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Effects of Educational Productivity on Career Aspiration Among United States High School Students

The purpose of this study was to examine the effects of mathematics-related educational productivity on student career aspiration. We developed a structural model describing the relationship between educational productivity and career aspiration based on Walberg's (1981, 1992) theory of educational productivity. Using data from the Longitudinal Study of American Youth (LSAY), we identified eight mathematics-related factors of educational productivity descriptive of educational outcome, motivation, instructional characteristics, and psychological environment. Statistical results of the structural model supported Walberg's theory of educational productivity from the perspective of student career aspiration (as the educational outcome) in the context of mathematics education. Suggestions were made to enhance student career aspiration and improve the quality of mathematics education.

Cette étude avait comme but d'analyser les effets qu'a la productivité éducationnelle en mathématiques sur les aspirations professionnelles des élèves. En nous appuyant sur la théorie de la productivité éducationnelle de Walberg (1981, 1992), nous avons développé un modèle structural qui décrit le rapport entre la productivité éducationnelle et les aspirations professionnelles. Des données de l'étude longitudinale de la jeunesse américaine (Longitudinal Study of American Youth, LSAY) ont permis d'identifier huit facteurs mathématiques de la productivité éducationnelle qui ont des incidences sur la production des élèves, leur motivation, leurs caractéristiques pédagogiques et leur environnement psychologique. Les statistiques qui découlent du modèle structural appuient la théorie de Walberg sur la productivité éducationnelle quant aux aspirations professionnelles des élèves (comme mesure de la production) dans le contexte des cours de mathématiques. Nous proposons des stratégies pour rehausser les aspirations professionnelles des élèves et pour améliorer la qualité de l'enseignement en mathématiques.

Students leave schools with differing educational preparation for either higher education or the labor market. Many researchers have used the term *educational productivity* to reflect the quantity and quality of educational preparation. School-to-work transition has been a long-lasting problem attracting the attention of policy-makers and educators. Halperin, Melaville, and Taylor (1988) reported that "youth today, especially those who do not go to college, find it

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increasingly difficult to match changing market demands" (pp. 7-8). As the number of academic years in high school remains unchanged, an effective coping strategy is to enhance students' educational preparation, particularly in core academic subjects like mathematics and the sciences (National Research Council, 1996). Researchers have termed this strategy *improvement of educational productivity* (Johnson, 2000; Wang, 1999; Young, Reynolds, & Walberg, 1996).

Based on an extensive research synthesis, Walberg (1981, 1992) proposed a theory of educational productivity that highlights nine important factors behind student academic preparation. Reynolds and Walberg (1992a) classified these factors into three sets. The set of student aptitudes and attributes includes (a) student ability (i.e., prior achievement), (b) motivation, and (c) developmental level (e.g., age). The set of instruction includes (d) instructional quantity (i.e., amount of time), and (e) instructional quality (i.e., appropriateness) for the student. The set of psychological environment includes (f) class environment, (g) home environment, (h) peer environment, and (i) exposure to mass media outside of school (e.g., television). Walberg (1992) recollected that "syntheses of about 8,000 studies suggests that these generalizable factors are the chief influences on achievement and, more broadly, cognitive, affective, and behavioral learning" (p. 8).

Raising educational productivity is an important task to meet the demands of higher education and the labor market. Although the rapid development of computer sciences has created many technological jobs for the college-bound labor force, more than half of high school graduates do not go to college (Bishop, 1996). As a result, future employment for many high school graduates is not optimal. Decker (1997) reported that "over the past 30 years, a substantial proportion of high school graduates and dropouts were unemployed shortly after leaving high school" (p. 6).

The difficulty in school-to-work transition has placed educational productivity at the center of educational reform. Students with lower levels of educational preparation are personally severely disadvantaged economically (Snyder, Hoffman, & Geddes, 1996). Socially, as Decker (1997) stated,

> Education appears to play an important role in worker productivity in all industrialized countries. The industrialized countries with the highest productivity levels tend to have highly educated work forces, and the convergence in productivity among these countries generally parallels that in educational attainment. (p. 5)

Sociologists are eager to raise career attainment (Chung, Loeb, & Gonzo, 1996; Luzzo & Ward, 1995), and educators strive to improve educational productivity. Few researchers, however, have linked the two sides. The purpose of the current study is to investigate the relationship between student career aspiration and educational productivity. The emphasis is placed on mathematics education because "mathematics has become a critical filter for employment and full participation in our society" (National Council of Teachers of Mathematics, 1989, p. 4).

