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A Retrospective Cohort Comparison of Career and Technical Education Participants and Non-Participants on a State-Mandated Proficiency Test

Sang Hoon Bae
The Pennsylvania State University

Kenneth Gray
The Pennsylvania State University

Georgia Yeager
The Pennsylvania State University

Abstract

The sometimes poor performance of Career and Technical Education (CTE) concentrators on a state-mandated proficiency test is a major concern of CTE educators. This study examined whether (a) there are performance differences on state-mandated 11th-grade math and reading tests between CTE and non-CTE students with similar proficiency scores in the 8th-grade; and (b) 11th-grade math test scores are related to 8th-grade math proficiency and high school math course-taking patterns. This exploratory study was conducted using two different cohorts of students from the high school classes of 2004 and 2005, from two CTE schools and their sending schools in Pennsylvania. The study found no statistically significant differences in reading proficiency on the state-mandated 11th-grade math test. In one of the two cohort groups, a statistically significant difference was found in math performance between CTE students and their counterparts, with the CTE students scoring lower. CTE students as a group had taken fewer college-prep math courses than their non-CTE peers. Such differences were associated with CTE students' lower achievement on a state-mandated math test. When math course-taking was controlled, CTE participation was found not to be associated with math test scores.

Background

With the increasingly popular public notion that higher academic performance is vital to promoting individual opportunity and national economic growth, improving students' academic achievement is becoming the norm for educators and policymakers (Cohen, 1996; Gray, 2004; Levin, 2001). Educational systems and programs considered to hamper student learning outcomes become a target for reform. A case in point is career and technical education (CTE), which has long been stigmatized as a second-class education for low-achieving and non-college-bound

students. Despite the compelling evidence that CTE programs help students' high school completion and postsecondary success in the labor market, more often than not, CTE students are viewed as the ones left behind, CTE schools are blamed for the allegedly lower academic performance of their students, and ultimately the viability of CTE as a differentiated school curriculum is questioned (Gray, 2004; Harvey, 2002; Harvey & Koch, 2004). For instance, the 2004 National Assessment of Vocational Education (NAVE) reported that "vocational courses and programs do not themselves add value to academic achievement" (U.S. Department of Education, 2004, p. 7).

Of particular importance in the debates regarding academic achievement of CTE students is their performance on state-mandated tests required by the federal No Child Left Behind (NCLB) legislation. The Carl Perkins Act of 2006, for example, again stipulated that academic achievement data collected by states in compliance with NCLB will be the metric used to evaluate academic performance of CTE students. The dilemma of course is that in many cases, CTE concentrators do not perform as well as their peers who do not take CTE. Such comparisons are problematic, however, if in fact CTE students as a group were less academically proficient when they entered high school than the population (Stone, 2004). If this is the case, then a valid assessment of CTE on academic achievement requires a comparison of CTE students with students who did not take CTE courses but had similar math skills when they entered high school. Such a comparison was the purpose of this research.

Another problem with comparing the academic test score performances of those taking and not taking CTE is the possibility of differential course-taking patterns while in high school. It could be, for example, that CTE students as a group take less advanced math in the 9^{th}- and 10^{th}-grade than non-CTE students. While the national trend data show that CTE students have considerably increased their academic course-taking over the past decade, large gaps remain in the completion rate of the college-prep courses between CTE and non-CTE students (Stone, 2004; U.S. Department of Education, 2004). Given that participation in the advanced college-prep courses is advantageous in improving test scores (Plank, 2001), it is of interest to examine how CTE students' academic course-taking patterns are related to their performance on a state-mandated academic proficiency test – specifically, math course-taking patterns and math achievement. An examination of this issue was a second purpose of this research.

Review of the Related Literature

Academic Performance of CTE Students

There seems to be a common belief among policymakers and the public that CTE students in general do not perform as well as the general non-CTE students in academic courses such as math and reading. One example is the 2004 NAVE report,

a national report about CTE and non-CTE students' academic achievement. Using the recent 12th-grade National Assessment for Educational Progress (NAEP) test scores, the report revealed that while CTE students have made substantial progress on math and reading achievement along with a significant increase in participation in more rigorous math and reading classes, they were still far less likely to be proficient in math and reading as compared to the general students. More strikingly, the report indicated that such improvement by CTE students in academic achievement was mostly due to "higher graduation requirements and emphasis on upgrading academic courses" (p. 18), not their CTE enrollment.

