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The contribution of gender, parental education, achievement goals and intelligence

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HÁSKÓLI ÍSLANDS

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Abstract

Four important factors that have been shown to correlate with academic performance are intelligence, family socioeconomic status, achievement goals and gender. The simultaneous contribution of these four predictors to academic achievement, as measured by the Icelandic National Examinations in two subject areas, language arts and mathematics, was examined in this study. The relative contribution of these factors was examined separately for fourth and seventh grade, as well as their contribution to the change in performance over time, from fourth to seventh grade. It is clear that intelligence remains the most important known predictor of achievement, even when controlling for prior performance, but parental education, achievement goals and gender also play a role. Although the effects of these factors persist to some extent, they become smaller as students move from fourth to seventh grade. Thus, once students have entered the school environment, other factors appear to become more influential. The importance of prior performance for subsequent performance was also investigated in the present study. Prior performance contributes substantially to subsequent performance, even when controlling for background variables and general ability, and thus it is crucial that students have a solid knowledge base to build on as they move from one grade to the next.

Table of Contents

Academic achievement in 4th and 7th grade - The contribution of gender, parental education, achievement goals and intelligence

Academic performance affects students‘ opportunities for further education and future occupation. In fact, school grades have been shown to be a powerful predictor of future success, as measured by education, occupation and income (Slominski, Sameroff, Rosenblum, & Kasser, 2011; Strenze, 2007). A major goal of the educational system must therefore be to maximize students‘ performance. This may not be such a straightforward task, however, since it is not obvious how to reach this goal. It has been debated in the literature whether the resources being allocated to the educational system are truly influencing student outcome, since it is unclear which variables in fact make a difference (Hanushek, 1986, 1994; Hedges, Laine, & Greenwald, 1994a, 1994b). Thus, it is important to examine the factors that actually affect students‘ achievement in school. Different factors may come into play at different grade levels and some may be more malleable to change than others. An elucidation of this pattern may provide schools with tools to effectively allocate their resources and consequently enhance their students‘ performance. Several factors are known to associate with academic achievement. Four important predictors of students’ performance are intelligence, family socioeconomic status, achievement goals and gender.

Intelligence

Of the known predictors of achievement, measures of intelligence are the most important. Correlations between intelligence scores and school performance have been estimated at 0.50 and generally range from 0.40 to 0.70 (Mackintosh, 1998; Naglieri & Bornstein, 2003; Neisser et al., 1996). These correlations are predictive in that children's intelligence scores correlate with their educational attainment as well as social position in adulthood (Deary et al., 2005; Mackintosh, 1998; Neisser et al., 1996; Slominski et al., 2011; Strenze, 2007; von Stumm, Gale, Batty, & Deary, 2009; von Stumm, Macintyre, Clark, & Deary, 2010). Normally, the correlation between intelligence and academic performance decreases with higher levels of education, but this decline may be due to the increasing restriction of range at later educational stages (Gustafsson & Undheim, 1996; Mackintosh, 1998). Intelligence tends to account for a higher portion of the variance in mathematics-related subjects than language-related subjects (Balboni, Naglieri, & Cubelli, 2010; Deary, Strand, Smith, & Fernandes, 2007; Pind, Gunnarsdottir, & Johannesson, 2003; Spinath, Spinath, Harlaar, & Plomin, 2006).

A factor common to a variety of intelligence measures has been termed general mental ability (g). Jensen (1998) has suggested that this factor represents individual differences in information processing, such as attending, searching, discriminating and generalizing. A distinction is made

in the literature between crystallized intelligence, stored knowledge and learned operations, and fluid intelligence, the ability to learn and to solve novel problems without relying on stored knowledge (Nisbett et al., 2012).

The heritability of general intelligence is substantial and is more prominent in studies with adults than children. Estimates range from 30% in early childhood to as much as 80% in adulthood. Thus, by adolescence, a larger portion of the variance in intelligence scores is contributed by genetic than environmental factors (Deary, Johnson, & Houlihan, 2009; Jensen, 1998). Nevertheless, there is a substantial environmental effect on intelligence as well, as demonstrated by both adoption studies and the large societal gains in intelligence scores over time (Nisbett et al., 2012; Raven, 2000). Although intelligence measured in early childhood cannot accurately predict adult intelligence, intelligence scores are quite stable from adolescence into adulthood (Gustafsson & Undheim, 1996; Neisser et al., 1996; Mackintosh, 1998).

It is somewhat unclear to what extent interventions are able to affect intelligence. School attendance does appear to affect intelligence, as demonstrated by children of nearly the same age starting school one year apart and by seasonal changes in children's intelligence scores (Nisbett et al., 2012). However, many early intervention programs designed to increase academic ability often only have a transient effect on intelligence scores (Jensen, 1998; Nisbett et al., 2012). Recent studies have shown that specific

training in working memory tasks can enhance fluid intelligence scores (Nisbett et al., 2012).

Studies have shown that intelligence independently predicts academic achievement in the presence of other variables such as family socioeconomic status, personality traits and motivational factors (Chamorro-Premuzic & Furnham, 2008; Colom & Flores-Mendoza, 2007; Johnson, McGue, & Iacono, 2007; Laidra, Pullmann, & Allik, 2007; Ong, Chandran, Lim, Chen, & Poh, 2010; Spinath et al., 2006; Steinmayr, Bipp, & Spinath, 2011; von Stumm, Hell, & Chamorro-Premuzic, 2011). In addition, Steinmayr and Spinath (2009) found that intelligence affected change in academic performance such that it still predicted school performance when prior performance was controlled for.

Socioeconomic status

Another well known correlate of academic performance is family socioeconomic status (SES), with an average correlation coefficient of around 0.30 (Sirin, 2005; White, 1982). The correlation is predictive such that family SES in childhood predicts educational and social status in adulthood (Entwisle, Alexander, & Olson, 2005; Fergusson, Horwood, & Boden, 2008; von Stumm et al., 2009; von Stumm et al., 2010).

