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ABSTRACT

This report quantitatively shows the progress of students in the area of general education development at College of DuPage (Illinois). The aims of general education are to promote students' understanding and appreciation of their culture and environment; to develop a system of personal values based on accepted ethics that lead to civic and social responsibility; and to attain skills in analysis, communication, and quantification, leading to development of lifelong learning. In response to assessment challenges, and to provide a means of comparison, the college randomly selected students to take one of the six College Assessment of Academic Proficiency (CAAP) area tests. A total of 1154 tests were administered to students at the beginning and towards the end of their studies. Slightly more than half of the examinees identified themselves as female, 76 percent were enrolled full-time, and roughly half of the students indicated that their primary goal was transferring to a four year university. Compared with national community college norms, the freshman appeared to be significantly higher in general education skills of essay writing and mathematics, but no different in writing, reading, critical thinking and science reasoning skills. DuPage sophomore students score significantly higher in mathematics and science reasoning but lower in reading than community college students nationally. Statistical tables and test models are included. (AF)

An Assessment Report on Students' General Educational Development at College of DuPage

Submitted by the Student Outcome Assessment Committee

October 12, 1999

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The research model and analysis was designed and executed by —
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Assessment of general education at an institutional level at College of DuPage, or any community college, is a challenging task. Consideration of the challenges can be divided into at least two distinct sets of issues. One set of issues focuses on defining general education and then operationalizing that assessment. A second set of issues focuses on designing and then operationalizing the measures selected in the first focus. Responding to these challenges, the General Education sub-committee of the Student Outcome Assessment Committee and the General Education Enduring Purposes Committee memberships have cooperated during the past two years to complete a first round of representative testing of general education and to provide feedback to all constituencies concerning their findings.

Challenges to assessment at College of DuPage

As with any inquiry, the first steps involve identifying what one intends to study. Within the general assessment framework, student learning needs to be examined through multiple measures at multiple levels from each classroom up through institutional levels. Activities at classroom and disciplinary levels have been initiated and are described in other documents of the Student Outcome Assessment Committee. When considering general education assessment, two limits need to be addressed: what are the skills, attitudes, and characteristics being assessed and who is eligible within the population as representative of the cohort being assessed?

Answering the first question, "What is general education?" is a challenge faced at any institution attempting general education assessment. Discussion and debate as to a meaning for "general education" can occupy years and careers. A choice made by members of the Student Outcome Assessment Committee was to operationalize some inquiry, accepting that future discussions and alternative measures might result in other assessment formats. Thus, this round of assessment of general education at College of DuPage utilized the following premises.

- General Education is learning which occurs as a result of multiple experiences and courses throughout a student's educational activities, not a specific learning resulting from a sequence of identified courses.

- General Education is defined as those ideals expressed in the college catalog.

  The aims of general education are to enable students to understand and appreciate their culture and environment; to develop a system of personal values based on accepted ethics that lead to civic and social responsibility; and to attain the skills in analysis, communication, quantification, and synthesis necessary for further growth as a lifespan-learner and productive member of society.

Consideration of this published statement results in identification of seven competencies that may be taken as an operational definition of general education at College of DuPage.

1. An aim of general education is to enable students to **understand and appreciate their culture**
2. An aim of general education is to enable students to **understand and appreciate their environment**
3. An aim of general education is to **develop a system of personal values based on accepted ethics that lead to civic and social responsibility**
4.* An aim of general education is to attain the skills in **analysis (critical thinking, scientific reasoning)** necessary for further growth as a lifespan-learner and productive member of society.
5.* An aim of general education is to attain the skills in **communication** necessary for further growth as a lifespan-learner and productive member of society.
6.* An aim of general education is to attain the skills in **quantification** necessary for further growth as a lifespan-learner and productive member of society.
7.* An aim of general education is to attain the skills in **synthesis** necessary for further growth as a lifespan-learner and productive member of society.

It should be evident that there is no single procedure adequate to assess all of these outcomes. However, there is a core of general education competencies which can be identified as academic skills and which can be assessed using nationally standardized tests. These skills are analysis, communication, and quantification, and they are marked with *'s above. We will return to operationalizing this definition of general education later. Continuing with defining the project, one moves to consider identification of the population.

At many colleges and universities one can clearly identify students as admitted to the college or program, graduating or finishing a program, etc. Some of these same criteria are used at College of DuPage when students in programs are clearly admitted and completed. Such is not, however, the situation with general education. Students come for a few courses, come to complete degrees, come to earn enough credit to transfer, etc.

Along with this lack of clearly identified qualification, past efforts at the college to recruit students' participation in testing have failed despite rewards including free course work and bookstore coupons. (It may be that the idea of **testing** is the issue, given students' willingness to participate in focus groups when offered pizza and pop.)

Responses to the assessment challenges:

Designing a response to these challenges resulted in applying a process first developed by the Value Added Committee in 1996. It was that committee which first designed a random section based sampling used to field test use of the six CAAP area-tests.

Why the CAAP tests?

Since one goal of general education assessment was to provide a comparison to other institutions, selection from among three national standardized tests of general skills was undertaken rather than the development of a local college specific test of minimum competence. Members of the Student Outcome Assessment Committee chose the College Assessment of Academic Proficiency (CAAP) based on four observations.

- CAAP provided national norms for both 2-year and 4-year colleges of different categories.
- CAAP provided unique area tests which could be aggregated as valid and reliable institution bases. This feature contrasted with more global single tests from which subject area scores were derived.
- Each of these area tests could be administered in 50 minutes (according to the test protocol documents).
- CAAP was judged least dependent on specific content ideas and, therefore, was judged most likely to evaluate general learning when students were not mandated into specific core courses.

The six area-tests lined up well with a general education focus. **Analysis** was assessed with the area-tests of Critical Thinking, and Science Reasoning. **Communication** was assessed with Writing Skills (a multiple choice test), Essay Writing (a demonstrated essay), and college level Reading in both the arts and social sciences area-tests. **Quantification** was assessed using a Math test which covered material from algebra through calculus. With the choice of evaluation tool in place, the next issue was student-subject selection. Assessment of **synthesis** was integral to each of the six area-tests.

Sampling model:

Because mandatory college wide testing was judged as not feasible and voluntary testing efforts of the past had resulted in high recruiting costs for low participation, a sampling model utilizing a stratified, random sampling of class-sections was developed. The random selection of class-sections assured testing a broad range of students with relatively low non-participation. But, as may be evident and perhaps already distracting to the reader, such testing will result in the assessment of a range of students, only a few of whom may match the ideal characteristics of entering freshmen or completing, graduating or transferring sophomores. Utilizing this full range of students' data is an issue we considered in designing the analysis of these data. The design of the analysis will be discussed later (see page 3). For now let's finish the explanation of the sampling mode.

Assessment is conducted twice a year -- fall and spring. In each round of assessment we attempted to gather at least 100 tests in each area. Thus, approximately 700 tests are administered in each testing

cycle. The model called for random sampling from all possible sections of introductory classes (100 level single classes and sequences classes ending in 1 during the fall. During the spring the sampling was drawn from 200 level courses and end of sequences courses. In all selected sections, each of the six area-tests was rotationally assigned to some students. Thus, in any one section students would be completing each of the area-tests.

Analysis model – Questions being addressed
Given the challenges of defining and administering a simple pre-post test model at College of DuPage, the model for analysis must also be designed to accommodate the constraints. If one accepts that a clear pre-post test model cannot be implemented, but that a representative sampling of all students can be drawn using the data collection method described, then several alternative analysis models can be designed.

Coming closest to traditional pre-post test modeling is comparing a cross-section of students beginning their studies with another cohort near completion of their studies. Such a comparison can focus on two questions. First, are the entering and leaving students similar to national standards for similar students at other colleges and universities? Second, is there an indication that students have changed during their studies at an institution?

In the report section these types of models are reported (see page 13). However, it needs to be noted that such models are limited in the number of cases which can be classified as appropriate to the two points used in the model.

An alternative analysis lies in constructing a statistical model which attempts to predict general education skills development based on a continuous development over the number and type of courses taken. Such a model can use most of the data collected in that it focuses on more than the initial and final points on the conidium of learning. Such models, although more complex than the two point analysis, can be very interesting. These models are reported starting on page 13.

The characteristics of students taking one of the CAAP area-tests during the 1999 academic year are summarized below, followed by comparisons of College of DuPage students with national norms starting on page 6.

Report findings:

General student characteristics:
A total of 1154 tests were completed during the fall and spring testing cycle. During the fall of 1998 twenty-seven course sections were sampled, and during the spring of 1999 thirty-two course sections were sampled. The number of tests in each of the six area-tests are roughly equivalent.

Frequencies of subject-area tests by quarter	Fall, 1998 (1999.1)	Spring, 1999 (1999.3)	Total
Writing Skills	111	84	195
Math	96	92	188
Reading	100	95	195
Critical Thinking	98	91	189
Science Reasoning	95	94	189
Essay	109	89	198
Total Tests Completed	609	545	1154
Number of Course Sections Sampled	27	32	

Fifty-five percent of these test takers identified themselves as female.

Sex	Frequency	Percent
Female	628	54.8
Male	518	45.2
Total	1146	100.0

Seventy-six percent reported being enrolled full-time for the quarter during which they completed the CAAP assessment.

Enrollment status	Frequency	Percent
Full-Time	865	76.3
Part-Time	269	23.7
Total	1134	100.0

The goal most frequently selected as most important was transferring to a college or university with over one-half of the students selecting this option. At a substantially lower level was receiving a degree or certificate. Given this focus on transfer, it is not surprising that we have a difficult time finding students who can be traditionally defined as entering as freshmen, completing two years of studies, then leaving as sophomores having completed some degree.