Similarly, at the state level, a policy paper prepared by Jobs for the Future (2005), a Boston-based education consulting firm, reported that CTE regional school students tended to lag behind their sending schools on the "percentage of their completers who have passed advanced academic courses" and that CTE students' academic skills are "unacceptably low" (p. 12). According to the report, two main reasons for CTE students' underachievement were: less participation in the advanced math courses and the low expectations for CTE students' academic performance. The authors pointed out, however, that given the lower academic performance status of CTE students upon entering CTE programs, the effectiveness of CTE programs should be evaluated "based on the gain in performance during a student's tenure there" (p. 14).

Elliot, Foster, and Franklin (2005), in comparing the high stakes test scores between CTE students and other general students in Arizona, found that the academic performance of CTE students was lower than their counterpart students. However, they found that the extraneous factors, including limited English proficiency, special needs, and socioeconomic status, had a statistically significant influence on the high stakes test scores. When these variables were controlled, CTE enrollment was not related to students' academic achievement. However, most previous policy papers and studies had compared CTE students with all other students in the academic track, which include academically advanced college-bound students. From a policy perspective, such a comparison may not be valid in evaluating the effectiveness of high school CTE programs (Jobs for the Future, 2005).

Math Achievement and Math Course-Taking Patterns

Using the data from the National Education Longitudinal Study of 1988, Plank (2001) revealed that high school course-taking patterns are highly associated with test scores. He particularly pointed out that academic concentrators' achievement advantage is partly due to their greater participation in advanced academic subjects. Likewise, Levesque (2003), as cited in Stone (2004), suggested that the completion of advanced academic courses is a critical determinant of academic achievement. With regard to the high school math course-taking patterns of CTE students, Stone

(2004) reported evidence that CTE reforms over the last decade had significantly promoted CTE students' participation in higher-level math courses. However, he noted that the effects of such an increase on math performance are uncertain.

Research Questions

This study investigated two research questions:

1. Is there a statistically significant difference between CTE students' performance on state-mandated 11th-grade math and reading proficiency tests and a comparison group of non-CTE students with similar math proficiency scores in the 8th-grade?
2. Is student performance on an 11th-grade state-mandated proficiency test associated with math course-taking patterns prior to enrollment in CTE?

Conceptual Framework

This research was guided by the concept that prior math achievement and high school math-taking patterns—particularly the level of difficulty of math course completed—were associated with math achievement by students (Jobs for the Future, 2005; Plank, 2001; Stone, 2004**).** Based on this framework, the underlying assumption of this study was that when academic abilities, as measured by 8th-grade test scores taken before entering high school, and the level of difficulty of math courses taken while in high school, were controlled, the academic achievement of CTE students would not differ from that for the general population of students who took the academic program, only.

Method

Research Design

The current study employed a retrospective cohort study method extensively used in clinical research to compare outcomes between those who receive a particular treatment and another group not influenced by the treatment under investigation (Kazdin, 2003)—in this study, CTE enrollment. This method was used because it provided a better research context for comparisons between CTE and non-CTE students. To be specific, a cohort was defined as students with similar academic performance in the 8th-grade. Among the cohort, CTE students were defined as those who take 3.0 or more credits in occupational courses in CTE.

Sample and Data

The study was conducted using two different cohorts of students from two different CTE area vocational schools and their respective sending schools in Pennsylvania. Specifically, for one CTE school and its sending schools, the class of

2005 was the population from which a cohort was selected (hereafter referred to as Cohort 04-05); for the other CTE school and its sending schools, the class of 2004 was examined (hereafter, Cohort 03-04).

Data used in this study were collected from two sources: (a) the Pennsylvania System of School Assessment (PSSA) database for student performance data; and (b) high school transcripts to ascertain students' math course participation. The PSSA is a statewide mandatory test designed to assess academic performance of students, schools, and districts in Pennsylvania. The reading and math PSSA has been administered to students in the 5th-, 8th-, and 11th-grades since 1996.