We used confirmatory factor analysis[1] on data from the Longitudinal Study of American Youth (LSAY) to test a structural equation model[2] of educational productivity with student career aspiration as the outcome measure. The LSAY data have been used to confirm the theory of educational productivity

(Reynolds & Walberg, 1991, 1992a, 1992b; Young et al., 1996). In addition, Miller and Brown (1992) reported that "results of the LSAY data analyses permit an understanding of the relative importance of the factors constituting a model to predict the development of career expectations" (p. 221). Nonetheless, attempts have yet to be made to examine the relationship between educational productivity and student career aspiration (Wang, 1999). Therefore, this investigation features both confirmatory and exploratory characteristics. The confirmatory component is grounded on the adoption of Walberg's (1981, 1992) theory to select important factors from the LSAY database. The exploratory nature is distinguished by disentangling various relationships among the factors of mathematics-related educational productivity and student career aspiration, as Walberg's model has often been used to identify influential factors of educational productivity on student academic achievement. In the current study we investigated two main research questions:

1. Is the career aspiration model (developed on the basis of the theory of educational productivity) supported by national survey data (i.e., the LSAY)?
2. If yes, what is the relationship between student career aspiration and factors of educational productivity?

Method

Data

The Longitudinal Study of American Youth (LSAY) is a national panel study funded by the National Science Foundation (NSF). Around 3,000 students were randomly selected at the grade 10 level across the United States to participate in the LSAY. Participants wrote academic achievement tests and completed a student questionnaire in the 1987-1988 academic year when they were in grade 10. We selected grade 10 students as the population in the current study for various reasons. First, students in grades 9 and 12 are subjected to adjustment for entry to and graduation from high school, which may interfere with their career aspiration. On the other hand, students in grades 10 and 11 can focus more on academic learning. Second, "dropouts from the 1990 sophomore class were more likely to return to school than were their counterparts a decade earlier" (Smith et al., 1996, p. 50). Thus the sophomore is a crucial grade level (corresponding to grade 10 in US high schools) in which student career aspiration may play a role in preparation for a smooth transition from school to work.

Measures

In the application of structural equation modeling techniques, the use of indicators[3] for factors involved in the structural model is critical, particularly in testing the theory of educational productivity. Fraser, Walberg, Welch, and Hattie (1987b) stated that "use of better indicators in the future could yield even stronger links between productivity factors and student outcomes" (p. 230). Hence we paid close attention to the selection of indicators that measured each factor in a valid and reliable way.

Raelin (1980) stated that "by far the most important attitude ... in terms of its contribution to later work experience is career aspiration" (p. 132). The development of aspiration can lead students to clarify their career goals and thus make the learning experience in high school more meaningful. Educational psychologists consider the concept of aspiration a psychological construct that can be influenced by the contextual factors of a school setting (Plucker 1998; Quaglia & Perry, 1995). Specifically, student career aspiration can be indicated by two components: ambition and inspiration. Ambition refers to students' sense of educational and vocational goals for the future (Quaglia & Perry), and inspiration refers to students' involvement in an activity for its intrinsic value and enjoyment (Plucker). In line with this specification, we selected two indicators to reflect the levels of student ambition and inspiration for the future career.

One indicator described student job expectation in the future. In the LSAY, students reported their first choice of future occupation. This information was scaled on a socioeconomic index (Stevens & Cho, 1985; Stevens & Featherman, 1981). The other indicator described the mathematical requirement for the expected job. It was measured on a 5-point Likert scale from *very useful* to *no use*. To facilitate the interpretation of the statistical findings, both indicators were scaled such that a higher value indicates a more positive response.