Most important goal	Frequency	Percent
Associates Degree	390	37.6
Certificate in specific field	36	3.5
Transfer to college or university	536	51.7
Transfer to technical school	9	.9
Upgrade current job skills	10	1.0
Learn a specific skill	13	1.3
Personal Interest	16	1.5
Other	26	2.5
Total	1036	100.0

Issues of time availability are a reoccurring theme among community college students. When asked how many hours per week they spent studying for their average class, the most frequent response was 0. Seventeen percent of the students reported they spent no time on their average course outside of class attendance. The average study time reported was 3.8 hours with 4 hours being the median reported time (s.d. = 2.85). The issue of study time will be examined as it relates to development of general education skills starting on page 22.

Average hours per week study time per class					
	Frequency	Percent		Frequency	Percent
0	177	17.2	5	121	11.7
1	90	8.7	6	74	7.2
2	111	10.8	7	47	4.6
3	131	12.7	8	57	5.5
4	126	12.2	9	98	9.5
			Total	1032	100.0

Two time demands which often competed with studying were employment and household commitments. The question about employment was expanded to include commitments to volunteer work hours. The median reported employment/volunteer commitments was between 16 and 30 hours. The median reported household work was between 1 and 15 hours.

Time commitments	Employment (volunteer)		Household work	
	Frequency	Percent	Frequency	Percent
None	242	23.4	210	20.3
1 -15 hours per week	154	14.9	603	58.1
16 - 30	366	35.4	124	12.0
31 - 45	208	20.1	43	4.1
Over 45 hours per week	63	6.1	55	5.3
Total	1033	100.0	1037	100.0

So, one might ask if outside time demands compete with study time. To evaluate this question a series of correlations is reported. Each of the three correlations are statistically significant. The correlation between study time and employment is .269. The positive correlation indicates that as study time goes up, so does employment time. The size of the correlation is weak, but significant. The same applies to the other two correlations between employment and household work (r=.379) and between household work and study (r=.453). If employment detracted from study one would expect a negative correlation. So, the following correlations table would indicate that those students who report the greater study time, also report greater employment and greater household work commitments. This relationship is indicative of the non-traditional adult learners among students. Since the sum of these three time commitments does not equal the total available time, one may conclude that among students who report lower study times, they also report lower employment and household commitments. It appears possible to conclude that social commitments absorb the time not otherwise reported. (However, it should also be noted that in later examination, study time is minimally related to general education skills. See page 22)

Spearman's rank order correlations		Average class study time	Employment (volunteer)	Household work
Employment (volunteer)	Correlation Coefficient	.269	1.000	
	Sig. (2-tailed)	.000		
	N	1028	1033	
Household work	Correlation Coefficient	.453	.379	1.000
	Sig. (2-tailed)	.000	.000	
	N	1031	1032	1037

Sixty-four percent of the respondents reported frequent or daily use of a computer to complete their course work with only 7.7% reporting limited or no use of a computer.

Computer use	Frequency	Percent
Daily	290	28.3
Frequently	368	36.0
Occasionally	287	28.1
Limited	64	6.3
No use	14	1.4
Total	1023	100.0

Among students participating in the assessment 85% reported English as their first language.

English as first language	Frequency	Percent
No	168	14.7
Yes	975	85.3
Total	1143	100.0

The characteristics of participants in this assessment indicate a broad variety of students. The inherent representativeness of these data then present both a rich potential for research and a challenge to simplify that complexity sufficiently to allow for focused assessment and evaluation. This examination will focus on comparing a freshmen and sophomores cross-section to national norms, then on change between freshmen and sophomores, and finally on what factors may impact the development of general education skills.

College of DuPage students compared with national norms — Freshmen

The challenge of comparing College of DuPage students with national norms lies in identification of appropriate cohorts and cross-sectional samples. The entry cohort — freshmen — can be selected from students entering College of DuPage with no previous college level credits. In this analysis 213 students were identified as entering freshmen. However, this is not a sufficient selection criterion since some students entering may not persist for two years. Persisting freshmen were identified as students in the fall cohort of test takers who identified themselves as beginning their college studies at College of DuPage, who had earned less than 15 quarter hour credits at the time of the test and who were enrolled in the Spring, 1999 quarter. These criteria eliminated "drop-outs" and school leavers. This group of non-persisters is labeled as "leavers" to avoid the connotation and assumptions about "dropping out." In contrast to these negative stereotypes, several of the following analyses directly contradict such assumptions, with leavers sometimes scoring higher than persisters and graduates.

A traditional assumption, perhaps incorrect, might be that leavers may be primarily lower achievers. If this (or the opposite) is the case, then a bias is introduced in comparing entering cross-sections with persisting cross-sections. Such a bias might be labeled a "freshmen survival effect." To avoid this bias, the analysis utilizes only entry level students who persist to the next round of testing. Of the 213 students categorized as entering freshmen, 151 (71%) persisted to spring quarter enrollment and 62 (29%) did not persist. In the academic year 2000 analysis, it may also be possible to examine the entry cohort persisting for two years.

Throughout this and the following sections, comparisons between averages are reported in one or both of two ways. Each table simplifies and summarizes the comparison by listing the area-test and its relative position as statistically significantly higher, not statistically significantly different, or statistically significantly lower. These conclusions are based on calculated confidence intervals at the .95 level of significance. A second section of the table contains a listing of the (mean) average for each of the area-tests. Gray cells indicate no statistically significant difference between scores with a footnote reporting the probability of type I error based on a t-test for difference in means. T-tests were performed on comparisons between cohorts in the College of DuPage student research population, but not for comparisons of those cohorts and the national norms.

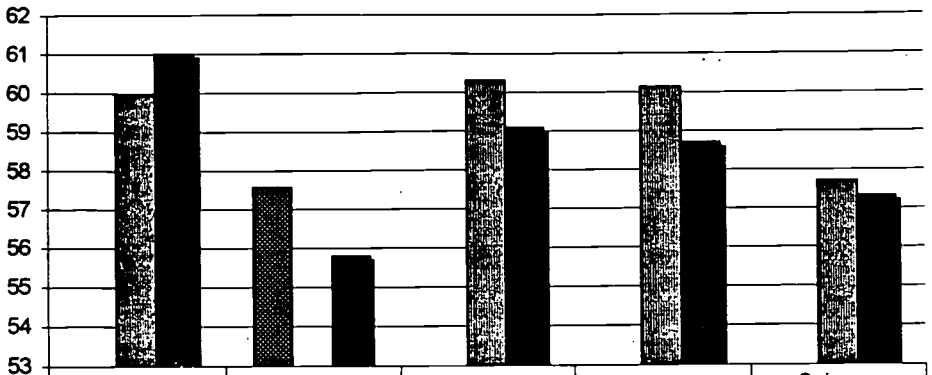
Comparing freshmen-persisters with freshmen-leavers, there were no statistically significant differences on any of the area-test scores. In most of these comparisons, the means of leavers and persisters are very close (less than 1 standard error). In three comparisons, Writing Skills, Essay Writing, and Mathematics, the mean score differences were larger and might obtain significance with additional cases. In the comparison of Writing Skills, the mean of leavers was higher than that of persisters. In the comparison of Essay Writing and Mathematics, the scores of leavers were lower than that of persisters as might support a general assumption of least qualified students "dropping-out."

Entering freshmen who persist compared with those who leave prior to next test round (Fall test-takers not enrolled in Spring with fewer than 15 hours at time of test who report beginning their studies at College of DuPage.)						
Persisters higher						
No significant difference	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Leavers higher than persisters						
Freshmen leavers	61.0	2.93	55.30	59.25	59.9	57.25
Freshmen persisters	59.97	3.27 [1]	57.57	60.29	60.11	57.68

The scores from the 151 persisting-freshmen were compared with the national norms published by ACT. In this comparison, the College of DuPage persisting freshmen cohort scored significantly higher on two area-tests — Essay Writing and Mathematics. On all of the other area-tests average scores were not statistically different from the 2-year public community college norms.

Persisting freshmen compared with 2-year public community colleges						
C.O.D. freshmen higher		Essay Writing	Mathematics			
No significant difference	Writing Skills			College Reading	Critical Thinking	Science Reasoning
C.O.D. freshmen lower						
C.O.D. freshmen	59.97	3.27	57.57	60.29	60.11	57.68
2-year public community college	61.0	3.0	55.8	59.1	58.7	57.3

[1] In a t-test the native freshmen persister average is higher than the native freshmen leaver average with a probability of Type I error of .064.



	Writing Skills	Mathematics	College Reading	Critical Thinking	Science Reasoning
COD Freshmen: significant		57.57			
COD Freshmen: no difference	59.97		60.29	60.11	57.68
1998 Fresh. national norm	61	55.8	59.1	58.7	57.3

After publication of the Fall Quarter - 1998 freshmen scores, some faculty responses posited that our standard should be freshmen entering 4-year public colleges and universities. As an examination of the following chart supports, comparison to 4-year norms shifts most of the conclusions about significant differences down by one step. While the College of DuPage Essay Writing scores remain significantly higher than the 4-year public college norms, persisting- freshmen demonstrated no statistical difference from 4-year public college students in Mathematics. On the other four area-tests, their skills are statistically significantly below 4-year public college students. It is important to note, however, that the College of DuPage sample, like the public community college norm, contains both students intending to transfer and those pursuing terminal degrees, and thus the comparison to 4-year norms is less appropriate than the 2-year norms.