The dependent variable was a student's 11th-grade math and reading performance on the PSSA test. For Cohort 04-05, student performance was measured by *scaled scores*; for Cohort 03-04, it was measured by *percentile ranks*, a student's relative standing in comparison with other students taking the PSSA test statewide. The independent variables were as follows: (a) 8th-grade math and reading performance on the PSSA test, (b) CTE enrollment, which was coded into two dummy variables (1 = CTE students, 0 = non-CTE students), (c) years of math (algebra I or higher level) taken by the 11th-grade, and (d) taking Algebra I before the 10th-grade—this variable indicates whether a student took Algebra I before the 10th-grade and was coded into two dummy variables (1 = Yes, 0 = No) .

Sample Selection

Since the target population and scale of measurement for the variables were not consistent across two cohorts, sample selection and data analysis were conducted separately for each cohort. However, the procedures for sample selection and data analysis techniques were the same for both cohorts. The sample selection procedures for the two cohorts are explained below:

***Cohort 04-05*.** Among students from the class of 2005 from one CTE school and its sending school, 25 CTE students and 49 non-CTE students were randomly selected. All had both 8th- and 11th-grade math and reading performance scores. Next, 8th-grade math and reading achievement scores of CTE students were averaged to find a mean (*M*) and standard deviation (*SD*). Then, a cohort was identified as students whose 8th-grade math and reading scores were within the range of $M \pm 1SD$. As a result, 18 CTE students and 43 non-CTE students were identified as an *8th-grade math performance cohort* (n = 61). Likewise, 17 CTE and 34 non-CTE students were identified as an *8th-grade reading performance cohort* (n = 51). It should be noted that CTE students in this cohort were taking math at the CTE area school the year they took the 11th-grade state-mandated test.

***Cohort 03-04*.** Fifty-one CTE students and 102 non-CTE students were first drawn from graduates of the class of 2004 of the other CTE area school and its sending schools. To identify a cohort among them, the same procedure used for

Cohort 1 was employed except that the range of $M \pm 0.75SD$ was used because the range of $M \pm 1SD$ had failed to find the cohort students who had similar 8th-grade math and reading performance scores. Finally, 24 CTE students and 31 non-CTE students were selected as an *8th-grade math performance cohort* ($n = 55$). Similarly, 24 CTE and 29 non-CTE students were identified as an *8th-grade reading performance cohort* ($n = 53$). CTE students in this cohort were not taking math at the area CTE school. Thus, some CTE students were not taking math in the year they took the 11th-grade state-mandated test.

Data Analysis

To examine whether there was a statistically significant difference between the 11th-grade math and reading performance of CTE and non-CTE students, an independent samples t-test was conducted. An independent t-test *conventional* comparison was also conducted between CTE students and "all" non-CTE students to provide a contrast between the traditional NCLB comparison method and the cohort group comparison method. The purpose was to demonstrate the value of cohort over conventional comparison methods.

To determine the relationship between math achievement and math course-taking patterns, multiple regression analysis was employed. Since the data on students' math course-taking patterns were not available for Cohort 04-05, this analysis was done only for Cohort 03-04. The data were analyzed using SPSS statistical software. All statistical assumptions required for independent t-test and multivariate analyses were checked.

Findings

Academic Performance of CTE Students

The results of independent samples t-tests are presented in Table 1. For Cohort 04-05, no statistically significant differences on the state-mandated 11th-grade math exam were found for either the cohort or conventional comparison. In the case of reading, the conventional comparison of CTE students with all other non-CTE students revealed that CTE student scores were significantly lower with an alpha level of .05.

The math test results for the conventional comparisons are important. As mentioned above, CTE students in this cohort were taking math at the CTE area school during the year they took the test. Thus, it is important to note that there was no statistically significant difference between CTE and all non-CTE students (meaning those in the college and general programs of study) from the sending schools.

For Cohort 03-04, there was no statistically significant difference in reading performance between the two cohort groups; a statistically significant difference was

found for math performance ($p < .05$). However, compared with results for the conventional comparison, the cohort analysis found a considerably smaller mean difference (*MD*) between the two groups in math performance. As in the case of Cohort 04-05, while a conventional comparison found a statistically significant difference in reading performance between the two groups, the cohort comparison showed no statistically significant difference. These results suggest that the commonly used comparison method is more likely to magnify the achievement gap between CTE students and non-CTE students.