Family SES generally constitutes any or all of the parents‘ education, occupation and income. As Jeynes (2002) points out, SES is a complex

variable, since it reflects numerous qualities that result in a certain level of education, occupation and income. For example, SES can serve as a proxy variable for personality traits or other attributes of the parents, such as their intelligence, work ethic and values. These attributes may be either genetically or socially passed on to their children. Therefore, the causality of family SES is difficult to determine and it can symbolize both genetic and environmental factors.

Family SES correlates with intelligence, and this correlation has been shown to remain even when attained social position is controlled for (Deary et al., 2005; Lemos, Almeida, & Colom, 2011; Sorjonen, Hemmingsson, Lundin, & Melin, 2011; von Stumm et al., 2009; von Stumm et al., 2010; Vista & Grantham, 2010). Since SES is known to correlate with intelligence scores, these two predictors of academic achievement are likely to overlap to some extent. Fergusson et al. (2008) found that much of the association between early family SES and later educational achievement was mediated by cognitive ability and family educational aspirations, although a substantial component of the association remained unexplained. Johnson et al. (2007) found that intelligence accounted for about a third of the effect of SES on school grades, but that SES did exert a small but significant environmental effect on grades. Steinmayr, Dinger and Spinath (2010) found that the association between family SES and academic achievement was partially mediated by the children‘s intelligence and

personality traits. Ong et al. (2010) found an independent effect of family SES in the presence of intelligence, whereas Colom and Flores-Mendoza (2007) did not detect an additional contribution by family SES when intelligence was controlled for. Taken together, these results suggest that the effects of family SES on academic achievement are partially accounted for by intelligence.

There are mixed results on how the effect of family SES varies with grade level. Some studies have indicated that the correlation between SES and achievement diminishes with increasing age, whereas others have suggested that the gap between high and low SES students persists (Bradley & Corwyn, 2002; Sirin, 2005). A study that directly examined the effect of family SES on change in academic performance suggested a small effect of SES on subsequent performance when prior performance was controlled for (Steinmayr et al., 2011).

Achievement goals

Within the motivation literature relating to academic achievement, achievement goals have become a central concept (Murphy & Alexander, 2000). Achievement goals refer to the purpose of the individual‘s learning behavior. Learning goals reflect the pursuit of mastery, whereas performance goals center on the demonstration of competence (Anderman & Wolters, 2006). The latter has been divided into performance-approach,

where the demonstration of competence is sought, and performance-avoidance, where the demonstration of incompetence is avoided (Elliot & Harackiewicz, 1996; Elliot, 1999; Elliot & Covington, 2001; Middleton & Midgley, 1997).

An orientation towards learning goals generally leads to a better performance than an orientation towards performance goals (Anderman & Wolters, 2006; Utman, 1997). Performance-avoidance goals are generally negatively correlated with achievement, whereas the results for performance-approach goals are less conclusive, with some studies showing a positive association and others a lack of association (Anderman & Wolters, 2006; Elliot & Moller, 2003). The usefulness of performance-approach goals may depend on the students' characteristics and the situation (Midgley, Kaplan, & Middleton, 2001). Results from Darnon, Harackiewicz, Butera, Mugny and Quiamzade (2007) indicate that performance-approach goals enhance performance at low uncertainty but impede performance at high uncertainty. Recent data also suggest that learning goals affect academic achievement directly, whereas performance goals affect achievement through self-estimated intelligence, such that students oriented towards performance-approach goals overestimate their intelligence but students oriented towards performance-avoidance underestimate their intelligence (Bipp, Steinmayr, & Spinath, 2012).

The orientation towards certain types of achievement goals appears to be stable over time (Tuominen-Soini, Salmela-Aro, & Niemivirta, 2011). Steinmayr et al. (2011) found that learning goals significantly added to the prediction of school performance when added after intelligence, personality factors and other achievement goals in a multiple regression model. Steinmayr and Spinath (2009) found that learning goals, but not performance goals, incrementally predicted achievement when controlling for prior performance and intelligence.

Gender

Gender is known to relate to academic performance. Females show an advantage over males on language ability from early on and they generally outperform males on verbal measures, both school exams and standardized achievement tests. The female advantage increases throughout childhood and is relatively large by adolescence, especially on tests based on writing and language usage (Halpern, 2006; Halpern et al., 2007). The pattern for quantitative skills is somewhat more complex. Females tend to get higher grades than males on mathematics school exams at all grade levels. On measures that are less related to the school curriculum, however, there is a female advantage in the early school years that reverses into a male advantage later on. Since males do show a consistent advantage in visuospatial ability, this reversal may be due to the mathematical problems becoming more spatial in nature (Halpern et al., 2007). Males are also more

variable in their quantitative ability and are thus more numerous at both ends of the distribution (Halpern et al., 2007; Strand, Deary, & Smith, 2006). A number of factors, biological and sociocultural, are likely to contribute to these gender differences in achievement (Halpern et al., 2007).

Some authors have suggested a gender difference in general intelligence, such that males gain an advantage from adolescence, whereas others have argued that the difference between males and females is either non-existent or of inconsequential magnitude (Colom & Lynn, 2004; Irwing & Lynn, 2005; Lynn, 1999; Lynn, Allik, Pullmann, & Laidra, 2004; Lynn & Irwing, 2004a, 2004b; Mackintosh, 1998). Regardless, differences in general intelligence are not able to account for gender differences in academic performance (Calvin, Fernandes, Smith, Visscher, & Deary, 2010; Deary et al., 2007).

Research on achievement goals has shown that females tend to be more oriented towards learning goals, whereas males tend to be more oriented towards performance goals, which may partially explain the female advantage on school exams (Kenney-Benson, Pomerantz, Ryan and Patrick, 2006).