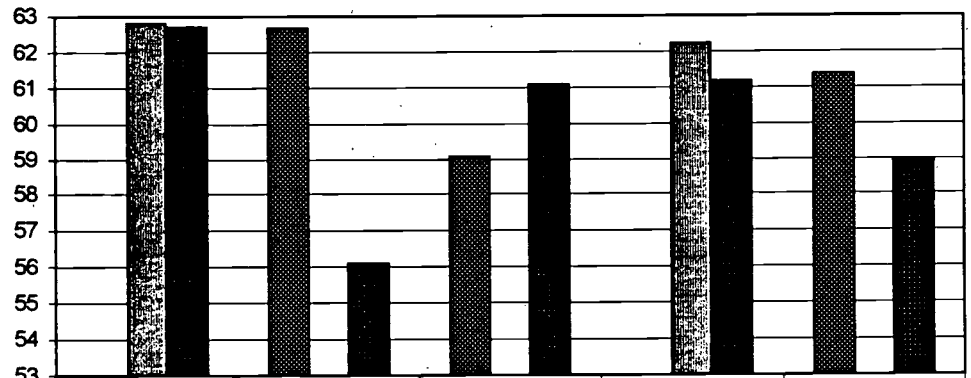
Persisting freshmen compared with 4-year public colleges and universities						
C.O.D. freshmen higher		Essay Writing				
No significant difference			Mathematics			
C.O.D. freshmen lower	Writing Skills			College Reading	Critical Thinking	Science Reasoning
C.O.D. freshmen	59.97	3.27	57.57	60.29	60.11	57.68
4-year college & university freshmen	65.	3.0	58.9	63.1	63.3	60.7

Sophomores:

As previously mentioned, the challenge of identifying which students among the general sample should be classified as sophomores is greater than that of identifying freshmen. The selection of completing sophomores utilized in this analysis includes cases identifying themselves as beginning their studies at College of DuPage and having earned between 80 and 110 credits by the time they took an area-test. These criteria resulted in 92 cases being selected. Of these cases, 25 were tested in the fall cycle and 67 completed their assessment in the spring. None of these 92 cases was a duplicate or retest.

The College of DuPage completing sophomores cohort displayed average area-test scores higher than national norms in the areas of Mathematics and Science Reasoning. The completing-sophomores' average college Reading score is notably lower than the comparable 2-year community college sophomores scores. On the remaining three area-tests the completing sophomores' averages are not statistically significantly different from the national norm.

Completing sophomores compared with 2-year public community college sophomores						
C.O.D. sophomores higher			Mathematics			Science Reasoning
No significant difference	Writing Skills	Essay Writing		College Reading[2]	Critical Thinking	
C.O.D. sophomores lower						
C.O.D. sophomores	62.81	3.23	62.67	59.06[3]	62.24	61.39
2-year public community college sophomores	62.7	3.1	56.1	61.1	61.2	59.0



	Writing Skills	Mathematics	College Reading	Critical Thinking	Science Reasoning
CoD Soph: significant		62.67	59.06		61.39
CoD Soph: no difference	62.81			62.24	
1998 Soph. National Norm	62.7	56.1	61.1	61.2	59

As with the freshmen, some people may be interested in how the completing sophomores cohort compares with 4-year college sophomores. The Mathematics performance remains statistically significantly higher than the 4-year sophomores norms, although the Science Reasoning is not statistically significantly different. The college Reading performance remains statistically significantly lower while the other three area-tests are not statistically significantly different.

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[2] Statistical significance for this section of a table was set at the 95% confidence level. The difference fails to meet this standard. However, the difference does satisfy other acceptable standards for a statistically significant difference.

[3] t-test = -1.876: p <= .0789

Completing sophomores compared with 4-year public college and university sophomores						
C.O.D. sophomores higher			Mathematics			
No significant difference	Writing Skills	Essay Writing			Critical Thinking	Science Reasoning
C.O.D. sophomores lower				College Reading		
C.O.D. sophomores	62.81	3.23	62.67	59.06	62.24	61.39
4-year public college & university sophomores	64.5	3.2	57.9	63.0	62.8	60.7

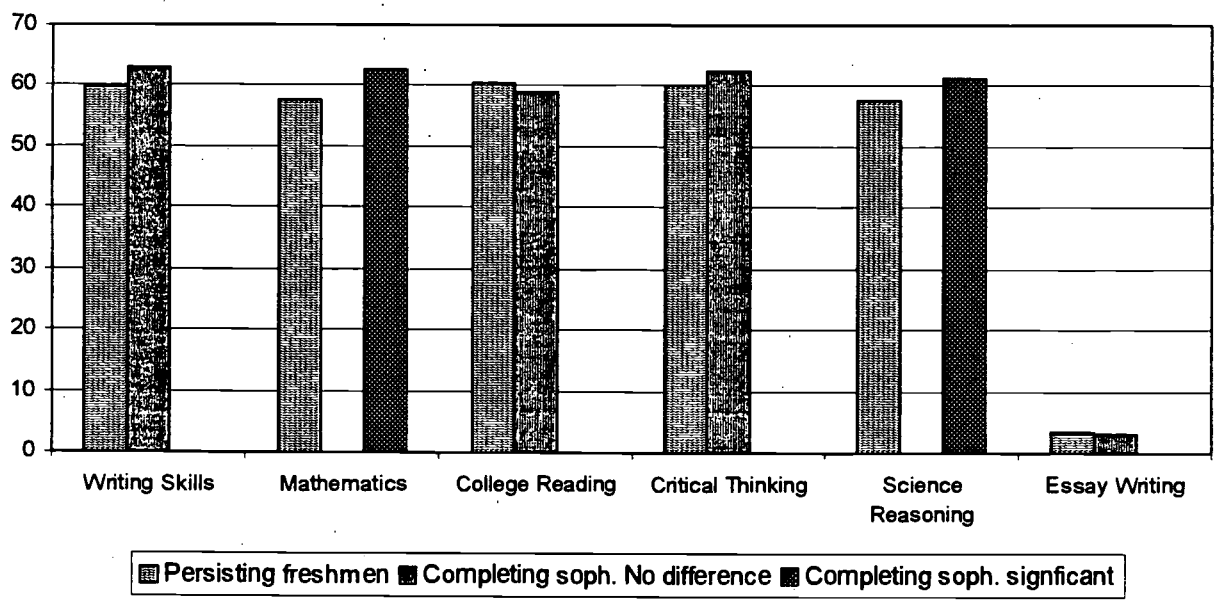
Students' progress over the course of studies

If the general conclusion from the first set of considerations is that College of DuPage students are not generally different from other 2-year community college students either as they begin or as they end their studies, then the next issue is to consider if they change over the duration of their studies. To examine this issue, a comparison is made between the cohort of entering-persisting freshmen, completing-sophomores earning 80 to 115 quarter hour credits, and graduating sophomores.

The following table compares native-persisting-freshmen with sophomores completing 80-115 credits. In results from two area-tests, Mathematics and Science Reasoning, sophomores scored statistically significantly higher than freshmen (based on a statistically significant differences in both t-test and confidence intervals). In the Writing Skills comparison, the difference in averages may be accepted as showing an improved performance (despite not attaining statistically significance in confidence intervals but significant differences based on a t-test).

In the remaining three area-tests, the scores are not statistically significantly different. In Critical Thinking, the cohort averages differ in an appropriate direction. On the remaining two area-tests, Essay Writing and college Reading, the averages for sophomores are lower than those for freshmen. Some part of this lack of statistically significant differences lies in the small number of cases in each area-test cohort. The freshmen cohort counts range from 22 (in Science Reasoning) to 31 (in Writing Skills). The sophomores cohort counts range from 10 (in Essay Writing) to 23 (in Science Reasoning).

Freshmen persisters compared with completing sophomores at College of DuPage						
Completing sophomores higher			Mathematics			Science Reasoning
No significant difference	Writing Skills	Essay Writing		College Reading	Critical Thinking	
Persisting freshmen higher						
Persisting freshmen	59.97	3.27	57.57	60.29	60.11	57.68
Completing sophomores	62.81 [4]	3.23	62.67 [5]	59.06	62.24	61.39 [6]



Higher educational research focused on general learning tends to find very limited changes in general education skills. Pascarella and Terenzini's (1991) summarized findings from twenty-years of educational research conclude that change over a 4-year college degree is limited to a range between .5 to .56 of a standard deviation in verbal skills, and about half that amount (.24 s.d.) in quantitative skills. Change in Critical Thinking skills over 4 years of college demonstrates more variance among studies but tends to average a bit higher, at around 1 standard deviation of freshmen norms. Several of the studies found that the greatest change occurs in the freshmen year. Thus, the variation in any one category of students at one point in their studies far exceeds the net change of college.

To place these statistical ideas in a more general framework, the net impact of 4-years of college is a change in general verbal skills similar to the difference in these skills on first testing of one hundred students between a student ranked 50th and one ranked 69th. For quantitative skills, the net change is the

[4] In a t-test the sophomores average 62.81 is higher than the freshmen persisters average 59.97 with a probability of Type I error of .052, but not the minimum .05 level.

[5] In a t-test the sophomores average higher than the persisting freshmen average with a probability of Type I error of .000.

[6] In a t-test the sophomores average higher than the persisting freshmen average with a probability of Type I error of .007.

difference at first testing between a student ranked 50th and one ranked 59th. The net impact of 4-years of college on Critical Thinking skills is the difference in these skills on first testing between a student ranked 50th and one ranked 84th.

