Skipping Questions in School Exams: The Role of Non-Cognitive Skills on Educational Outcomes

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Abstract

Economists, educators and policy-makers have became increasingly interested in the importance of socio-emotional skills for students' performance. Conscientiousness, openness to experience, and emotional stability, among others, have been shown to be related with taking harder classes, graduating from high school and earning higher grades. Understanding the nature of the accumulation of these skills and identifying education interventions that could boost them, however, has been restricted by the availability of objective and inexpensive measures of socio-emotional skills. This paper proposes an objective and relatively inexpensive proxy for students' socio-emotional skills directly derived from test-taking behavior. The measure is the incidence of skipping questions on a statewide standardized test. This exam has no penalties for guessing and gives students as much time as they need to answer. We believe that skipping questions is related to a reduced level of important socio-emotional skills. We find that, conditional on test scores, the incidence of skipping questions in middle school is consistently related with educational outcomes in high school and college, such as grade repetition, high school drop-out, on-time graduation and going to a 4-year college. These results are robust to the definition of skipping incidence and to the measurement of cognitive ability as captured by test scores.

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1. Introduction

Increasingly, the Economics literature has been focusing on the role of socio-emotional skills in the economic performance of individuals. By socio-emotional skills we mean temperament, personality traits, persistence and motivation, among other traits different than intelligence. In line with the Psychology literature, researchers in Economics have found that these skills play an important role in agents' economic performance and in students' education outcomes, in particular.

Almlund, Duckworth, Heckman, and Kautz (2011) present a detailed review of the literature on this topic. The review describes how socio-emotional skills, measured under the Big Five Personality traits model[2], have been found to be related with more schooling (Goldberg et al. 1998; Eijck and De Graaf, 2004; Lleras, 2008), taking harder classes (Wong and Csikszentmihalyi, 1991), lower school absences (Lounsbury et al. 2004), graduating from high school (Baron and Cobb-Clark, 2010; Heckman, Stixrud and Urzua, 2006; Cunha, Heckman and Schenach, 2010) and getting higher grades (Poropat, 2009; Duckworth and Seligman, 2005; Duckworth et al. 2010). Furthermore, their review reveals how traits related with Conscientiousness[3], like effortful control and attention skills, play an important role on predicting test scores (Blair and Razza, 2007; Valiente et al. 2010; Mischel, Shoda and Rodriguez, 1989; Ponitz et al. 2008; Duncan et al. 2007).

Self-report measures are by far the most widely used to measure adult personality traits and soft skills (Almlund et al. 2011). One example are the questions included in the National Longitudinal Survey of Youth (NLSY), that measure respondents' perception of the degree of control they possess over their life (Rotter Locus of Control Scale) and their perception of self-worth (Rosenberg Self-Esteem Scale). Although self-reported measures are widely used, the evidence on their accuracy is mixed. In the case of motivation, for instance, self reports do not change when an award is removed, even though a response in behavior is indeed observed (Deci, Koestner and Ryan, 1999). On the other hand, self-

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[2] The Big Five Personality Traits is a taxonomy of traits that uses factor analysis of observer and self-reports of behaviors. It summarizes personality on five broad components: i) Openness to Experience (the tendency to be open to new aesthetic, cultural, or intellectual experiences); ii) Conscientiousness (the tendency to be organized, responsible and hardworking); iii) Extraversion (orientation of interests and energies to the outer world of people and things, positive affect and sociability); iv) Agreeableness (Act in a cooperative, unselfish manner); v) Neuroticism (the opposite of emotional stability, which is predictability and consistency in emotional reactions).

[3] The tendency to be organized, responsible and hardworking

reported motivation increases when it is expected to do so, such as when exam stakes are higher (Demars and Wise, 2005).

Alternatives for self-reported measures are parent and teacher reports on child's observed behavior. For instance, the National Educational Longitudinal Survey (NELS), includes teacher reports on absenteeism, disruptiveness, inattentiveness, and tardiness. Another alternative for measuring socio-emotional skills are task measures, such as the number of seconds a child waits for a more preferred treat in a preschool test of delay of gratification (Mischel et al., 1989). Nonetheless, observer reports or task measures can be very expensive for researchers because they may require altering established longitudinal surveys to include new questions or taking measures on the field.