Study aims

The purpose of this study was to examine how the above mentioned predictors of academic achievement, i.e. intelligence, family SES,

achievement goals and gender, relate to students‘ progress in school. The Icelandic National Examinations (INEs) provide a unique opportunity for such a study as they are administered to all Icelandic students in both fourth and seventh grade. The INEs are administered in two subject areas, language arts and mathematics. The first aim was to analyze the relative contribution of intelligence, family SES, achievement goals and gender to the students‘ overall performance in these two subject areas, separately for fourth and seventh grade. The second aim was to examine the effect of these same factors on change in performance over time, from fourth to seventh grade. To this end, their contribution to the prediction of seventh grade performance was examined while fourth grade performance was controlled for. Conversely, the third aim was to estimate the contribution of prior performance to subsequent performance when the above mentioned predictors, as well as other indicators of general academic ability, were controlled for.

Method

Participants and procedure

Students in the seventh grade of the Icelandic school system participated in a study that was undertaken in the school year of 2000-2001. Students were randomly recruited from all geographical regions in Iceland.

An intelligence test was administered to the participating students in the spring of 2001. The students and their parents were also asked to fill out questionnaires during the same time period. The seventh grade INEs were administered in the fall of 2000. In addition, fourth grade INE scores for the participating students were obtained from school authorities. A total of 1592 students were initially recruited to the study. Included in the present analysis were students who had complete data on all analyzed variables (except family income and parental occupation, see Results section), a total of 1019 students. The drop in participant numbers was largely due to the lack of returned parental questionnaires. The total number of seventh grade students in 2000 was 4,569 and thus the present sample equals 22.3% of the entire student population. Demographics of this sample are shown in table 1, along with the actual distribution of students across gender and geographical region in Iceland in 2000 (Statistics Iceland, 2012). As seen in table 1, the sample is quite representative of the actual student population.

Table 1. Demographics of the study sample as well as corresponding percentages for the actual student population.

	Sample		Actual
	N	Percent	Percent
Total	1019	100.0	
Year of birth			
1987	0	0.0	
1988	1013	99.4	
1989	6	0.6	
Gender			
Male	528	51.8	52.4
Female	491	48.2	47.6
Geographic region			
Reykjavik	373	36.6	33.4
Reykjavik surrounding area	206	20.2	24.9
Reykjanes peninsula	49	4.8	6.4
West	58	5.7	5.7
Western fjords	63	6.2	3.1
North-west	28	2.7	3.5
Norht-east	65	6.4	9.7
East	66	6.5	5.0
South	111	10.9	8.4

Measures

Icelandic National Examinations. The Icelandic National Examinations (INEs) were administered to the students in fourth and seventh grade according to standard procedures. There are two INE subjects in both fourth and seventh grade, language arts and mathematics. The blueprint of these examinations closely follows the national curriculum guide. The structure of the INE in language arts is the same in fourth and seventh grade and is the following: 15% spelling, 10% writing, 25%

language use and 50% reading/listening comprehension. The structure of the fourth grade INE in mathematics is the following: 25% numbers, 55% arithmetic and operations and 20% geometry and measurement. The structure of the seventh grade INE in mathematics is the following: 63% arithmetic and operations, 25% geometry and measurement and 12% probability and statistics. Factor analysis of the INEs has suggested that the fourth and seventh grade exams measure comparable educational domains, indicating that a comparison of the two is a valid measure of student progress (Guðmundsson, Skúlason, & Arnkelsson, 2000). Grades on these examinations are given on a scale from 0 through 10 with 0.5 unit increments.

Intelligence measure. Intelligence was measured using the Raven's Matrices that measure intelligence in a non-verbal manner. The Raven's Matrices are considered a good measure of general intelligence (*g*). More specifically, they are considered the best available measure of fluid intelligence, the ability to learn and solve novel problems without relying on stored knowledge (Nisbett et al., 2012). There are three forms of the Raven's Matrices that differ in complexity. The Standard Progressive Matrices (SPM) were used in the present study. This form is most commonly used for adolescents and adults and has been widely used for research purposes. The SPM test was administered in a group format according to the guidelines provided in the SPM manual (Raven, Raven and

Court, 1998). Possible scores on the SPM test range from 0 through 60. The internal consistency (Chronbach alpha coefficient) of SPM scores in this Icelandic sample was 0.84.

Parent questionnaires. Questionnaires completed by the students' parents included questions on the parents' education level, employment and family income. The paternal and maternal education levels were classified according the International Standard Classification of Education from 1997 which consists of levels 1 through 6 (UNESCO, 1997). These levels were the following: 1) primary education, first stage of basic education or less, 2) lower secondary or second stage of basic education, 3) upper secondary education, 4) post-secondary non-tertiary education, 5) first stage of tertiary education and 6) second stage of tertiary education. Family income consisted of six levels of income for the family as a whole. These levels were the following: 1) 1.7 million ISK or less, 2) 1.8 – 2.5 million ISK, 3) 2.6 – 3.4 million ISK, 4) 3.5 – 4.2 million ISK, 5) 4.3 – 5.1 million ISK and 6) 5.2 million ISK or more. Parental occupation consisted of nine different occupational categories for each parent that were analyzed as nominal variables. These categories were the following: 1) owner of a small business, 2) office worker, 3) service industry worker, 4) skilled agricultural or fishing industry worker, 5) tradesperson 6) general laborer, 7) business director, member of the parliament or other leadership in the public sector, 8) professional and 9) technician or assistant.

Student questionnaires. Questionnaires completed by the students themselves included questions probing their achievement goals, adopted from Middleton and Midgley (1997). Learning and performance-approach goals consisted of five items each, whereas performance-avoidance goals consisted of four items. Each question was answered on a scale from one through five, and the scores for each goal were obtained by adding the scores for the relevant items. Factor analysis confirmed the original three factors of learning (alpha = 0.81), performance-approach (alpha = 0.84) and performance-avoidance (alpha = 0.74) goals. However, the performance-approach factor was somewhat correlated with the other two factors (see Results section). The descriptive statistics for all variables used in the present analysis are shown in table 2.

Table 2. Descriptive statistics of variables used in the study.