Based on these very general benchmarks, changes in College of DuPage students' general education skills present a mixed finding. In Writing Skills, the persisting freshmen to completing sophomores scores change by .64 s.d. units based on the freshmen scores. This is in line with the general benchmarks reported above. In Essay Writing and college Reading no statistically significant change is evident. In Mathematics the change is 1.42 s.d. units, well above the reported benchmarks. In Critical Thinking the change is .43 s.d. units, a substantial change in the right directions, but somewhat below the reported benchmarks. While no research summary of change in Science Reasoning could be found, the change of .88 s.d. units approaches the Critical Thinking reported changes and should be viewed as a noteworthy accomplishment.

Change between persistent freshmen and completing sophomores						
	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Net change.	2.84	-0.04	5.10	-1.23	2.13	3.71
Change in freshmen s.d. units	0.64	-0.09	1.42	-0.22	0.43	0.88

Because there are many students transferring after their freshmen year, we further examine change between students at the freshmen to sophomores transition with completing sophomores. The completing sophomores demonstrated statistically significantly higher Mathematics scores, and a higher average (but not statistically significantly different) Science Reasoning score. The freshmen-sophomores, on the other hand, recorded higher average scores (but not statistically significantly different) in college Reading. Further examination of persistence over the next year and discussion of this observation may provide insight into this paradox.

Freshmen, freshmen-sophomore, and completing-sophomores comparisons						
	Writing Skills	Essay Writing	Mathe-matics	College Reading	Critical Thinking	Science Reasoning
Persisting freshmen	59.97	3.27	57.57	60.29	60.11	57.68
Mid-freshmen-sophomores	62.65 [7]	3.27	58.27	59.89	62.30	58.61
Completing sophomores	62.81 [8]	3.23	62.67 [9]	59.06	62.24	61.39 [10]

[7] In a t-test the freshmen-sophomores average is higher than the freshmen persisters' average with a probability of Type I error of .018.

[8] In a t-test the sophomores average 62.81 is higher than the freshmen persisters' average 59.97 with a probability of Type I error of .052, but not the minimum .05 level.

[9] In a t-test the sophomores average higher than the freshmen-sophomores average with a probability of Type I error of .001.

[10] In a t-test the sophomores average higher than the freshmen-sophomores average with a probability of Type I error of .041.

The following table compares native-persisting-freshmen with students receiving an A.A.S., A.A., A.S. degree this year. Students earning a certificate were not included since there are minimal or no general education requirements for a certificate. The one case receiving an A.G.S. degree was also excluded. Statistically significant differences between students earning A.A.S. degrees and A.A./A.S. degrees were found for Mathematics and Science Reasoning, but not in the other four area-tests.

In this comparison, graduating students demonstrated statistically significantly higher Science Reasoning than persisting freshmen, but on all other area-tests there were no statistically significant differences.

Freshmen persisters compared with students receiving a degree						
	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Freshmen persisters	59.97	3.27	57.57	60.29	60.11	57.68
Graduating students	59.94	3.12	57.00[11]	59.83	56.00	62.95

College of DuPage contributing factors

A third focus for these inquiries concerns identification of characteristics influencing the development of the general education skills. A fundamental challenge in conducting higher education research is controlling for the wide variation among entering students' backgrounds, previous learning, and selection based on ability and interests. Students bring these characteristics to college. Such characteristics both open options and limit opportunities.

A specific challenge to modeling College of DuPage students' performance is availability of student characteristics. A list of characteristics available for inclusion in these analyzes is limited to those self-reported items from the CAAP test (for all respondents except those taking the Essay area-test) and student characteristics from their application and transcripts. The background, social, and psychological characteristics are, therefore, very limited. While most higher education research attempts to have measures of family background, skills and abilities, and prior school performance, College of DuPage's "open-admissions" results in only the most rudimentary measures of any of these characteristics. For example, the only consistent measure of entering skills and abilities currently collected is a Reading pre-test frequently paired with a Writing Skills pre-test. Since Math pre-testing may be delayed for many students until just prior to first math course, these scores are not entry level skills.

General model

The comparisons thus far have contrasted different cohorts. Those comparisons were based on students taking each of the tests who meet specific criteria. In order to further examine development of general education skills across the curriculum the following structural models utilizes almost all of the CAAP area-test scores collected combined with information retrieved from student tracking records.

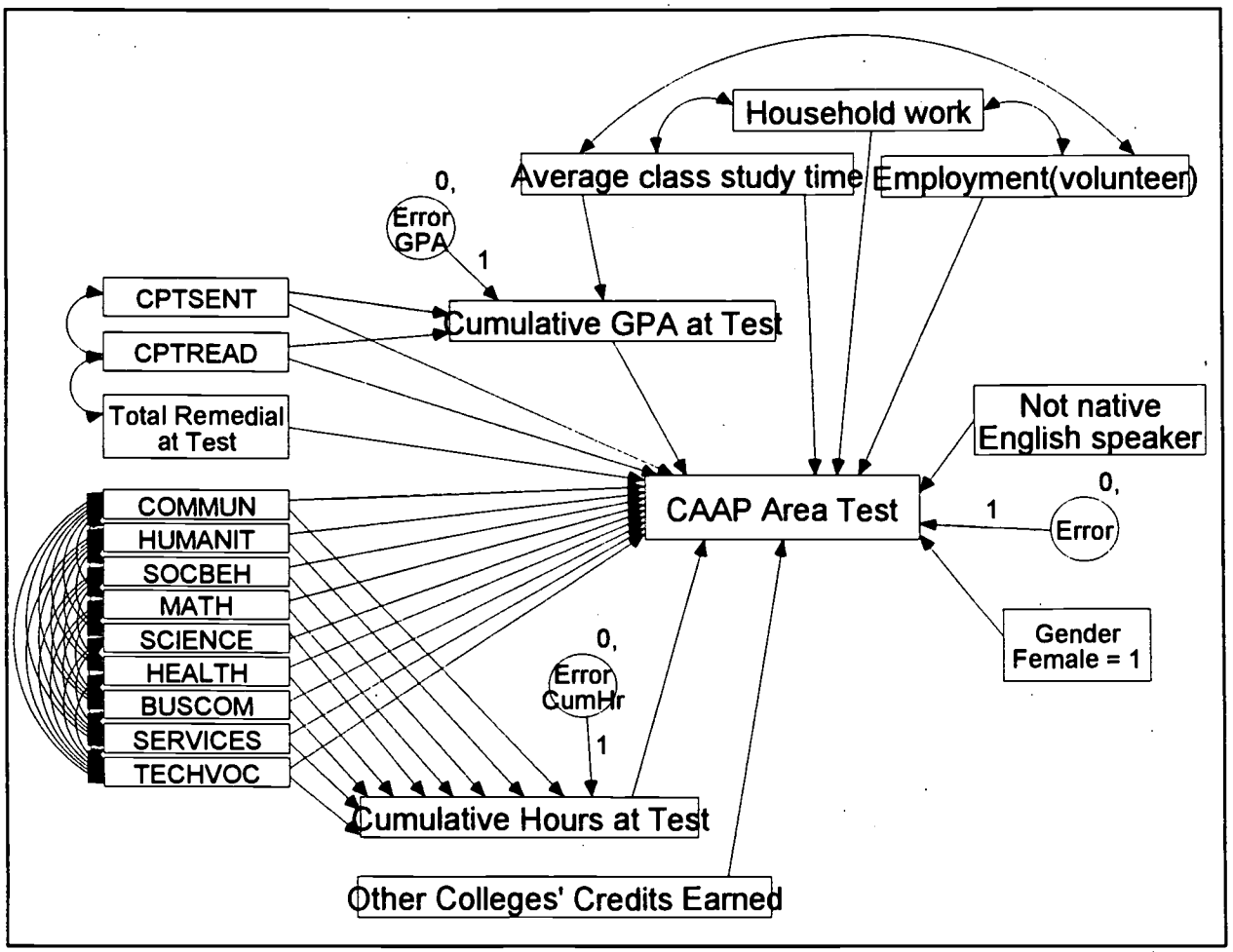
Based on the characteristics available, the general model used as an starting point for each analysis is graphically laid in the following diagram (page 14) containing twenty-one variables. A key summarizing operational definitions follows the general model.

Starting with the same general model, six reduced models were developed, one for each of the CAAP area-tests. A reduced model retains each of the paths (lines connecting variables) with a standardized coefficient of at least .10. These paths can be interpreted as connections between the variables in which a positive coefficient indicates that as the values increase in one variable, they tend to increase in the other. Paths with negative coefficients can be interpreted as connections in which as values increase on

[11] In an ANOVA comparison of students receiving an A.A.S. degree with students receiving an A.A. or A.S., the Mathematics and Science Reasoning area-test scores were statistically significantly higher.

one variable they tend to decrease in the other. The larger the absolute value of a path, the stronger the path connections. Thus, a path with .10 indicates a slight tendency for the values in one variable to increase as those in the connected variable increase. A path with a -.20 indicates a stronger (more deterministic) relationship in which values for one variable have an inverse relationship to the other variable.

The patterns observed in these simplified models may help us begin to understand how our students gain general education skills. **However, it should be noted that all of these models are very broad generalizations, which fail to achieve acceptable levels of predictive strength**. As discussed later, the assumptions of cause and effect are implied in the model graphic, but such direction of influence is not certain. Also, setting .10 as the minimum path criteria for inclusion in the core of the model is arbitrary. Most paths with a coefficient of .13 are statistically significant, and a few with coefficients as low as .10 are statistically significant.