This paper proposes a new proxy for students' soft skills, one that is low cost and objective, since it can be directly derived from students' test taking behavior. The measure is the incidence of skipping questions on state-wide standardized assessment examinations. For our study, we measure the incidence of skipping questions by 7^{th} and 8^{th} grade students on a standardized statewide examination in Michigan. The Michigan Educational Assessment Program (MEAP), which is taken by 3^{rd} to 8^{th} grade students in Michigan public schools, possesses two characteristics that make skipping questions a suitable proxy for soft skills. First, the exam gives students the same score (zero) whether the student answers the question incorrectly or leaves it unanswered, so students would be better off (or no worse off) by guessing the answer and getting the question right with 25% probability, as opposed to skipping it. This implies that the incidence of skipping questions does not capture that some students are strategic responders. Second, time is not a binding constraint in this exam, since those students who have not finished when time is over have the possibility of moving to another room and continue until they finish. Therefore, students have enough time to guess at the last moment, if they want to do so.

Previous literature has found a relationship between nonresponse on surveys and socio-emotional skills. For example, non-item response on adult survey items could reflect lower levels of both cognitive and socio-emotional skills, such as the understanding of the question, the carefulness when answering it, the valuation of privacy or the willingness to share information with a stranger (Groves et al. 2009). In support of this argument, Hedengren and Stratmann (2012) find that item non-response in surveys is correlated with IQ and self-reported measures of Conscientiousness and, furthermore, that this behavior is predictive of earnings and longevity.

Researchers have also found a relationship between willingness to answer on examinations and socio-emotional skills. For instance, Baldiga (forthcoming) suggests that when there are penalties for guessing, the willingness to

strategically guess in a high stakes exam could reflect confidence on the material or risk aversion. Similarly, Torija (2012) suggests that getting correctly a very basic numeracy question in an international standardized test (counting dots in a graph) is a measure of willingness to answer, since it is a basic exercise that reflects students' effort and collaboration with the exam.

Students' decrease in performance over the course of an examination has also been associated with socio-emotional skills. According to Borghans and Schils (2012), when the order of the question is random (so questions do not increase in difficulty) the decline in performance during the test can be used to decompose test scores in cognitive and "non-cognitive" components. The authors show that this decline overall is related with Conscientiousness and Agreeableness and that it is correlated with future outcomes such as having a fulltime job, academic qualification, smoking and drinking behavior. However, they note the measure is too imprecise to calculate at the student level.

Our paper contributes to this new literature in several ways. We propose a proxy for socio-emotional skills that rules out behaviors like strategic answering, since the MEAP has no penalties for guessing. We show that this proxy captures traits different than intelligence, knowledge or speed in test taking, since time is not a binding constraint in the MEAP and the proxy is predictive of future educational outcomes even after controlling for students' test scores. In line with Borghans and Schils (2012), we propose an inexpensive proxy for students' socio-emotional skills that could be used in other tests with similar characteristics, in an era of expanded use of education administrative databases. In contrast with them, we suggest a proxy that can be measured precisely at the student level[4] and can be used even if the order of the questions in the exam is not random.

The incidence of skipping questions on a statewide standardized assessment examination could capture socio-emotional skills such as persistence with difficult questions, ability to focus, attention to instructions, intrinsic motivation with learning and/or disengagement with school or examinations. Although at this time it is not possible to exactly identify which of these traits nonresponse captures, patterns observed in the data give some suggestions. Skipping does not seem to be related with age or question number, which suggests that non-response is not associated with socio-emotional skills that change in a short-time frame (from the 7^{th} to the 8^{th} grade) or with the inability to focus at the end of the exam. On the other hand, skipping does appear to be related with the difficulty of the question, which suggests that skipping is related with persistence when facing challenges, once academic ability is controlled for.

[4] The large standard errors in the regressions at the student level prevented these authors to have a measure of socio-emotional skills by student.

Skipping questions in standardized exams constitutes an objective proxy for a bundle of socio-emotional skills that overcomes the weaknesses of self-report measures. It is also less costly since it does not require collecting observer reports or task measures in the field. This proxy could be used in other states or countries that have comprehensive education administrative databases, and that apply standardized tests with no additional penalties for answering a question incorrectly and no binding time constraints. Moreover, this measure could be useful for identifying interventions that boost student's socio-emotional skills, and for detecting the mechanisms through which some educations interventions have effects on student achievement and behavior.

