational growth with four years of college. Research in Higher Education, 14, 31-47.

Furedy, C. & Furedy, J. (1985). Critical thinking: Toward research and dialogue. In J. Donald and A. Sullivan (Eds.). Using research to improve teaching. San Francisco: Jossey-Bass, pp. 51-69.

Glass, G., McGaw, B. & Smith, M. (1981). Meta-analysis in social research. Beverly Hills, Calif.: Sage.

Harris, J. (1970). Gain scores on the CLEP General Examination and an overview of research. Paper

presented at the annual meeting of the American Educational Research Association, Minneapolis.

Harris, J. & Hurst, P. (1972). Does college assure academic growth? Change, 4, 8-9, 60.

Hyman, H., Wright, C. & Reed, J. (1975). The enduring effects of education. Chicago: University of Chicago Press.

Keeley, S., Browne, M. & Kreutzer, J. (1982). A comparison of freshmen and seniors on general and specific essay tests of critical thinking. Research in Higher Education, 17, 139-154.

Kuh, G. (1993). In their own words: What students learn outside the classroom. American Educational Research Journal, 30, 277-304.

Lehmann, I. (1963). Changes in critical thinking, attitudes and values from freshman to senior years. Journal of Educational Psychology, 54, 305-315.

Lehmann, I. (1968). Changes from freshman to senior years. In K. Yamamoto (Ed.). The college student and his culture. Boston: Houghton Mifflin.

Lenning, O., Munday, L. & Maxey, J. (1969). Student educational growth during the first two years of college. College and University, 44, 145-153.

Light, R. & Pillemer, D. (1982). Numbers and narrative: Combining their strengths in research reviews. Harvard Educational Review, 52, 1-26.

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

Mentkowski, M. & Strait, M. (1983). A longitudinal study of student change in cognitive development learning styles, and generic abilities in an outcome-centered liberal arts curriculum. Final Report number 6, Office of Research and Evaluation, Alverno College.

National Institute of Education. (1984). Involvement in learning: Realizing the potential of American higher education. Washington, D.C.: U.S. Government Printing Office.

Pace, C.R. (197). Measuring outcomes of college: Fifty years of findings and recommendations for the future. San Francisco: Jossey-Bass.

Pascarella, E. (1985). College environmental influences on learning and cognitive development: A

critical review and synthesis. In J. Smart (Ed.). Higher education: Handbook of theory and research. Vol. I. New York: Agathon.

Pascarella, E. (1987). Are value-added analyses valuable? In Assessing the outcomes of higher education: Proceedings of the 1986 ETS Invitational Conference. Princeton, N.J.: Educational Testing Service.

Pascarella, E. (1989). The development of critical thinking: Does college make a difference? Journal of College Student Development, 30, 19-26.

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

Pedhazur, E. (1982). Multiple regression in behavioral research: Explanation and prediction (2nd ed.). New York: Holt, Rinehart & Winston.

Robertshaw, D. & Wolfle, L. (1982). The cognitive value of two-year colleges for whites and lacks. Integrated Education, 19, 68-71.

Steele, J. (1986). Assessing reasoning and communication skills of postsecondary students. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Whitla, D. (1978). Value added: Measuring the impact of undergraduate education. Cambridge, Massachusetts. Office of Instructional Research and Evaluation, Harvard University.

Winter, D., McClelland, D. & Stewart, A. (1981). A new case for the liberal arts. San Francisco: Jossey-Bass.

Wolfle, L. (1980). The enduring effects of education on verbal skills. Sociology of Education, 53, 104-114.

Wolfle, L. (1983). Effects of higher education on achievement for blacks and whites. Research in Higher Education, 19, 3-9.

Wolfle, L. (1987). Enduring cognitive effects of public and private schools. Educational Researcher, 16, 5-11.