	Father's edu	Mother's edu	Family income	Learn goals	Perform-appr	Perform-avoid	Intelli-gence	Lang arts 4th	Math 4th	Lang arts 7th	Math 7th
N valid	1019	1019	906	1019	1019	1019	1019	1019	1019	1019	1019
N missing	0	0	113	0	0	0	0	0	0	0	0
Mean	3.4	3.2	4.1	17.4	14.3	9.7	45.5	6.9	7.0	7.1	7.0
Median	3	3	4	18	14	10	46	7.0	7.0	7.5	7.0
Std Dev	1.4	1.3	1.6	4.6	4.9	3.7	6.0	1.6	1.7	1.3	1.6
Skewness	0.4	0.6	-0.3	-0.8	0.0	0.3	-0.9	-0.5	-0.6	-0.5	-0.5
Kurtosis	-0.7	-0.8	-1.1	0.4	-0.5	-0.5	1.9	-0.2	-0.3	-0.5	-0.4
Minimum	1	1	1	3	1	2	10	2	2	3.0	1.5
Maximum	6	6	6	25	25	20	58	10	10	9.5	10.0

Statistical analysis

In addition to standard correlation and multiple regression analyses, the relative importance of predictors was estimated. LeBreton, Hargis, Griepentrog, Oswald and Ployhart (2007) define relative importance as the contribution that each predictor makes to the R^2 and suggest two new statistics to determine this. One of these statistics, general dominance weights, was used in the present study. Dominance analysis involves computing the mean ΔR^2 of each predictor across all possible subset regression models. Consequently, general dominance weights represent the average usefulness of each variable. Further, rescaled dominance weights were calculated by dividing the general dominance weights by the model R^2, thus representing the proportion of the explained variance that can be attributed to a particular predictor (LeBreton et al., 2007). In the case of change in performance, prior performance was controlled for while performing dominance analysis for the remaining variables.

Results

Zero-order correlations

Correlations between all variables are shown in table 3. The correlation of intelligence with INE grades ranges from 0.46 to 0.60, the

highest correlation being with mathematics in seventh grade. The correlation coefficients between the various standardized tests range from 0.63 to 0.82. The parents‘ education has a moderate correlation with academic performance, ranging from 0.22 to 0.32. The mother‘s education has a correlation of 0.54 to the father‘s. Family income correlates with the parents‘ education, ranging from 0.36 to 0.44, and with academic achievement, ranging from 0.17 to 0.21. Performance-avoidance goals correlate negatively with academic achievement, whereas performance-approach and learning goals generally do not correlate significantly with achievement. Performance-approach goals show substantial correlation with both learning goals and performance-avoidance goals, whereas learning goals and performance-avoidance goals are fairly orthogonal to each other. Due to their high overlap with the two other types of goals and their low relationship with achievement, performance-approach goals were excluded from further analysis. Gender differences in performance are generally small. Correlations suggest that girls are doing slightly better on the intelligence test as well as on the INEs in language arts. In line with previous research (Kenney-Benson et al., 2006), girls appear to be more oriented towards learning goals whereas boys are more oriented towards performance goals.

Table 3. Zero-order correlations between variables used in the study.

	Gender (0=male 1=fem)	Father's edu	Mother's edu	Fam income	Learn goals	Perform-appr	Perform-avoid	Intelli-gence	Lang arts 4th	Math 4th	Lang arts 7th
Father's edu	0.03										
Mother's edu	-0.01	0.54									
Fam income	0.01	0.44	0.36								
Learn goals	0.22	0.06	0.02	0.04							
Perform-appr	-0.11	0.01	-0.04	0.01	0.38						
Perform-avoid	-0.14	-0.07	-0.08	-0.03	0.14	0.50					
Intelligence	0.08	0.17	0.20	0.13	0.00	0.04	-0.10				
Lang arts 4th	0.08	0.24	0.32	0.17	0.01	-0.09	-0.26	0.46			
Math 4th	-0.03	0.22	0.27	0.21	-0.06	-0.04	-0.17	0.53	0.68		
Lang arts 7th	0.13	0.27	0.31	0.17	0.06	-0.05	-0.25	0.51	0.82	0.63	
Math 7th	-0.06	0.27	0.31	0.20	-0.02	-0.01	-0.17	0.60	0.65	0.77	0.71

N = 1019, except for correlations with family income where N = 906

All correlation coefficients of ±0.07 or greater are statistically significant at the 0.05 level

Multiple regression assessing the prediction of academic achievement in fourth and seventh grade

The four factors of gender, parental education, achievement goals and intelligence were used to predict academic achievement. Although information on family income and parental occupation were also available, these variables did not add substantially to the prediction of academic performance in multiple regression models and were thus excluded from further analysis. As outlined in the Method section, assessment of achievement goals and intelligence was not conducted until the seventh grade and therefore these variables cannot accurately be labeled as

predictors for fourth grade scores. Nevertheless, these variables were included at both grade levels for comparison purposes. The regression results for the language arts INE in fourth grade are shown in table 4a. Gender does not significantly affect performance in the complete model, even though zero order correlations showed that girls were doing slightly better than boys on this examination. The mother‘s, but not the father‘s, education contributes significantly to the model. Performance-avoidance goals and intelligence associate with performance in this model, performance-avoidance goals negatively and intelligence positively. The total variance explained by this model is 30.8%. The last two columns in table 4a show a general dominance analysis of the included predictors, which is suggestive of the relative importance of each variable in the model (LeBreton et al., 2007). According to this analysis, intelligence contributes 57.3%, parental education 25.5%, achievement goals 16.2% and gender 1.0% to the explained variance.

The regression results for the mathematics INE in fourth grade are shown in table 4b. Here gender contributes significantly to performance in the complete model, even though the zero order correlation between gender and performance on this examination was not significant. Both parents‘ education contributes significantly, though the mother‘s education has a larger effect. Performance-avoidance goals associate negatively and intelligence associates positively with achievement. The total variance

explained by this model is 32.8%. Again the last two columns show the results of general dominance analysis, suggesting that intelligence contributes 76.0%, parental education 16.4%, achievement goals 6.5% and gender 1.1% to the explained variance.