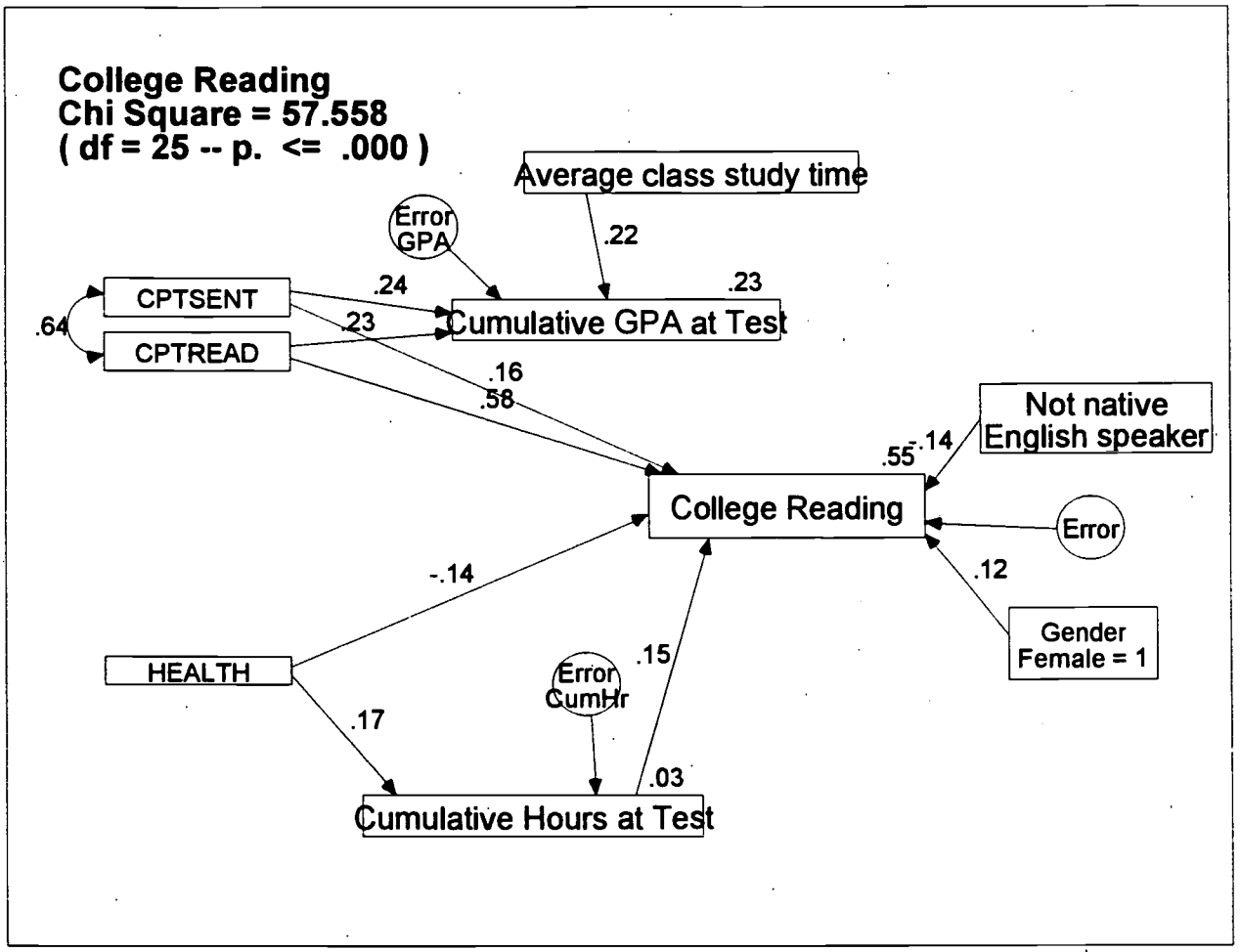
Variable key:

Average class study time	A self-report on the CAAP of the number of hours spent studying outside of class for an "average course."
BUSCOM	A count of the number of business and commercial courses at the 100 or higher level taken between 1995.4 through 1999.3.
CAAP Area-test	The dependent variable scores in each of the six area-tests (Writing Skills, Essay Writing, Reading, Mathematics, Critical Thinking, and Science Reasoning).

COMMUN	A count of the number of communication courses at the 100 or higher level taken between 1995.4 through 1999.3. Count is based on subject designations so all English courses are classified as communication.
CPTREAD	The CPT reading score from pre-testing. This pre-test was administered through mid-Fall, 1999; thus, scores are available for most students.
CPTSENT	The CPT sentence score from pre-testing. This pre-test was administered through mid-Fall, 1999; thus, scores are available for most students.
Cumulative Hours at Test	The sum of quarter hour course credits passed (D or better) at the 100 or higher levels at the end of the quarter during which the student completed the area-test.
Cumulative GPA at Test	The cumulative GPA for courses at the 100 or higher levels at the end of the quarter during which the student completed the area-test.
Employment (volunteer)	A self report on the CAAP of categories of employment and/or volunteer work. 0 = None, 1 = 1-15 hours, ... , 4 = Over 45 hours.
Gender	A self-report on CAAP to Sex recoded to 0 = Male, 1 = Female
HEALTH	A count of the number of allied health and related courses at the 100 or higher level taken between 1995.4 through 1999.3.
Household Work	A self report on the CAAP of categories of household work and family duties. 0 = None, 1 = 1-15 hours, ... , 4 = Over 45 hours.
HUMANIT	A count of the number of humanities designated courses at the 100 or higher level taken between 1995.4 through 1999.3. Count is based on subject designations so history courses are classified as humanities.
MATH	A count of the number of mathematics courses at the 100 or higher level taken between 1995.4 through 1999.3.
Not native English speaker	A self-report on the CAAP to English being ones first language, recoded to 0 = Native Speaker, 1 = Not a native speaker of English.
Other Colleges - Credit Earned	A self report on the CAAP of categories of credits earned prior to the current quarter. 0 = No other college , 1 = 0-20 q.h., 2 = 21-40 q.h., ... 5 = Over 61 quarter hours.
SCIENCE	A count of the number of science courses at the 100 or higher level taken between 1995.4 through 1999.3.
SERVICES	A count of the number of public service courses at the 100 or higher level taken between 1995.4 through 1999.3.
SOCBEH	A count of the number of social and behavioral courses at the 100 or higher level taken between 1995.4 through 1999.3.
TECHVOC	A count of the number of technical and vocational courses at the 100 or higher level taken between 1995.4 through 1999.3.
Total Remedial at Test	A sum of remedial course quarter hour credits for the quarters 1995.4 through 1999.3. Data derived from the Student Tracking system and accepted as very accurate for the covered period, but not for students with remedial course work prior to the initial quarter.