Table 1
Summary of Independent Samples T-test Results

	Conventional Comparison				**Cohort Comparison**			
	M	**SD**	**MD**	**P**	**M**	**SD**	**MD**	**P**
Cohort 04-05								
Math								
CTE	1233.80	165.55	27.61	.43	1246.17	96.55	12.76	.62
Non-CTE	1261.41	66.25			1258.84	66.31		
Reading								
CTE	1268.56	240.06	125.79	.02*	1260.36	161.62	86.56	.06
Non-CTE	1394.35	162.06			1346.00	145.83		
Cohort 03-04								
Math								
CTE	26.37	22.00	26.68	.00***	25.67	15.41	12.53	.00**
Non-CTE	53.05	17.78			38.19	15.07		
Reading								
CTE	28.67	15.10	27.59	.00***	32.71	12.49	6.89	.13
Non-CTE		56.25	23.83		39.69	18.76		

Note: Cohort 04-05 CTE $N = 25$, Non-CTE $N = 49$; *Cohort 03-04* CTE $N = 51$, Non-CTE $N = 102$. Conventional comparison is a comparison between CTE students and all other students on the academic track. Cohort comparison is a comparison between CTE students and students who had similar proficiency scores in the 8th-grade but did not take CTE.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Math Achievement and Math Course-taking Patterns: 03-04 Cohort

Table 2 presents descriptive statistics for students' math course-taking patterns for the two groups (CTE & non-CTE) in the cohort. The non-CTE students as a group had taken 0.81 more years of advanced math courses in the 9th- and 10th-grades than had CTE students. Whereas 70.0% of non-CTE students had taken Algebra I before the 10th-grade, only 33.3 % of the CTE students had completed Algebra I before the 10th-grade.

Table 2
Average Years of Math Taken by Grade 11 and Percentage of Students Who Had Taken Algebra 1 before Grade 10 by Groups (n = 55): 03-04 Cohort

	CTE (*n* = 24)	Non-CTE (*n* = 24)
Years of math (algebra I or higher level) taken by grade 11	1.67 (.64)	2.48 (1.03)
Percentage of students who had taken algebra I before grade 10	33.3%	70.0%

Note: Standard deviation in parentheses.

Given the differences in the math course-taking patterns between the two groups, multiple regression analysis was conducted to examine the relationship between 11th-grade math achievement on PSSA and math course-taking patterns. Since the variable *Taking algebra I before grade* 10 was found to be highly correlated with the variable *Years of math taken by grade 11* (r =.67), the regression analysis included only the variable *Years of math taken by grade 11* as an independent variable, taking into account the multicollinearity problem (see Tabachnick & Fidell, 2001).

Table 3 presents a summary of the regression analysis. First, the regression analysis revealed that 8th-grade math achievement was statistically significant and positively associated with 11th-grade math achievement ($p < .05$). Second, *Years of math (algebra I or higher level) taken by grade 11* was statistically significant and positively related to 11th-grade math test scores ($p < .05$). That is, the higher the math achievement prior to entering high school and more years of advanced math courses taken in high school, the higher the performance on the 11th-grade mandated math test. Finally, when controlling for the differences in course-taking patterns and 8th-grade math performance, CTE enrollment was not found to be a statistically significant predictor of 11th-grade math achievement on the PSSA. In other words, math performance on the 11th-grade test was found to have no statistically significant relationship to taking CTE, but in fact was related to math proficiency upon entering high school and especially to the number of math courses completed in high school.

Table 3
Summary of Multiple Regression Analysis for Variables Predicting the 11th-Grade Math Achievement on the PSSA (n = 55)

	B	*SE B*	*β*	*p*
(Constant)	2.96	7.75		.70
CTER Enrollment	-5.92	3.79	.44	.12
8th-Grade Achievement	.47	.21	.25	.03
Years of Math (Algebra 1 or Above) taken by grade 11	7.48	2.10	-.18	.00

Note: $R^2 = .44$

Discussion and Implications

This study examined (a) whether performance differences exist on state-mandated 11th-grade math and reading tests between CTE and non-CTE students who had similar proficiency scores in the 8th-grade; and (b) whether 11th-grade math test scores are related to 8th-grade math proficiency and high school math course-taking patterns. The study was conducted using two different cohorts of students from two CTE regional schools and their respective sending schools in Pennsylvania. Independent samples t-tests and multiple regression analyses were employed.