Table 4. Multiple regression predicting fourth grade INE scores in (a) language arts and (b) mathematics.

(a) Dependent variable: Language arts 4th grade

	B	Standard error	Beta	Significance level	General dominance	Percent of explained variance
Constant	1.974	0.369		<0.001		
Gender (0=male, 1=female)	0.064	0.085	0.021	0.452	0.003	1.0%
Father's education	0.049	0.036	0.043	0.172	0.078	25.5%
Mother's education	0.239	0.037	0.203	<0.001		
Learning goals	0.009	0.009	0.028	0.304	0.050	16.2%
Performance-avoidance goals	-0.082	0.011	-0.197	<0.001		
Intelligence (Raven's SPM)	0.101	0.007	0.391	<0.001	0.177	57.3%
Total R^2					0.308	100%

(b) Dependent variable: Mathematics 4th grade

	B	Standard error	Beta	Significance level	General dominance	Percent of explained variance
Constant	0.757	0.398		0.057		
Gender (0=male, 1=female)	-0.265	0.091	-0.078	0.004	0.004	1.1%
Father's education	0.081	0.039	0.064	0.038	0.054	16.4%
Mother's education	0.164	0.040	0.128	<0.001		
Learning goals	-0.011	0.010	-0.030	0.271	0.021	6.5%
Performance-avoidance goals	-0.051	0.012	-0.111	<0.001		
Intelligence (Raven's SPM)	0.137	0.007	0.485	<0.001	0.249	76.0%
Total R^2					0.328	100%

The regression results for the language arts INE in seventh grade are shown in table 5a. Girls are doing somewhat better than boys on this examination, though exhibiting only a marginal effect in the presence of other predictors. Both parents‘ education level predicts performance. Achievement goals play a role, such that learning goals improve performance whereas performance-avoidance goals impede performance. As expected, intelligence predicts achievement. The total variance explained by this model is 35.1%. The relative contribution of each predictor, as estimated by general dominance analysis, is shown in the last two columns. Intelligence contributes 61.9%, parental education 22.2%, achievement goals 13.6% and gender 2.3% to the explained variance.

The regression results for the mathematics INE in seventh grade are shown in table 5b. Although the zero-order correlation was not significant, boys are clearly outperforming girls when other factors (namely intelligence, data not shown) are controlled for. Both parents‘ education level as well as intelligence associate positively with performance. Performance-avoidance goals contribute significantly and impede performance. The total variance explained by this model is 43.1%. General dominance analysis, shown in the last two columns, suggests that intelligence contributes 76.0%, parental education 17.1%, achievement goals 4.9% and gender 2.0% to the explained variance.

Table 5. Multiple regression predicting seventh grade INE scores in (a) language arts and (b) mathematics.

(a) Dependent variable: Language arts 7th grade

	B	Standard error	Beta	Significance level	General dominance	Percent of explained variance
Constant	2.419	0.288		<0.001		
Gender (0=male, 1=female)	0.128	0.066	0.051	0.052	0.008	2.3%
Father's education	0.077	0.028	0.083	0.006	0.078	22.2%
Mother's education	0.156	0.029	0.165	<0.001		
Learning goals	0.017	0.007	0.063	0.016	0.050	13.6%
Performance-avoidance goals	-0.062	0.009	-0.182	<0.001		
Intelligence (Raven's SPM)	0.091	0.005	0.438	<0.001	0.217	61.9%
Total R^2					0.351	100%

(b) Dependent variable: Mathematics 7th grade

	B	Standard error	Beta	Significance level	General dominance	Percent of explained variance
Constant	-0.221	0.353		0.530		
Gender (0=male, 1=female)	-0.397	0.081	-0.121	<0.001	0.009	2.0%
Father's education	0.105	0.034	0.086	0.002	0.074	17.1%
Mother's education	0.174	0.035	0.141	<0.001		
Learning goals	0.007	0.009	0.020	0.424	0.021	4.9%
Performance-avoidance goals	-0.053	0.011	-0.119	<0.001		
Intelligence (Raven's SPM)	0.151	0.007	0.558	<0.001	0.328	76.0%
Total R^2					0.431	100%

Incremental multiple regression assessing the prediction of change in academic performance over time

In order to examine the persistent effects of gender, parental education, achievement goals and intelligence on progress in school, the

contribution of these predictors to seventh grade performance was examined while controlling for fourth grade performance. Thus, incremental regression for seventh grade scores was performed such that the four predictors were added after fourth grade scores. The results for the INE in language arts are shown in table 6a. Fourth grade INE scores alone explained 66.4% of the variability of seventh grade performance (see table 3). This leaves 33.6% unexplained, which then constitutes the isolated variance between fourth and seventh grade. The four predictors of gender, parental education, achievement goals and intelligence add 3.2% unique variance to this prediction, i.e. explaining 9.5% of the isolated variance. The effect of gender is significant, such that girls are improving more than boys during this time. When examining this change over time, only the father‘s, but not the mother‘s, education has a significant effect. Students with a higher intelligence score improve more than students with a lower intelligence score. A tendency towards learning goals associates with better performance over time whereas a tendency towards performance-avoidance goals associates with poorer performance. The relative contribution of gender, parental education, achievement goals and intelligence to change in performance was examined by performing dominance analysis on these predictors while continually controlling for prior performance. The last two columns in table 6a show the results from this analysis. Intelligence

contributes 66.4%, parental education 15.9%, achievement goals 11.2% and gender 6.5% to the unique variance explained by these factors.