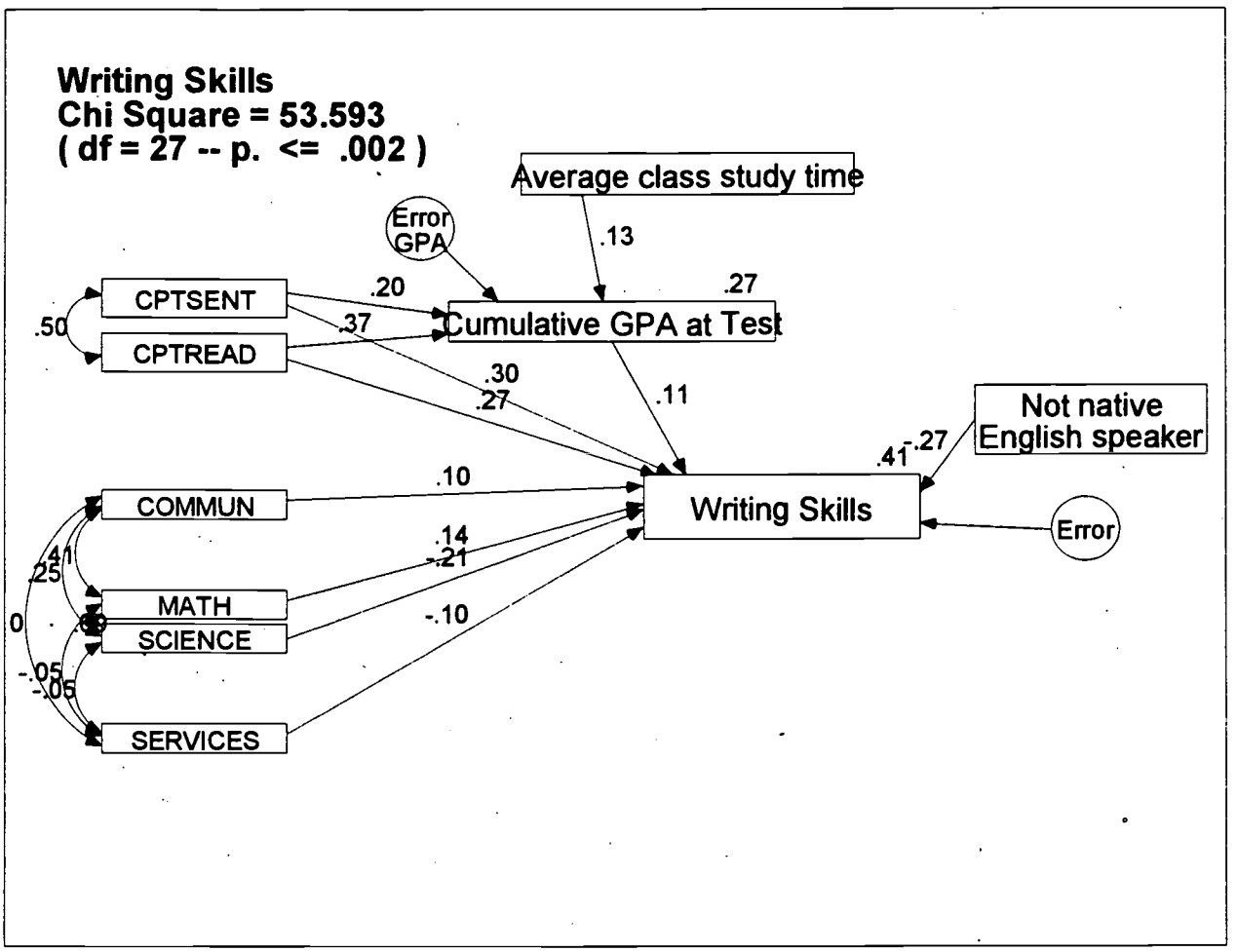
College reading model

The college Reading model explains 55% of the variance in these area-test scores. The single strongest influence on current Reading level is the pre-test reading score (β=.56). Among all of the counts of courses, only the category of allied health courses has a statistically significant coefficient with college Reading (β = -.14). However, the cumulative effect of taking more courses is significant (β =.15). Thus, the net effect of taking classes is improved college Reading skills. Even though this connection confirms a positive learning impact across the curriculum, it must be noted that in the previous analysis of freshmen to sophomores change, a net gain in college level reading was **not** observed (see page 12). Thus, the positive connection observed in this model may alternately be interpreted as those who read better persist in their studies.



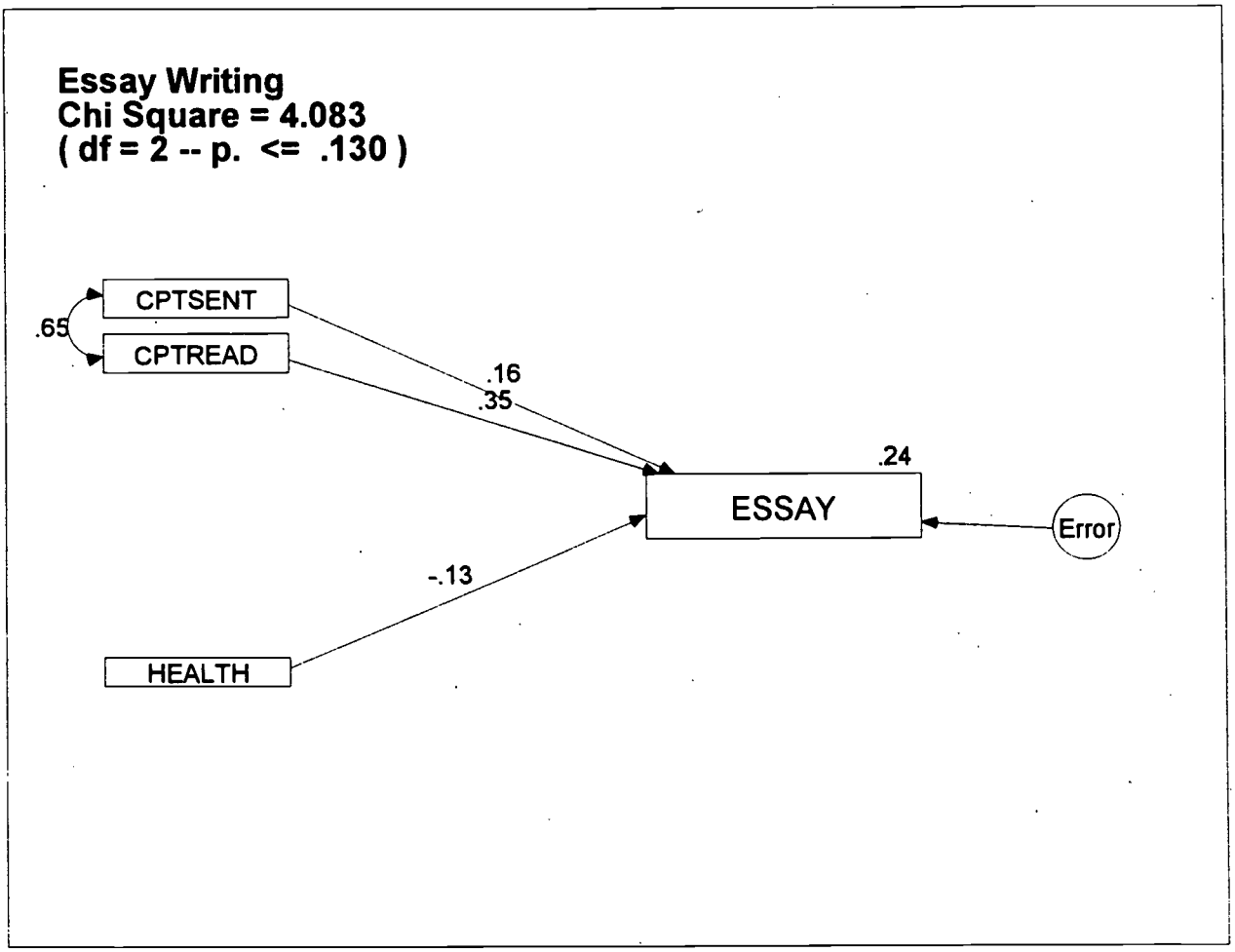
Writing skills model

The Writing Skills model is based on multiple choice items examining sentence structure, organization, strategy, and style. The Writing Skills model explains 41% of the variance in these area-test scores. The single strongest influence on the Writing Skills level is the pre-test sentence score (β=.30) closely followed by the pre-test reading score (β =.27). This is as expected; that these pre-tests and skill levels are highly related confirms these tests' validity as skills measurement. The significant coefficient between Not a Native English Speaker and Writing Skills confirms a language disadvantage as one might expect. Among the counts of courses, the categories of math (β =.14) and communication (β = .10) courses have a statistically significant positive coefficient with Writing Skills. The categories of science (β =-.21) and services (β = -.10) courses have a statistically significant negative coefficient with Writing Skills. These paths may be more indicative of the sorting of students among majors than of impact from course completion. However, the commutative effect of taking more courses is **not** significant indicating that the type of skills measured are not developed throughout the curriculum.



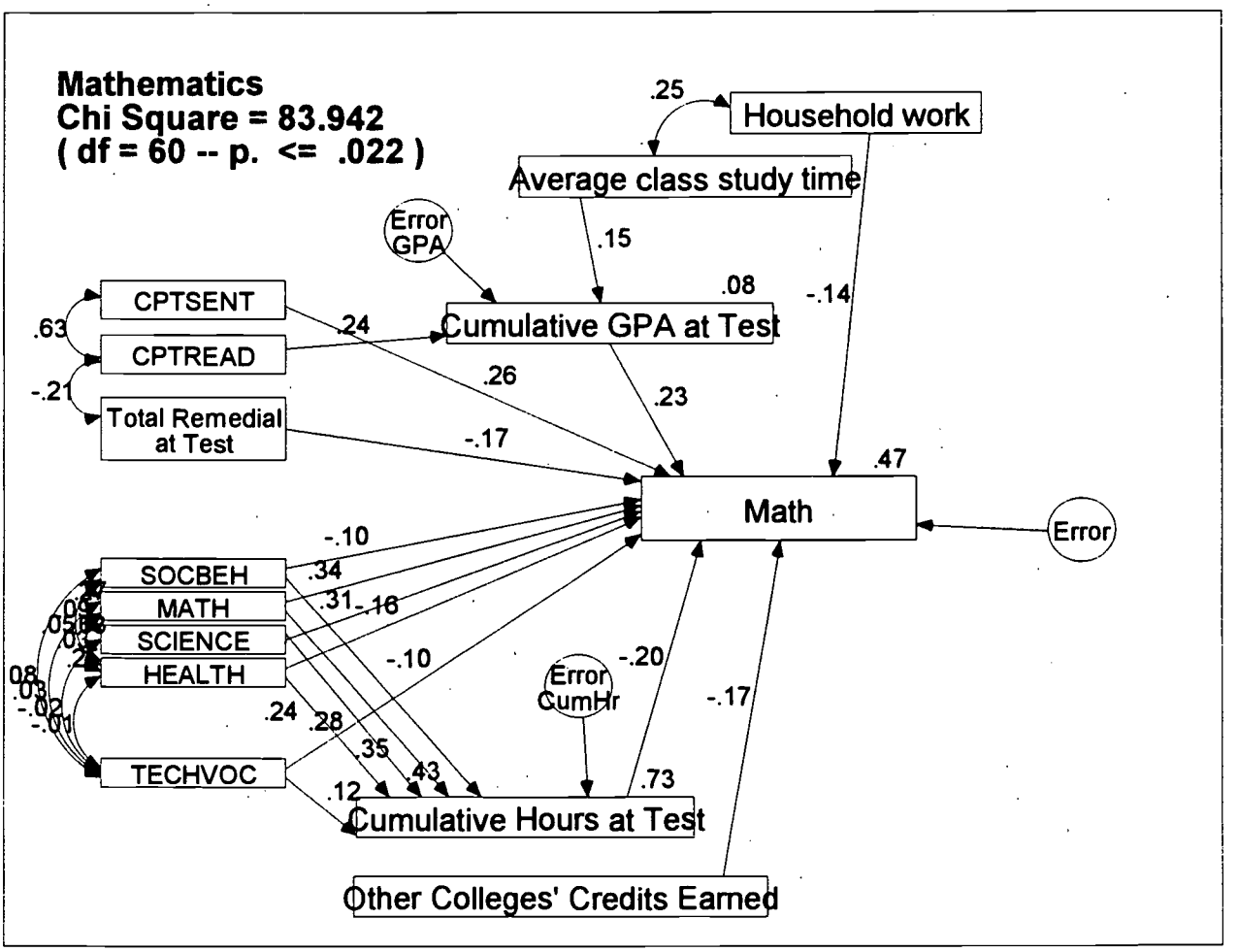
Essay writing model

The Essay Writing model is based on scores derived from two essays written by the respondents as compared with the other area-tests which consisted of multiple choice items. The Essay Writing model is not statistically significant; thus consideration of factors should be restricted. This model is also restricted by a lack of self-reported variables gathered from the multiple choice format area-tests. The reduced model explains only 24% of the variance in these test-area scores; indicating that it is not possible to model these area-test scores using the available variables. The single strongest influence on Writing Skills level is the pre-test reading score (β=.35).