We study the relationship between skipping questions and future educational outcomes using administrative data from the Michigan Department of Education (MDE) and the National Student Clearinghouse. These data allow researchers to track students in Michigan from Kindergarten through college and allows observing all the standardized exams the student takes from the 3rd to the 12th grade for each year the student is enrolled in a Michigan public school. We find that, conditional on test scores (which controls for students cognitive skills), the incidence of skipping questions in the 7th and 8th grade is consistently related to educational outcomes in high school and college. For instance, a student who skips multiple questions in one or more exams[5] in the 7th and 8th grades is between 5.8 and 6.5 percentage points less likely to graduate on-time from high school, 1.4 to 1.8pp more likely to drop out of school, 3.1 to 4.3pp more likely to repeat grades in high school and 2 to 2.5pp less likely to enroll in a any type of college, relative to a comparable student who did not skip any questions in 7th or 8th grade. These results are robust to the definition of skipping incidence or to the measurement of cognitive ability as captured by test scores. This evidence suggests that the incidence of skipping questions in exams serves as a proxy for traits that are not related with intelligence or knowledge, which are likely to be socio-emotional skills.

2. Data

Part of the following description comes from Dynarski, Frank, Jacob and Schneider (2013). More detailed information about the structure and background of the data sources can be found in their paper. The data for this study comes primarily from MDE. Several sources of cross-sectional MDE administrative databases were joined together to form a longitudinal student database for the 2006 cohort of first-time 7th grade students. This longitudinal database tracks students forward with respect to their school enrollment, achievement scores, high school graduation and college attendance.

[5] Students enrolled in grades 7 and 8 during this period are expected to take 5 assessment exams, described in further detail later.

The MDE administrative data includes the Michigan Student Data System (MSDS) [6], which provides information on student demographics such as race, gender, free/reduced price lunch eligibility (a measure of poverty status) and students' final exit status. The exit status allows us to identify the standing of the student the last time he was seen in the administrative data system. Specifically, the exit status reports if the student graduated from high school, moved out of state or to a private school, dropped out to obtain a GED, among others. The MSDS also identifies if the student was in a special education or limited English proficiency program.

The MDE data also includes two sources of assessment information. The first one is the Michigan Educational Assessment Program (MEAP), which provides test scores data for grades 3-8 between 2004-2012. The MEAP test is administered in various grade-subject combinations. Not all subjects are tested in each grade and, within a grade, testing of some subjects started later in that period. For instance, math and reading are assessed every year, while science is only assessed in grades 5 and 8. Also, math was only initiated for testing in the 7^{th} grade in the 2006 academic year. The second assessment database is the Michigan Merit Examination (MME) database, which provides assessment data for 11th grade students in subjects such as mathematics, English, reading and science, among others. The MME also includes a full ACT component, which is the college entrance exam applied in the state of Michigan, equivalent to the SAT. Since ACT testing became mandatory (and free) in Michigan public school students in 2007, all students in our analysis sample were expected to take the ACT when reaching the 11^{th} grade.

The MDE administrative data was supplemented by postsecondary enrollment and retention information obtained from the National Student Clearinghouse (NSC). The NSC tracks students' college enrollment, including the type of institution he was enrolled in (public, private, 4-year or 2-year). The NSC data also allows measuring persistence, since it identifies how long students were enrolled in college for.

Our key variable of interest – incidence of skipping behavior on 7th and 8th grade exams – comes from the MEAP database. The MEAP includes two variables with the necessary information to determine if a question was skipped. The first variable is the string of question answers, which records the responses that students marked (A to D) or a blank if no answer was provided. The second variable is the string of scored question answers, which consists of 0s and 1s, 1s for all questions correctly answered and 0s for all questions incorrectly answered

[6] The MSDS system is in place since 2010. It replaced the Single Student Record Database (SRSD), which fulfilled the same role in 2009 and before.

or left blank. A skipped question, therefore, is an item that has a blank on the string of answers and a zero on the string of scored answers.