Among the nine factors of educational productivity, student age is a main indicator of the individual developmental level. Nonetheless, we did not use this indicator in our structural equation model, "because the students in the [LSAY] sample were all from the same grade level, age was relatively constant and therefore omitted" (Reynolds & Walberg, 1992b, p. 373). Consequently, we constructed our structural equation model with the remaining eight factors of educational productivity.

Pertinent variables from the LSAY database were identified to represent the factors of educational productivity (see Table 1). Specifically, the factor of education outcome was indicated by two variables, achievement in mathematics and attitude toward mathematics. Mathematics achievement measured three components: basic skills and knowledge, routine problem solving, and complex problem solving. "The scale [of attitude toward mathematics] is based on the mean of four components of mathematics attitude: interest, utility, ability, and anxiety" (Miller, Hoffer, Suchner, Brown, & Nelson, 1992, p. 51). The motivation factor was indicated by two variables. One was a composite scale measuring students' independence and persistence in problem-solving; the other was a measure of student self-respect or self-esteem. Instructional quantity also had two indicators: mathematics homework hours in each week and ethics about school work in mathematics. Instructional quality was represented by a composite variable of mathematics teachers' commitment, including encouraging students to complete homework every day, to take all mathematics courses, and to work hard all the time in mathematics.

Home environment was indicated by parental socioeconomic status (SES) as well as parental emphasis on mathematics education, academic success, and college attendance. Class environment was measured by student fear of academic success for unpopularity. Unlike the class settings that include interactions with general classmates, peer environment described a circle of close friends, reflecting their attitude toward mathematics education and academic success. Mass media was represented by a composite variable that covers student use of magazines, newspapers, and TV news shows. All these variables have been scaled such that a higher value indicated a more positive response.

Table 1
Indicators Used to Measure Educational Productivity and Their Factor Loadings

Educational productivity	*Indicator*	*Factor loading*
Career aspiration	Socioeconomic index of expected occupation	21.48
	Occupational utility of mathematics	–0.01
Educational outcome	Mathematics achievement	1.00
	Attitude toward mathematics	0.39
Motivation	Independence and persistence	1.64
	Self-esteem	1.59
Instructional quantity	Homework hours	2.68
	School work ethic	2.22
Instructional quality	Teacher mathematics push	1.00
Home environment	Socioeconomic status	0.31
	Parent mathematics push	0.69
	Parent academic push	1.20
	Parent college push	0.38
Class environment	Fear of success	1.00
Peer environment	Peer mathematics push	0.60
	Peer academic push	0.78
Mass media	News acquisition	1.00

In the process of selecting indicators, we emphasized the use of multiple sources of information to reduce potential measurement errors (Bentler, 1980; Hayduk, 1987; Reynolds & Walberg, 1991).

Model Specification

Figure 1 shows the structural equation model that we developed on the basis of Walberg's theory of educational productivity. With respect to Walberg's model, which posits direct, simultaneous influences of the nine factors of educational productivity on schooling outcomes (Reynolds & Walberg, 1991), in our model we postulated direct structural relationships between student career aspiration and factors of educational productivity.

Not shown in our structural equation model for reasons of simplicity of presentation are interrelationships among the eight factors of educational productivity, but we did take into account the correlations among the eight factors of educational productivity (see Table 2). Also not presented in Figure 1 are measurement errors associated with the indicators. These measurement errors were subsumed in the examination of the model-fitting indices (see the following section). Therefore, our structural equation model in Figure 1 indicated only direct relationships between student career aspiration and the eight factors of educational productivity to emphasize the theoretical aspect of the model.

Confirmation of the Model

A common problem that most large-scale surveys face is the existence of missing values. To construct the correlation matrix among the indicators, we used pairwise deletion to cope with missing values. The minimum number of