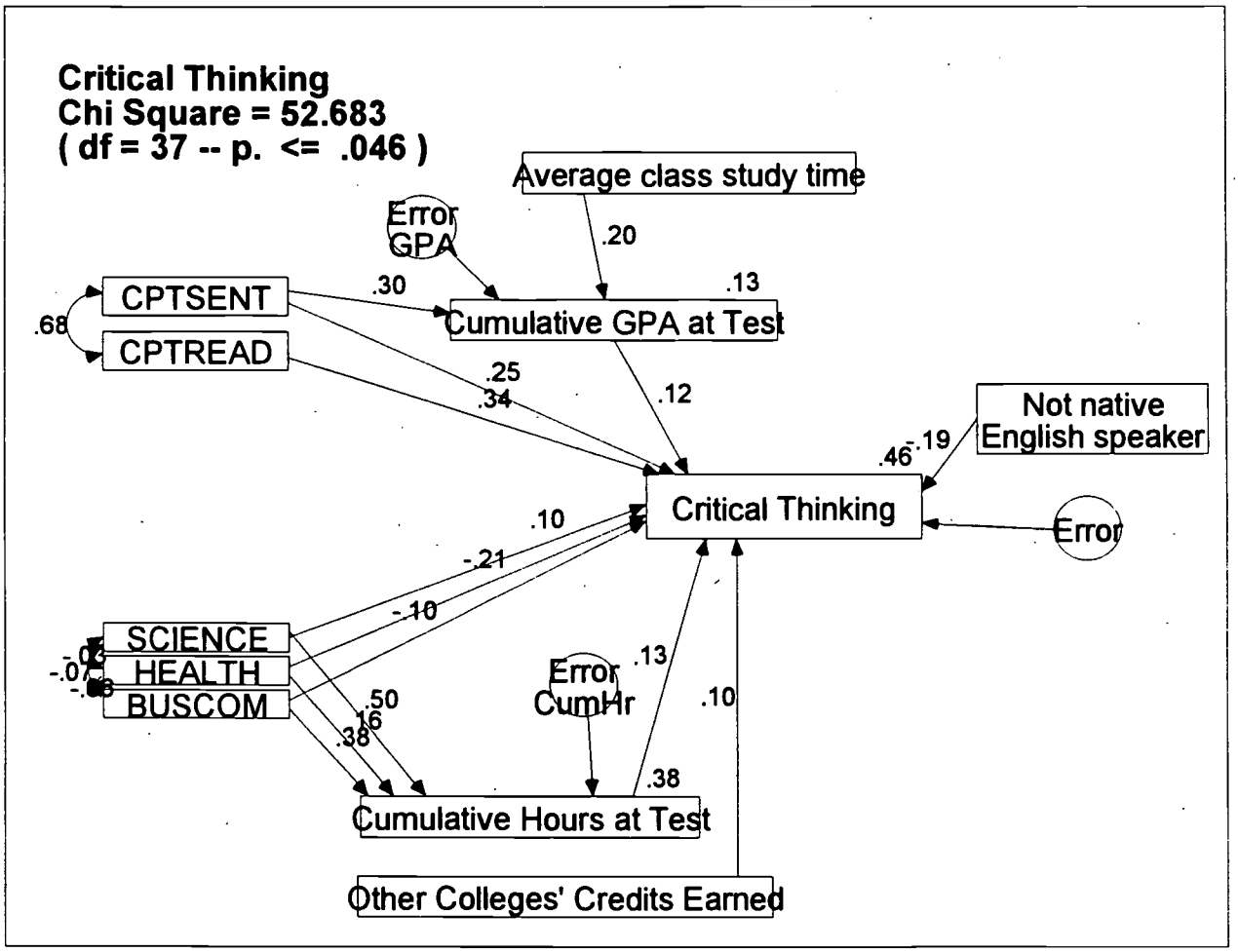
Mathematics model

The reduced Mathematics skills model explains 47% of the variance in these test-area scores. The strongest path connects from the count of mathematics courses (β =.33). Thus, course instruction in math improves math skills. There is also a strong connection with number of science courses taken (β =.31), a path which may indicate selection of science majors requiring higher levels of math skills. The connection of cumulative GPA with math skills (β =.23) echos the selectivity of majors versus students in non-science/math areas of study. It is interesting to note that this is the one model in which household work has a significant impact on general education skills. The negative β = -.14 indicates that students who are higher in math skills tend to have lower levels of family and household commitments. It's also encouraging to note that gender does not produce a statistically significant impact on this general education skill. The negative connection between other college's credits and math skills (β =-.17) is noteworthy, although specific interpretation is harder to deduce. This observation may indicate that students bringing in transfer credits may have completed math instruction some time ago, or have developed lower skills than those produced by College of DuPage general education requirements.



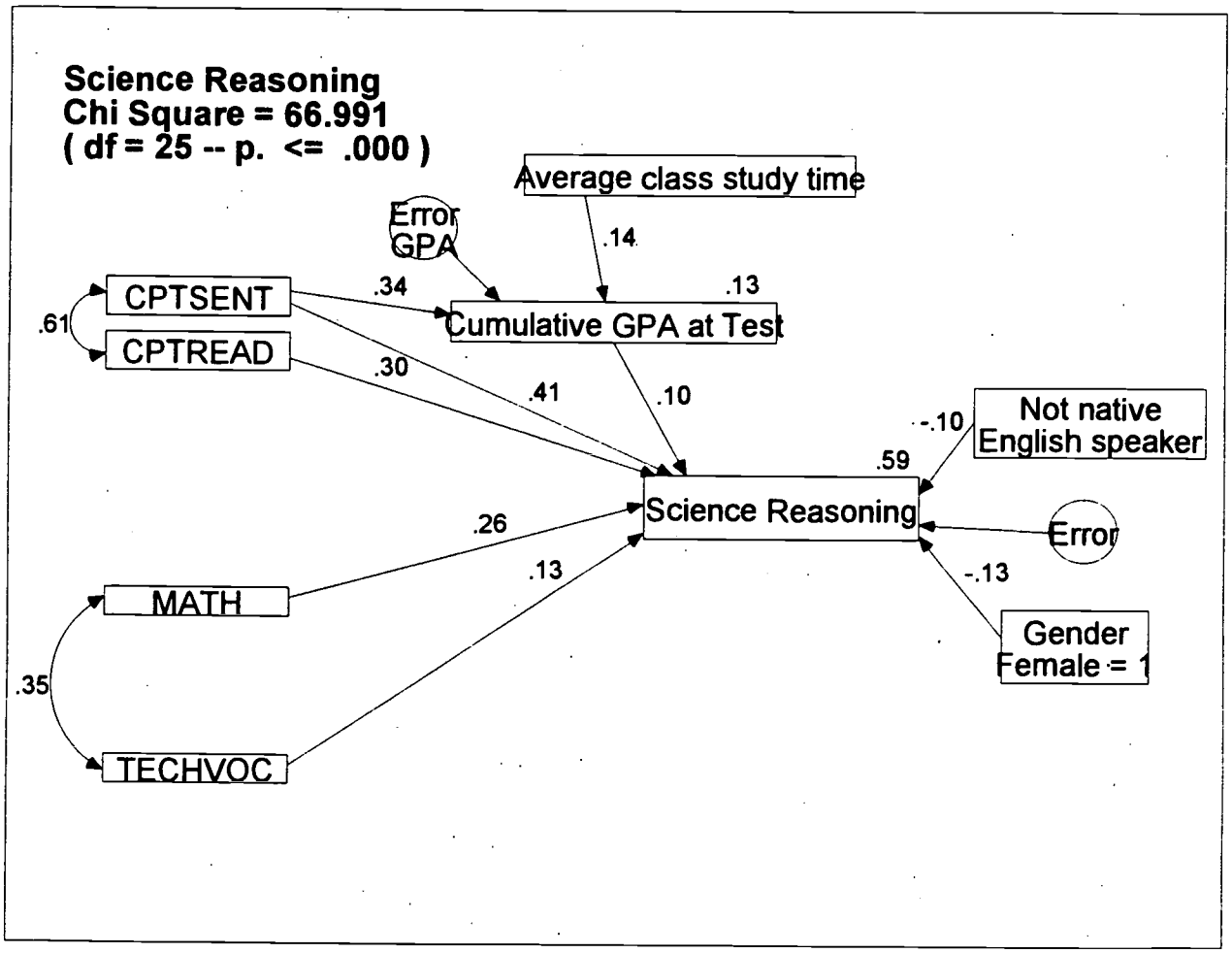
Critical thinking model

The Critical Thinking reduced model explains 46% of these area-test variations. The strongest single path connects the pre-test reading scores with Critical Thinking (β =.34). It appears reasonable to conclude that after controlling for major course selections, the cumulative courses taken at College of DuPage positively impact Critical Thinking (β = .13). The connection between cumulative GPA and Critical Thinking (β =.12) appears to indicate that the skill is developed by those being evaluated as learning more, or that the skill of Critical Thinking is valued in many different course settings. The negative paths between number of science courses and possible health courses (β = -.21 and β = -.10) may indicate the difference between the open challenges encouraging skepticism and questioning of Critical Thinking and the closed logic of Science Reasoning.