Comparable results for the mathematics INE is shown in table 6b. In this case, prior performance explains 59.4% of the variance in subsequent achievement (see table 3). This leaves 40.6% unexplained which constitutes the isolated variance between fourth and seventh grade. The additional factors of gender, parental education, achievement goals and intelligence add another 7.1% unique variance to this prediction, i.e. explaining 17.5% of the isolated variance. Over these three years, boys are improving more than girls when intelligence and other factors are controlled for. Both parents‘ education level affects change in performance. A tendency towards performance-avoidance goals predicts a larger decline in performance and a higher intelligence score predicts more improvement over time. The last two columns in table 6b show the relative importance of each of these factors to subsequent performance when prior performance is controlled for. Intelligence contributes 74.8%, parental education 16.5%, achievement goals 4.3% and gender 4.3% to the unique variance explained by these predictors.

Table 6. Incremental multiple regression predicting seventh grade INE scores in (a) language arts and (b) mathematics, controlling for the respective fourth grade INE scores.

(a) Dependent variable: Language arts 7th grade

	B	Standard error	Beta	Significance level	General dominance of additional variables	Percent of additional explanation
Constant	1.297	0.200		<0.001		
Icelandic 4th grade	0.569	0.017	0.706	<0.001		
Gender (0=male, 1=female)	0.092	0.045	0.037	0.042	0.002	6.5%
Father's education	0.049	0.019	0.053	0.010	0.005	15.9%
Mother's education	0.020	0.020	0.022	0.310		
Learning goals	0.012	0.005	0.044	0.016	0.004	11.2%
Performance-avoidance goals	-0.015	0.006	-0.044	0.018		
Intelligence	0.033	0.004	0.162	<0.001	0.021	66.4%
Unique R^2 of gender, parental education, achievement goals and intelligence					0.032	100%

(b) Dependent variable: Mathematics 7th grade

	B	Standard error	Beta	Significance level	General dominance of additional variables	Percent of additional explanation
Constant	-0.651	0.271		0.016		
Mathematics 4th grade	0.568	0.021	0.590	<0.001		
Gender (0=male, 1=female)	-0.246	0.062	-0.075	<0.001	0.003	4.3%
Father's education	0.059	0.026	0.049	0.026	0.012	16.5%
Mother's education	0.081	0.027	0.065	0.003		
Learning goals	0.013	0.007	0.037	0.050	0.003	4.3%
Performance-avoidance goals	-0.024	0.008	-0.054	0.005		
Intelligence	0.074	0.006	0.271	<0.001	0.053	74.8%
Unique R^2 of gender, parental education, achievement goals and intelligence					0.071	100%

Incremental multiple regression assessing the contribution of prior knowledge

In order to investigate the importance of prior knowledge in a subject matter on subsequent performance, incremental regression was again performed for INE results in seventh grade. In this case, however, performance in fourth grade was added last to the model on top of the previously analyzed factors. In an attempt to further control for general academic ability, school examination grades from the other subject area in fourth and seventh grade were also added to the model. The results for language arts are shown in table 7a. In addition to gender, parental education, achievement goals and intelligence, examination results from mathematics in fourth and seventh grade were added to the model. When prior language arts performance from fourth grade is added after all of these factors, it adds 16.6% unique variance to the prediction of subsequent language arts performance.

Comparable results for mathematics are shown in table 7b. In this case, in addition to gender, parental education, achievement goals and intelligence, school examination grades from language arts in fourth and seventh grade were added to the model. When prior mathematics performance from fourth grade is added after all of these other factors, it adds 9.9% to the prediction of subsequent mathematics performance.

Table 7. Incremental multiple regression predicting seventh grade INE in (a) language arts and (b) mathematics.

(a) Dependent variable: Language arts 7th grade

	B	Standard error	Beta	Significance level	Unique variance explained
Constant	1.559	0.189		<0.001	
Gender (0=male, 1=female)	0.182	0.043	0.073	<0.001	
Father's education	0.032	0.018	0.034	0.079	
Mother's education	0.006	0.019	0.006	0.749	
Learning goals	0.010	0.005	0.038	0.026	
Performance-avoidance goals	-0.011	0.006	-0.033	0.053	
Intelligence	0.012	0.004	0.056	0.007	
Mathematics 4th grade	-0.053	0.020	-0.072	0.010	
Mathematics 7th grade	0.248	0.022	0.325	<0.001	
Language arts 4th grade	0.484	0.019	0.601	<0.001	0.166
Total R^2					0.733

(b) Dependent variable: Mathematics 7th grade

	B	Standard error	Beta	Significance level	Unique variance explained
Constant	-1.545	0.259		<0.001	
Gender (0=male, 1=female)	-0.334	0.058	-0.102	<0.001	
Father's education	0.036	0.024	0.030	0.136	
Mother's education	0.044	0.025	0.035	0.088	
Learning goals	0.005	0.006	0.013	0.463	
Performance-avoidance goals	-0.007	0.008	-0.015	0.400	
Intelligence	0.055	0.006	0.203	<0.001	
Language arts 4th grade	-0.054	0.033	-0.051	0.104	
Language arts 7th grade	0.452	0.040	0.346	<0.001	
Mathematics 4th grade	0.444	0.024	0.461	<0.001	0.099
Total R^2					0.716

Discussion

In this study the effect of several important predictors, i.e. gender, family SES, achievement goals and intelligence, on academic achievement was examined. Academic achievement was measured using INE scores in two different subject areas, language arts and mathematics, at two different grade levels, fourth and seventh grade. Intelligence was measured using the Raven‘s Standard Progressive Matrices, a good measure of fluid general intelligence (Nisbett et al., 2012). Parental education was used as the only indicator of family SES. Although family income and parental occupation had significant correlations with the academic variables, they did not substantially add to the prediction of academic performance in the presence of parental education. Lemos et al. (2011) similarly found that when analyzed simultaneously, parental education, but not family income, predicted intelligence. The achievement goals examined here were learning and performance-avoidance goals. Performance-approach goals were excluded from the analysis as they largely appeared to represent a mixture of the two other types of goals in this study. In fact, the validity of the separation of the two performance goals has been debated in the literature, but Murayama, Elliot, & Yamagata (2011) have recommended that they remain distinct.