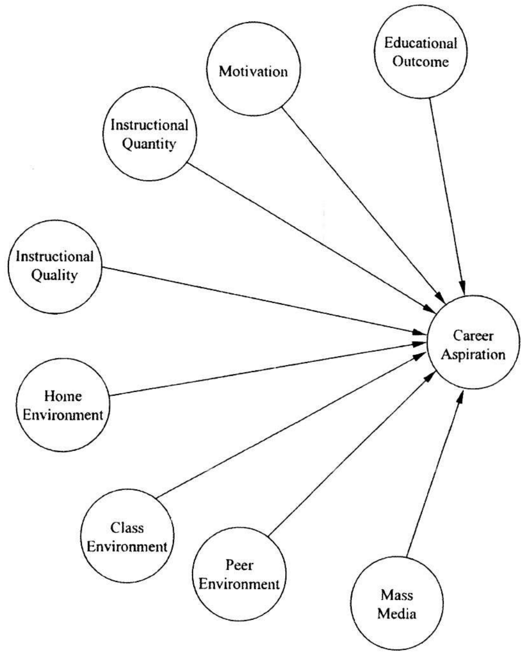

Figure 1. A structural model describing the relationship between career aspiration and educational productivity.

observations among all identified variables turned out to be 2,227, above 74% of the sample size. In the process of confirming the model, the minimum sample size was employed to avoid potential Type I error (Bentler & Bonett, 1980). In addition, we followed Marsh, Balla, and McDonald (1988) who, in consideration of the retention of different sample sizes for different variables, noted that incremental fit indexes (IFI) "are useful for comparing the fit of a particular model across samples that have unequal sizes" (p. 393).

We also used other indexes of the model-data-fit. Joreskog and Sorbom (1981) advocated the use of a goodness-of-fit index (GFI) to measure the relative amount of variances and covariances commonly explained by the model. Marsh et al. (1988) suggested the adoption of root mean square residual (RMR) to "justify the conclusion that a model adequately fits a particular set of data" (p. 391). We used multiple methods to test the model-data-fit, following Bollen (1989), who emphasized the use of multiple indexes to confirm the model-data-fit in a result triangulation way. The standardized RMR for our structural equation model was 0.069, which suggested an adequate control of the measurement and structural errors. In addition, the IFI was 0.710, and the GFI was 0.914. Both measures indicated a good fit of the LSAY data to our structural equation model (Joreskog & Sorbom, 1993). Those indexes reported came from the LISREL program that we used to estimate our structural equation model.

Results

Correlation coefficients among the eight factors of educational productivity (in Table 2) in general supported the conclusion that factors of educational productivity are related to one another (Reynolds & Walberg, 1991). However,

Table 2
Correlation Coefficients of Educational Productivity Factors

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1. Educational outcome	1.00							
2. Motivation	0.96	1.00						
3. Instructional quantity	0.62	0.67	1.00					
4. Instructional quality	0.44	0.26	0.26	1.00				
5. Home environment	0.44	0.50	0.47	0.27	1.00			
6. Class environment	−0.03	0.03	0.02	−0.03	0.04	1.00		
7. Peer environment	0.50	0.47	0.67	0.22	0.61	−0.01	1.00	
8. Mass media	0.26	0.31	0.25	0.09	0.29	−0.01	0.31	1.00

with the absolute magnitude of correlation coefficients less than 0.04, we found no relationships between class environment and other factors of educational productivity. Note that the factor of class environment in the LSAY tapped student fear of academic success in classroom, reflecting the extent to which the classroom climate might discourage students from pursuing academic excellence. This particular aspect of the class environment seemed to be independent of other factors of educational productivity.

A factor of educational productivity was often measured through multiple indicators in the structure equation model that we developed to explore the relationships between student career aspiration and factors of educational productivity in the context of mathematics education, so we used factor loadings to show the contribution of each indicator to the "latent" factor (see Table 1). As discussed above, student career aspiration was indicated by the socioeconomic index of expected occupation and career utility of mathematics. Career utility of mathematics had a much smaller factor loading than the socioeconomic index. This difference revealed that academic concerns carried much less weight than socioeconomic concerns in student career consideration. Table 3 shows the direct effects (path coefficients) of the eight factors of educational productivity on student career aspiration.

Educational outcome and motivation had the strongest direct effects on student career aspiration. Although with similar magnitude, the effects of educational outcome were positive on student career aspiration, whereas the effects of motivation were negative. The student mathematics-related educational outcome was indexed through achievement in mathematics and attitude toward mathematics, with achievement in mathematics as the major contributor to the factor (see Table 1). Higher educational outcome (i.e., achievement in mathematics and attitude toward mathematics) increased student career aspiration. Motivation was indicated through self-esteem and measures of independence and persistence in learning. The two indicators contributed almost equally to the factor (see Table 1). The negative effects showed that higher motivation (i.e., self-esteem, independence in learning, and persistence in learning) depressed student career aspiration.