The key findings are summarized as follows. First, for the 04-05 conventional comparison, no statistically significant differences were found in math for the conventional and cohort comparison; a statistically significant difference was found for reading performance in the conventional comparison but not in the cohort comparisons. For the 03-04 cohort comparisons, no statistically significant difference was found in reading scores but was found in the conventional comparison. A statistically significant difference was found in math performance in both comparisons. It should be noted that for both cohorts, while the conventional comparison of CTE students with all other non-CTE students revealed a statistically significant difference in reading performance, the cohort analysis found no statistically significant difference between the two groups, therefore, illustrating the value of the cohort comparison method.

Second, CTE students in the 03-04 group had taken fewer advanced math courses in the 9th- and 10th-grades, and fewer had taken Algebra 1 before grade 10, compared with non-CTE students in the cohort. Consistent with previous studies (Levesque, 2003; Plank, 2001), the differences in math course-taking patterns were

related to a math achievement gap between the two groups. Finally, when controlling for differences in course-taking patterns between the two groups, CTE enrollment was not associated with 11th-grade math performance outcomes.

Given that this was an exploratory study with small samples, the results should be interpreted with caution. Nevertheless, the implications are worth further investigation. First, the overall findings suggest that when compared with students who are like them in terms of previous math ability entering high school, and when differences in math courses taken in high school are controlled for, CTE student test scores were not meaningfully different than for their counterparts who did not take CTE. Of course, it can be argued that both groups should have performed better, and it was hoped that CTE students would have performed better; therefore, suggesting that CTE curriculum does improve math and science as suggested by previous research (Conroy & Walker, 2000; Grubb, 1995; Hernandez & Brendefur, 2003; U.S. Department of Education, 2004). Nonetheless, these findings are important in those situations where districts, looking for some excuse for their poor performance, choose to blame student involvement in CTE. In fact, they should be looking at math instruction in the pre-high school years and why students of similar math skills enroll in different courses. Furthermore, this research illustrated that the cohort comparison is a more accurate and reliable way to assess CTE students' academic performance. Therefore, conventional comparison methods should be avoided when assessing the academic skills of CTE students.

The study found that in the 03-04 cohort, CTE students had different math course-taking patterns in high school. Of note, very few CTE students had taken algebra in the 9th-grade compared to the non-CTE students in the cohort. Considering that both groups in the cohort entered high school with the same math ability, the question is—why? This research only allows speculation. What the research did reveal was that lack of higher-level math among CTE students was associated with lower 11th-grade math test scores. Federal and state policymakers appear to believe that CTE students' lack of advanced-level math courses is an obstacle to math achievement, postsecondary education, and success (Jobs for the Future, 2005; U.S. Department of Education, 2004). This study suggests that, at least in the case of math skills, this point of view has validity; it is important for as many students to take algebra in the 9th-grade as is possible. It would seem appropriate to suggest an investigation of differential math-taking patterns in general, especially among students who, when entering high school, have similar math skills.

Interestingly, the 04-05 conventional comparisons of CTE students showed that they did as well in math as the entire student body. This is important in that the 04-05 CTE students were taking math at the regional school during the 11th-grade when the test was given. These results suggest that the poor performance of CTE students, especially in regional school settings, may be due to the fact that they are not taking any math instruction in the year they take the test.