The main weakness of this study is that variables used as predictors were evaluated later in time than the dependent variables. For fourth grade

performance, the predictor variables were measured three years after the evaluation of academic achievement. Although the time frame is considerably shorter for seventh grade, academic achievement was nevertheless evaluated before predictor variables, in the fall and spring, respectively, within the same school year. While results for parental education are likely to be relatively unaffected by this shortcoming, intelligence and achievement goals are likely to vary with time and their causal relationships with academic achievement may be reciprocal. Another weakness is that the participant number was reduced from an initial 1592 to a final of 1019. It is possible that this reduction was non-random, especially since the greatest drop was due to non-returned parental questionnaires.

The first aim of the study was to examine the relative contribution of gender, parental education, achievement goals and intelligence to academic performance when analyzed simultaneously in a regression model, separately for fourth and seventh grade. The total variance explained by these predictors ranged from 30.8% to 43.1%, depending on the subject area and grade level. The total variance explained was larger in seventh grade than in fourth grade and greater in mathematics than in language arts. According to dominance analysis, the relative importance of the predictors was fairly similar at both grade levels and in both subject areas. Intelligence contributed the most, followed by parental education, then achievement goals and finally gender.

The contribution of intelligence ranged from 17.7% to 32.8% of the total variance. These numbers are similar to previous reports that have suggested that intelligence is able to predict around a quarter of the variance in achievement (Mackintosh, 1998; Naglieri & Bornstein, 2003; Neisser et al., 1996). Thus, intelligence remains an important predictor of academic performance, even when other factors are considered simultaneously. This extends other studies that have found intelligence to predict performance regardless of other factors, such as family SES, personality traits and motivational factors (Chamorro-Premuzic & Furnham, 2008; Colom & Flores-Mendoza, 2007; Johnson et al., 2007; Laidra et al., 2007; Ong et al., 2010; Spinath et al., 2006; Steinmayr et al., 2011; von Stumm et al., 2011). The relative importance of intelligence was higher in mathematics than in language arts. This is consistent with previous results showing that intelligence has a stronger relationship with quantitative than verbal tasks (Balboni et al., 2010; Deary et al., 2007; Pind et al., 2003; Spinath et al., 2006). As mentioned in the Introduction section, although intelligence does have an environmental component, it is largely genetic (Deary et al., 2009; Jensen, 1998; Nisbett et al., 2012). Consequently, it may be difficult to manipulate and indeed, the benefit of interventions designed to enhance intelligence is questionable (Jensen, 1998; Nisbett et al., 2012). Thus, intelligence may not be a factor that schools should strive to change. Nevertheless, it is important to be aware of individual differences in

intelligence and work around them as much as possible. Jensen (1998) has proposed a highly individualized learning environment with frequent branching where every student would receive appropriate instruction based on their skill level.

Parental education contributes from 5.4% to 7.8% of the total variance in academic achievement, thus contributing quite a bit less than intelligence despite being the second most important predictor. Although the effects of parental education are somewhat diminished in the presence of other background variables compared to zero-order correlations and simple regression (see table 3), these results extend previous studies indicating that the effects of family SES are partially maintained when other variables are controlled for (Fergusson et al., 2008; Johnson et al., 2007; Ong et al. 2010; Steinmayr et al., 2010). The causal effects of family SES tend to be difficult to disentangle (Jeynes, 2002). Thus, it is unclear what the independent contribution of family SES represents. It could reflect personality traits not measured in the present study, such as conscientiousness or intellectual curiosity (Chamorro-Premuzic & Furnham, 2008; Chamorro-Premuzic, Quiroga, & Colom, 2009; Laidra et al., 2007; O‘Connor & Paunonen, 2007; Poropat, 2009; Steinmayr et al., 2010; von Stumm et al., 2011). These attributes could then either be genetically or socially transmitted from the parents. Alternatively, it could reflect other environmental factors, such as access to resources or parental involvement (Bradley & Corwyn, 2002;

Stewart, 2008). Thus, further studies are needed to determine what factors are represented by family SES and how malleable they are.

Achievement goals appear to play a more important role in language arts, where they contribute 5.0% to the total variance, than in mathematics, where they contribute 2.1% to the total variance. This is in line with previous results that showed a greater contribution of learning goals to language arts than to mathematics in a German study, when added after prior performance and intelligence in a regression model (Steinmayr and Spinath, 2009). Since the same trend is found in zero-order correlation analysis (see table 3), it does not appear to be solely due to the larger contribution of intelligence to mathematics. Thus, different student attributes have variable importance depending on the subject area, with intelligence playing a larger role in mathematics and achievement goals playing a larger role in language arts. It is unclear to what extent achievement goals can be manipulated by the school environment, but schools should generally attempt to incorporate learning goals into the school climate and try to minimize students‘ orientation towards performance-avoidance goals.

The contribution of gender to overall academic performance appears to be relatively small compared to the other factors, ranging from 0.3% to 0.9%. Thus, students‘ gender does not appear to be an important factor compared to their other characteristics. The nature of this modest effect is

such that females tend to do better in language arts whereas males tend to do better in mathematics, which is consistent with previous findings (Halpern et al., 2007). Gender per se is clearly not a malleable trait and the role of sociocultural factors in the gender difference is uncertain (Halpern et al., 2007). Nevertheless, it is important for school authorities to be aware of the genders‘ strengths and weaknesses.

The second aim was to provide insight into the persistent effects of gender, parental education, achievement goals and intelligence on change in performance as students progress through the school system. To that end, the variance between fourth and seventh grade was isolated. It was then examined how the predictors contributed specifically to that variance. The four factors combined were able to explain 9.8% and 17.5% of the isolated variance between fourth and seventh grade in language arts and mathematics, respectively. Thus, these factors continue to play a role after children have started their academic career. These results are consistent with previous results showing the persistent effects of family SES, achievement goals and intelligence when prior performance is controlled for (Steinmayr and Spinath, 2009; Steinmayr et al., 2011). Nevertheless, the proportion of variance explained by these variables was quite a bit less when examining the isolated variance between fourth and seventh grade, compared to examining the overall variance of performance. Thus, although these variables do continue to influence academic progress, they appear to have

exerted much of their influence already by fourth grade. Other variables appear to become more important as students spend more time in the school environment. These could be school-level factors, such as school cohesion, or individual-level factors, such as peer associations (Stewart, 2008). They could also be class-level factors within each school. For example, it has been demonstrated that teachers‘ skills contribute substantially to achievement. The specific skill set of importance, however, has been difficult to determine, and only a minor portion is likely to be due to frequently measured variables such as teacher‘s education level and experience (Nye, Konstantopoulos, & Hedges, 2004).