Two factors had secondary effects on student career aspiration. Mathematics-related instructional quantity had positive effects on student career aspiration, whereas mathematics-related instructional quality had negative

Table 3
Estimates of Direct Effects of Educational Productivity on Career Aspiration

Educational productivity	*Direct effect on career aspiration*
Educational outcome	19.45
Motivation	–19.98
Instructional quantity	3.66
Instructional quality	–4.22
Home environment	3.15
Class environment	0.84
Peer environment	–4.00
Mass media	1.18

effects. The factor of instructional quantity was represented by mathematics homework hours and school work ethics in mathematics. As shown in Table 1, the two indicators contributed almost equally to the factor. A higher level of instructional quantity (i.e., homework quantity and ethics associated with school work) increased student career aspiration. The factor of instructional quality was represented by academic push (i.e., pressure) of mathematics teachers. The negative effects showed that a higher level of instructional quality (i.e., academic push of mathematics teachers) reduced student career aspiration.

Home environment and peer influence were the other two variables with secondary effects (similar in magnitude) on student career aspiration. Home environment showed a positive path coefficient. The factor of home environment was measured through educational commitment of parents to their children and family SES. Factor loadings in Table 1 showed that educational commitment, rather than SES, was the major player in this factor. Therefore, we concluded that home environment with greater educational commitment from parents promoted student career aspiration. Peer influence showed a negative path coefficient. The factor of peer influence was measured through academic push of peers in general and in mathematics in particular. Both indicators contributed similarly to the factor. Peer influence (i.e., academic push of peers) depressed student career aspiration.

Class environment had the smallest path coefficient. As mentioned above, the measure of class environment was mainly concerned with student fear of academic success in the classroom. This aspect of class environment had the least impact on student career aspiration. As mentioned above, class environment (measured through student fear of academic success in classroom) was hardly correlated with other factors of educational productivity (see Table 2). It seemed that this aspect of class environment was largely self-contained. Media environment was the second weakest factor of educational productivity in the current study. This factor mainly tapped students' access to news (the news sources that students used such as magazines, newspapers, and TV news shows). This aspect of media influence, although present in the daily life of students, did not seem to have a clear focus to guide student career orientation.

Discussion

As one of the critical schooling outcomes, student career aspiration has become an important index of social welfare. Researchers have investigated career aspiration and educational productivity separately (Miller & Brown, 1992; Reynolds & Walberg, 1991, 1992a; 1992b). Our empirical study merged the two sides in an attempt to establish critical relationships between student career aspiration and factors of educational productivity.

Although Fraser et al. (1987b) stated that "all factors seem important in that, without at least a small amount of each, students are likely to learn little" (p. 227), we did identify two factors of educational productivity as having the strongest direct effects on student career aspiration. One is educational outcome as measured through achievement in mathematics and attitude toward mathematics. Smith et al. (1996) stated that "proficiency in mathematics is an important outcome of education. In an increasingly technological world, the mathematics skills of the nation's workers may be a crucial component of economic competitiveness" (p. 72). Thus the positive effect of educational outcome we found in the current study has reconfirmed the critical role of mathematics education in the development of student career aspiration. This finding implies that one of the most effective things that mathematics educators can do to promote student career aspiration is to improve student educational outcomes in mathematics. We particularly encourage mathematics educators to continue to encourage student achievement in and attitude toward mathematics. Students who capitalize on positive educational outcomes in mathematics are more likely to aim for higher career goals.