Students in the 7th and 8th grades could have skipped questions in up to 5 exams, since they take math and reading examinations in both grades and science in the 8th grade only. The math and reading tests consist of approximately 50 questions[7] and the reading test consists of 30 questions.

The analysis sample for this study consists of a single cohort of students who were first-time 7th graders in Michigan public schools in the 2005-2006 academic year and were enrolled in Michigan public schools through at least the ninth grade. This cohort was chosen to first maximize middle-school test taking, since the 7th grade math test was first offered in 2006, and second, to follow students through college, given that this 7th grade cohort could be in first year of college by 2012. We exclude students who moved out of the state, or transferred to private schools or home schooling, since we cannot track them once they exit the system. We also exclude students in non-regular schools. This leaves us with 100,674 unique students included in our estimation sample. Henceforth, we will call our analysis sample the 2006 7th grade cohort, referring to the spring year.

3. Methodology

One of the objectives of this paper is to study the relationship between the incidence of skipping and future educational outcomes. We accomplish this by estimating OLS models with several measures of educational attainment in the left hand side and the incidence of skipping questions in the right hand side, together with other covariates.

Specifically, we estimate the equation

$$Y_{ij} = \beta_0 + \beta_1 skip_{ij} + \beta_2 f(S_{ij}) + \beta_3 X_{ij} + \varepsilon_{ij}$$

Where Y_{ij} denotes the educational outcome of student i in school j, $skip_{ij}$ is a vector of measures for the student's incidence of skipping in grades 7th and 8th, $f(S_{ij})$ is a quadratic function of average test scores in all exams taken in 7th and 8th grades, and X_{ij} is a vector of covariates, which includes student demographic and school characteristics.

The educational outcomes consist of several measures observed in high school and college. In high school we estimate the probability of grade repetition, dropping

[7] The math exam consists of 53 questions in the 7th grade and 49 questions in the 8th grade. The science examination, on the other hand, consists of 52 questions.

out, and on-time high school graduation[8] as well as predictive performance on high school standardized exams (MME and ACT). For college outcomes, we consider enrollment in college 1 year after expected on-time high-school graduation[9] in any postsecondary institution, as well as specific 4-year or 2-year college enrollment[10].

The main variable of analysis, , is a vector of indicators that assigns a student to one of three mutually exclusive groups according to the severity of his skipping behavior. The first indicator is skipping only one question on exactly one exam, which is the least severe group. The second is skipping multiple questions on exactly one exam, and the third, and most severe measure, is skipping questions in multiple exams. We believe this the most severe measure because it represents persistence on skipping behavior. This measure is also less likely to reflect a student who had a single "bad day". The excluded category is thus the group of students who never skip a single question on any exam.

One critical component of the equation above is the inclusion of the function of average test scores , which is incorporated to control for academic ability. This is a key aspect of the analysis because the students who skip questions could be precisely those with lower levels of intelligence or academic knowledge, since a student who knows how to answer a question would be unlikely to skip that question.

In order to isolate this confounding factor, we control for the average test scores that students received in all exams taken in the 7^{th} and 8^{th} grades. Although test scores are not a perfect measure of cognitive skills, they have been largely used in the literature to measure academic ability. By controlling for test scores, the coefficient on the incidence of skipping would reflect the importance of traits different than intelligence and academic knowledge, as for example, socio-emotional skills.

Controlling for test scores is equivalent to finding a comparable student for every skipper. The comparison student needs to be equally able to answer the same number of questions correctly on an exam. However, where one student leaves a

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[8] For our analysis sample (2006 7th grade cohort), a student with a normal grade progression would have started the 9th grade in the 2007-2008 academic year and graduated on-time by the 2010-2011 academic year. "On time" is reflective of the academic year in which a student begins the 9^{th} grade, so a student could still graduate on time even if he repeated the 7^{th} or 8^{th} grade.

[9] For a student with a normal grade progression in the cohort analyzed, this means enrolling in college any time in the 2011-2012 academic year.

[10] We do not study later enrollment (e.g. enrolling 2 years after expected on-time high school graduation or persisting in college after 1 year of enrollment) because we do no have yet data on college enrollment for the 2012-2013 academic year.

difficult question blank (the skipper), the other student chooses to guess (the comparison student). This means that the comparable student would actually have *higher* test scores than the skipper, because he guessed correctly and therefore got additional points. Therefore, it is necessary to adjust the test scores to account for this.