Regardless, students who choose the CTE path generally belong to the "academic middle" and seek "other ways to win" by pursuing both CTE and academic courses (Gray & Herr, 2005). Therefore, if CTE requires students to make a trade-off between participation in math courses beyond algebra and geometry and occupational training courses, such a tradeoff is justifiable for these students. Students who intend to work and/or pursue pre-baccalaureate technical education after high school should take CTE programs that offer both occupational and integrated academic skills (Harvey & Koch, 2004). The finding by Plank (2001) that 80% of CTE concentrators take virtually the same academic courses as the population at large suggests that most CTE students are in fact taking both. Furthermore, as economists Becker (1993) and Sicherman (1991) maintain, individual human capital consists of various components, including academic abilities and occupational skills. Thus, CTE students' decision to acquire occupational skills rather than take higher-level academic courses or both academics and CTE in preparation for one- and two-year technical education, is logical and should be both respected and valued by adults.

Finally, at the high school level, one curriculum will never meet the needs of all students. Those whose needs are not met all too often drop out of high school. Considering that the national dropout rate is now a staggering 33% and that in virtually every state the dropout rate has increased since the advent of mandatory testing (Gray, 2004), the importance of CTE cannot be overstated. For example, Plank (2001) found that a combination of academic and CTE courses had the highest probability of preventing students at risk from dropping out. CTE is to some students what advanced placement and honors courses are to others, namely, a curriculum alternative to the standard academic program. The rationale for the two programs is the same (Gray, 2004)—if advanced placement is needed, so too is CTE. Therefore, it may be necessary to address the unfairness and inappropriateness of the policy recommendation to insist on the same academic standards, the same tests, and the same curriculum for all high school students. Academic standards designed for students who are preparing for college may not best serve students who decide to go to work. Meanwhile, academic standards and CTE combined best serve those who aspire to post-secondary, pre-baccalaureate technical education. In both of these cases, CTE is necessary.

Recommendations for Further Research

The first and obvious recommendation is that this type of research should be duplicated with larger samples and in other states. Findings from the cohort design used in this study demonstrate the value of comparing CTE students with those who entered high school with similar math ability but did not take CTE. It demonstrated, for example, that when CTE students are compared to their peers, participation in CTE is not related to test performance on 11th-grade state-mandated tests. It also

revealed troubling differences in early math course-taking patterns among students who entered high school with similar math skills. A large study in each state might well prove very interesting.

Second, the current study examined CTE students' math course-taking patterns as factors in determining math achievement and found that in the 03-04 cohort, CTE students took less math. Given the fact that students with special needs are at an economic disadvantage, they are also typically overrepresented in CTE (Elliot, Foster, & Franklin, 2005). Since these students often do not take high-level math, subsequent studies should be conducted with independent variables representing such demographic characteristics of CTE students using the cohort study concept.

Third, this study found differences in course-taking patterns that began in the 9th-grade. When compared to non-CTE students in the cohort, few CTE students took Algebra I in the 9th-grade. Considering that all students in the cohort had similar math skills when they entered high school, differing math course-taking patterns cannot be explained by differing math ability. Of course, this could be an isolated phenomenon with a logical explanation such as a large number of special needs students. However, one wonders and the issue of tracking based on socioeconomic background comes to mind. Further investigation in other locales might prove interesting.

Last, this study used both "reading" and math scores. The CTE students' readings scores were significantly lower in both conventional comparisons. While the differences in the cohort comparisons were not statistically different at the .05 level, they were lower than those for non-CTE students. This is cause for concern if this is the case generally, not just in this study. It is a reminder that at present, research (Stone, 2004) has focused primarily on math. One could argue, however, that in light of the need to be lifelong learners, and since technology as a whole tends to deskill work, diminishing the level of math required, not increasing it, reading may become a more important skill than math for most workers in the future. Therefore, it is recommended that CTE researchers conduct studies in reading skills as well.

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The Authors

Sang Hoon Bae is the Director of the Korean Ministry of Education and Human Resources Development. Bae can be contacted at sanghoon_bae@hanmail.net.

Kenneth Gray is a Professor of Workforce Education and Development at The Pennsylvania State University, University Park. Gray can be contacted at gty@psu.edu.

Georgia Yeager was a principal at the Somerset County Technology Center in Pennsylvania when the study was conducted. Yeager is currently the Director at the Somerset County Technology Center. Yeager can be contacted at gyeager@sctc.net.

The authors can also be contacted c/o The Pennsylvania State University, Workforce Education and Development, 301 Keller Building, University Park, PA 16802-1303, Phone 814-880-1449.