We suggest that the interpretation of the negative effects associated with motivation be grounded on plausibility. Fraser, Walberg, Welch, and Hattie (1987a) pointed out that "research workers and educators should retain both open-mindedness and skepticism about educational productivity and syntheses of research" (p. 154). One possible reason for the negative effects of motivation on student career aspiration is that highly motivated students might have more anxiety about setting higher career goals. Most grade 10 students are in the process of establishing self-identity (Meeus, Geode, Kox, & Hurrelmann, 1992). They may underestimate their ability in self-assessment and may doubt their potential to achieve high career goals. As a result, it is possible that highly motivated students may underestimate their potential for future occupations. Many mathematics educators tend to think that highly motivated students require less educational attention than students with low motivation. Our finding suggests that mathematics teachers need to realize that highly motivated students may develop more anxiety about their future careers and that they need to spend enough time on these students to help them establish future career projections suitable to their academic capabilities and personal motivation.

The other two negative effects were associated with instructional quality and peer influence. As discussed above, these two factors were mainly concerned with academic push of mathematics teachers and peers. We concluded that this type of external academic push from teachers and peers may not facilitate the development of student career aspiration. We are concerned about how well students internalized this external academic push from teachers and peers for the benefit of their own career aspiration. The fact that many mathematics teachers have unrealistic academic expectations for their students has long been noted (National Commission on Excellence in Education, 1983). Bishop (1996) reported that "in the United States, the peer group actively discourages academic effort" (p. 83). In the current study, we found that unrealistic academic expectation of teachers and peers had a negative impact on student career aspiration.

On the other hand, educational commitment of parents to their children as measured through parental academic push showed positive effects on student career aspiration. We speculate that parents might have more realistic academic expectations for their children based on greater familiarity with them (e.g., their interests, passions, and potential). It is thus more likely for students to internalize parental academic expectation to promote higher career aspiration. We have proposed this notion about academic push from teachers, peers, and parents as a research hypothesis rather than a research conclusion for future studies.

Therefore, we encourage mathematics educators to examine their academic expectations for students carefully, making sure that their expectations are achievable, and they may wish to encourage student peers to do the same. Mathematics educators may also wish to take advantage of the positive effects of parental educational commitment on student career aspiration by actively working with parents to help students establish reasonable career goals for their future. Frequent parent-teacher communication may be an effective way to cooperate. In addition, given the positive effects of instructional quantity, mathematics educators may also wish to work with parents to nurture healthy work ethics in school and at home, and this effort can be enhanced along with a proper amount of homework.

In sum, in the current study we extended Walberg's model of educational productivity to include student career aspiration. We particularly examined the effects of educational productivity factors on student career aspiration in the context of mathematics education. This extended model seemed to fit the LSAY data well, indicating that the career aspiration model was supported by the national data. The model also helped us identify several critical factors of educational productivity that affected student career aspiration. We suggest that Walberg's model of educational productivity seemed to work well in the case of student career aspiration as a measure of schooling outcome. There was, however, a large discrepancy regarding the effects of educational productivity factors, in terms of both magnitude and direction of effects. This situation might have something to do with the specific measures that we obtained from the LSAY, and thus we think that the current study may open many new doors for future researchers to examine the career aspiration model with different aspects of educational productivity factors.

Notes

1. In confirmatory factor analysis, researchers build models "based on priori information about the data structure in the form of a specified theory or hypothesis, a given classificatory design for items or subtests according to objective features of content and format, known experimental conditions, or knowledge from previous studies based on extensive data" (Joreskog & Sorbom, 1993, p. 22). In exploratory factor analysis, researchers explore the

empirical data to detect and assess characteristic features of interesting relationships without imposing any definite model on the data (Joreskog & Sorbom).

2. Structural equation modeling is a set of comprehensive statistical techniques that construct relationships among indicator variables and latent factors (Hoyle, 1995). Reynolds and Walberg (1991) noted that "structural modeling can account for measurement error, determine construct validity of measures, and test model fit, none of which can be handled by classical regression analysis" (p. 98). We adopted this statistical approach also because structural equation models "provide researchers with a comprehensive method for the quantification and testing of theories" (Marcoulides & Schumacker, 1996, p. 1), which were the purpose of the current study.
3. The terms *variable* and *indicator* are used interchangeably in the current study. In the literature of structure equation modeling, indicators (which are measurable) are used to describe various aspects of a "latent" factor (which is unobservable). Often, as in the case of the current study, variables (e.g., from survey studies) are used as indicators to represent various characteristics of a latent factor.

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