Dominance analysis was performed to examine the relative importance of predictors in the context of change in performance over time. Within the explained variance, the predictors‘ relative contribution to change in performance was fairly similar to their relative contribution to overall performance. A noteworthy difference is that gender appears to gain importance compared to the other factors. In language arts, gender contributes 6.5% to the explained variance in the context of change in performance, compared to contributing 1.0% and 2.3% to overall performance in fourth and seventh grade, respectively. In mathematics, gender contributes 4.3% to the explained variance in the context of change in performance, compared to 1.1% and 2.0% in fourth and seventh grade, respectively, in the context of overall performance. Therefore, gender

effects appear to come into play during the three year period from fourth to seventh grade. Girls are gaining an advantage in language arts whereas boys are gaining more of an advantage in mathematics when other variables are controlled for. This is consistent with the gender difference pattern previously found for verbal and quantitative ability (Halpern et al., 2007). Perhaps the genders‘ specific abilities, whether they are due to innate or cultural factors, are becoming more apparent as the subject matter becomes more complex (Calvin et al., 2010; Halpern et al., 2007).

It is interesting to compare the effects of the mother‘s and father‘s education at different grade levels. In language arts, only the mother‘s education contributes significantly to performance in fourth grade, both contribute in seventh grade and only the father‘s education contributes significantly to the change in performance from fourth to seventh grade. Thus, it appears that the mother has a larger influence on the student‘s ability in the early years and has already exerted much of her influence by fourth grade. Conversely, the father‘s influence is small in the early years but gains importance later on. This is in line with some previous studies that have found a greater contribution of maternal education to the cognitive ability of younger students but an equal contribution to the ability of adolescents (Bradley & Corwyn, 2002). In mathematics, both parents‘ education plays a role at all levels, though the mother‘s contribution is always more important. This is consistent with studies showing that

maternal education normally has a greater impact on achievement than paternal education (Chevalier, Harmon, Sullivan, & Walker, 2005; Marks, 2008). As mentioned previously, family SES can represent both genetic and environmental factors. The differential pattern of parental contributions may suggest that the observed effect is environmental to a certain degree. Among the proposed mediating environmental effects of family SES are stress, nutrition, stimulating experiences, parenting styles and parental expectations (Bradley & Corwyn, 2002). Interestingly, a recent study found that post-natal changes in maternal education predicted changes in some measures of parenting practices, such as parental involvement and the number of children‘s books in the home (Domina & Roksa, 2012). Thus, the education level as such may be of importance.

Performance-avoidance goals contributed significantly to academic achievement, at both grade levels and in both subject areas. They also contributed significantly to change in performance between fourth and seventh grade, again in both subject areas. Learning goals only contributed significantly in language arts, to overall seventh grade performance and to change in performance from fourth to seventh grade. Thus, in the present study performance-avoidance goals appear to be a stronger predictor of achievement than learning goals. This is somewhat inconsistent with previous studies that found learning goals to be the stronger predictor of achievement (Steinmayr & Spinath, 2009; Steinmayr et al., 2011). The

previous studies examined a more homogeneous group of students at a higher educational level, which may explain the difference in results.

The third aim was to estimate the importance of prior knowledge in a subject area for future success in that area. To that end, the incremental contribution of fourth grade performance to seventh grade performance was examined when other available indicators of background and general academic ability were controlled for. According to this estimate, the unique variance added by prior performance was 16.7% in language arts and 9.8% in mathematics. Keeping in mind that this is the unique variance and thus represents a minimal contribution in the context of these predictors, this appears to be a substantial effect. The slopes in the regression analysis suggest that each additional point in fourth grade corresponds to an increase of almost half a point in seventh grade (0.48 in language arts, 0.44 in mathematics). These results suggest that the students‘ mastery of the subject matter in earlier school years is crucial for their continued success in the school years that follow. This is in line with Bloom‘s theory of mastery learning that recommends reducing the variation in student achievement by using certain teaching strategies, such as formative assessment and correctives (Guskey, 2007). Utilization of this strategy appears to improve students‘ performance (Kulik, Kulik & Bangert-Drowns, 1990). The theory further suggests that in order to reduce the variation in student achievement,

teachers must increase the variation in their teaching to better meet individual students‘ needs (Guskey, 2007).

Numerous factors influence student achievement, and these can be manipulated by school authorities to varying degrees. It has been debated how well resources allocated to education are being utilized to enhance students‘ performance (Hanushek, 1986, 1994; Hedges et al., 1994a, 1994b). In order to put these resources to the best possible use, it is vital to elucidate the factors that influence academic achievement and examine to what extent they can be manipulated. The present study has provided some insight into the contribution of gender, family SES, intelligence and achievement goals to academic performance. It is clear that intelligence remains the most important known predictor of achievement, even in the presence of other predictors and also when controlling for prior performance. Parental education, achievement goals and gender also play a role in predicting achievement. However, the role of most of the above mentioned factors appears to become smaller after students have entered the school environment. Thus, as students progress through the school system, other factors appear to become more influential. The present study further suggests that prior knowledge in a subject area is essential for future success in that area, even when controlling for background variables and general ability. Thus, it is crucial that students have a solid knowledge base to build on as they move from one level to the next. In order to work around

individual differences and get all students up the same basic level of knowledge, individualized instruction and teachers‘ flexibility may be required.

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