Science reasoning model

The Science Reasoning reduced model explains 59% of the area-test variation in scores. This is the greatest explained variation among the six models. The strongest paths connect the pre-course sentence and reading scores with Science Reasoning (β=.41 and β=.30) and the number of math courses completed (β=.26). These connections reflect a strong self-selection of students with higher demonstrated skills into "scientific" majors and closed logic perceptions. A test-taking positive bias may be indicated in the strong connection between the sentence pre-test and Science Reasoning, or the connection may arise from the closed-logical frame which supports both multiple choice test taking and Science Reasoning. A gender bias (in either self-selection or discrimination) is indicated by the β= -.13 path connecting gender with Science Reasoning. The negative path between "Not native English speaker" and Science Reasoning may reflect a test bias (the test questions being presented as text) rather than a general education Science Reasoning skill.



What can we conclude?

About our students:

Freshmen at College of DuPage are statistically significantly higher in general education skills of Essay Writing and Mathematics compared with a national sampling of 2-year public community college students. (However, it should be noted that the Essay Writing scores are suspect despite assurances from ACT concerning their reliability.)

Freshmen at College of DuPage are not statistically significantly different in general education skills of Writing Skills, Reading, Critical Thinking and Science Reasoning compared with a national sampling of 2-year public community college students.

Freshmen who persist to spring quarter are not statistically significantly different from those who do not persist in all general education skills.

Sophomores at College of DuPage demonstrate statistically significantly higher scores in Mathematics and Science Reasoning when compared with 2-year public college sophomores.

Sophomores at College of DuPage demonstrate statistically significantly lower scores in Reading compared with 2-year public college sophomores.

Sophomores at College of DuPage demonstrate no statistically significant difference in assessment of Writing Skills, Essay Writing, and Critical Thinking compared with 2-year public college sophomores.

Sophomores at College of DuPage demonstrate statistically significantly higher scores in Mathematics and Science Reasoning when compared to freshmen at College of DuPage .

Sophomores at College of DuPage demonstrate higher average scores on Writing Skills which, depending on statistical procedures, may be judged significant (using t-tests) or not significant (using confidence intervals at the .05 level of significance).

Sophomores at College of DuPage demonstrate no statistically significant difference when compared to freshmen at College of DuPage in scores on Essay Writing, college Reading, and Critical Thinking.

About our curriculum and general education:

In all models examining general education skills, the strongest influence is pre-test scores in Reading and/or sentence skills. The centrality of these skills in both success in college courses, and as a foundation on which other knowledge is built makes them central to learning. The paradox presented by low levels of change in college Reading skills with significant impact of commutative courses completed on improved CAAP college Reading skills point to a need to discuss how every course can support students' skills development in curriculum areas.

Although the Essay Writing assessment may be the least reliable scores from this round of testing, the low level of change and general lack of commutative course impact point to a need to discuss how development of this general education skill might be increased to support students in all of their further studies.

The direct connection of math courses taken with improved Mathematics skills and the connection of number of math courses completed with other general education skills illustrate the central importance of math as both an important skill, and as a basis for student self-selection and screening criteria for majors. Despite requiring only one math course as a general education requirement, that requirement significantly impacts the cohort averages representing all students' learning.

In all models there are statistically significant relationships between increased class study time and cumulative GPA which indicates that student efforts **do result** in improved classroom

performance. However, the effect of study time is expressed entirely though its impact of GPA, with no model containing statistically significant connections between study time and the general education skills except as it impact grades. It is interesting to note that in several simpler regression models the covariation of study time and general education skill is a negative one, indicating that students with a higher level of general education skills spend **less** time studying — probably because they are better at learning more for the time they spend. These observations make a strong case for both encouraging students to develop better general education skills and a direct reward (less study) for doing so.

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Overall, what can be concluded? In addressing the general education areas of quantitative skills (mathematics) and science reasoning skills College of DuPage students are making strong progress commensurate with national samples. In the areas of communication and Critical Thinking, College of DuPage students are demonstrating average skill development compared to national samples. In the area of developing college Reading skills which must be developed in content based courses not through remedial courses, this round of assessment would indicate that College of DuPage has educational developmental needs which must be examined further and, possibly, be addressed.

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ACT. Fall, 1997. CAAP User Norms. Iowa City, IA. 7

Pascarella, E. T. & P. T. Terenzini. (1991). *How College Affects Students: Findings and Insights from Twenty Years of Research*. San Francisco: Jossey-Bass Publishers. 11

Appendix A: Statistical Summary:

College of DuPage - Freshmen - sophomores comparisons (1999)						
C.O.D. - Entering Freshman - leavers	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	61	2.9	55.3	59.25	59.9	57.25
S.D.	3	0.4622	4.11	5.06	10	4.03
N	11	11	10	8	6.51	12
Std. Error of the mean	0.9045	0.1394	1.2997	1.7890	3.9193	1.1634
Confidence Interval	59.23	2.66	52.75	55.74	52.22	54.97
	62.77	3.20	57.85	62.76	67.58	59.53
C.O.D. - Entering Freshman - persisting	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	59.97	3.2700	57.57	60.29	60.11	57.68
S.D.	4.41	0.5099	3.58	5.56	5.01	4.2
N	31	25	28	24	27	22
Std. Error of the mean	0.7921	0.1020	0.6766	1.1349	0.9642	0.8954
Confidence Interval	58.42	3.07	56.24	58.07	58.22	55.92
	61.52	3.47	58.90	62.51	62.00	59.44
C.O.D. - Fresh- Soph	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	62.65	3.2717	58.27	59.89	62.3	58.61
S.D.	5.04	0.6097	4.27	5.58	5.85	5.36
N	48	46	44	45	33	38
Std. Error of the mean	0.7275	0.0899	0.6437	0.8318	1.0184	0.8695
Confidence Interval	61.22	3.10	57.01	58.26	60.30	56.91
	64.08	3.45	59.53	61.52	64.30	60.31
C.O.D. - Completing Sophomores	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	62.81	3.225	62.67	59.06[1]	62.24	61.39
S.D.	5.02	0.6816	3.7	4.48	6.66	4.5
N	16	10	15	17	17	23
Std. Error of the mean	1.2550	0.2155	0.9553	1.0866	1.6153	0.9383
Confidence Interval	60.35	2.80	60.80	56.93	59.07	59.55
	65.27	3.65	64.54	61.19	65.41	63.23
C.O.D. - Graduating Students	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	59.94	3.117	57.00	59.83	56.00	62.95
S.D.	4.65	0.4616	4.40	3.93	6.28	3.71
N	18	15	10	12	5	21
Std. Error of the mean	1.10	0.1192	1.39	3.93	2.81	0.81
Confidence Interval	57.78	2.88	54.28	52.13	50.49	61.36
	62.10	3.35	59.72	67.53	61.51	64.54

ACT - 1998 2-Year Public Freshman	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	61.0	3.0	55.8	59.1	58.7	5
S.D.	5.0	0.5	3.6	5.0	5.1	3.8
N	3245	1145	3137	1889	5420	1455
Std. Error of the mean	0.0878	0.0148	0.0643	0.1150	0.0693	0.0996
Confidence Interval	60.83	2.97	55.67	58.87	58.56	57.10
	61.17	3.03	55.93	59.33	58.84	57.50
ACT - 1998 4-Year Public Freshman	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	64.0	3.0	58.9	63.0	62.3	61.0
S.D.	5.3	0.5	3.6	5.1	5.1	4.3
N	4741	2439	3811	4003	4873	3435
Std. Error of the mean	0.0770	0.0101	0.0583	0.0806	0.0731	0.0734
Confidence Interval	63.85	2.98	58.79	62.84	62.16	60.86
	64.15	3.02	59.01	63.16	62.44	61.14

ACT - 1998 2-Year Public Sophomore	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	62.7	3.1	56.1	61.1	61.2	59.0
S.D.	4.7	0.5	3.4	5.3	5.2	4.1
N	20108	4039	17480	18514	15648	109
Std. Error of the mean	0.0331	0.0079	0.0257	0.0390	0.0416	0.03
Confidence Interval	62.64	3.08	56.05	61.02	61.12	58.92
	62.76	3.12	56.15	61.18	61.28	59.08
ACT - 1998 4-Year Public Sophomore	Writing Skills	Essay Writing	Mathematics	College Reading	Critical Thinking	Science Reasoning
Mean	64.5	3.2	57.9	63.0	62.4	60.5
S.D.	4.6	0.5	3.8	5.2	5.4	4.5
N	30364	14789	29851	26643	6520	21911
Std. Error of the mean	0.0264	0.0041	0.0220	0.0319	0.0669	0.0304
Confidence Interval	64.35	3.19	57.86	62.94	62.27	60.74
	64.45	3.21	57.94	63.06	62.53	60.86

1. t = -1.876, p <= .0876.

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