In addition to using actual test scores to control for academic ability, we thus use adjusted versions of the standardized scores. Actual test scores could underestimate a skippers' cognitive skills, since he receives zero points for the questions he skips, which assumes that he would have gotten the question wrong had he answered it. There are, however, alternative scenarios. The student could have at least guessed randomly and gotten the right answer with 25% probability[11]. Alternatively, he could have made an educated guess by eliminating incorrect answers, which is probably related to the rate at which he got the rest of the exam correct (e.g. a student who got 75% of the rest of the test correct may make better educated guesses than a student who got 25% of the rest of the exam correct).

In order to incorporate these alternative scenarios, and thus find a more accurate measure of skippers' academic ability, we modify test scores by adjusting skippers' proportion of correct answers and then translating these adjusted percentages into alternative standardized test scores.

The adjustment of the percentage of correct answers is performed in three different ways: (i) increasing the number of correct answers assuming that the student randomly guessed the answer (e.g., increasing the number of correct answers by 0.25 for each skipped question); (ii) increasing the number of correct answers by the rate at which the student got correct the questions he attempted (e.g. if he got right 60% of the questions he did not skip, we increase the number of correct answers by 0.6 for each skipped question); and (iii) assuming every skipped question would have been answered correctly (e.g. increasing the number of correct answers by 1 for each skipped question). We believe that student's true academic ability lies somewhere between scenarios (i) and (ii). However, we provide results for scenario (iii) to present an upper bound for the estimates.

Each of the three adjustments to the percentage of correct answers is then used to create an alternative standardized scaled score. The alternative scores are created using non-skippers information, since we do not know the specific function that maps percentage of correct questions into scaled test scores. We estimate the alternative scores by first regressing standardized scaled scores on the percentage of correct answers for the students who do not skip questions. Then, we use the estimated coefficients to make two out-of-sample predictions for

[11] This number comes from the chance of getting the correct answer in a multiple-choice question with 4 options.

skippers' standardized scaled scores, one using the adjusted percentage of correct answers and one using the unadjusted. The difference between the two predicted scores is then added to the actual standardized scaled score and, as a result, there are three final adjusted standardized scale scores, one for each way of adjusting the percentage of correct answers (options (i) to (iii) above).

Finally, we include other covariates in the regression, such as students' race, gender, poverty status (as measured by ever been eligible for free/reduced price lunch), age and participation in special education and limited English proficiency programs. We also include fixed effects for the school where the student was in the 7th and 9th grade. This set of covariates is added one by one, in order to identify how sensitive the coefficient of interest (the incidence of skipping) is to the inclusion of these variables.

4. Summary Statistics

Skipping questions on standardized exams is a behavior characteristic of a small percentage of the population of students. As Table 1 shows, 17% of students skip at least one question on one exam (out of the 5 exams they take in the 7th and 8th grades)[12], of which only 2,813 (3%) correspond to students skipping at higher frequencies, e.g. in two exams or more.

Although at the time it is not possible to identify what skipping exactly measures, observed patterns in the data give some suggestions. First, skipping does not seem to capture traits specific to a particular age, since students in the 7th grade skip questions at the same rate than students in the 8thgrade (Figure 1).

Second, skipping is related with the subject evaluated and the difficulty of the question. As Figure 1 reveals, students are almost two times more likely to skip questions in math exams (6%) than in reading exams (3%). The majority of them skip one question, but a non-negligible portion skips two or more questions. For example, out of the 6.5% of students who skip questions in the math exam on 7th grade, 1.5pp correspond to students skipping two or more questions. In addition, students tend to skip questions that other pupils get incorrect[13], which could be considered a raw measure of the difficulty of the question. As Figure 2 shows, there is a positive relationship between the percentage of 7th grade students that answer incorrectly a math question and the percentage who skip it. The magnitude of the relationship is non-negligible, since a question that everybody gets wrong is 3 times more likely to be skipped than a question that everybody gets right (0.4% vs. 0.12%). This positive relationship between difficulty and

[12] The total possible number of exams that a student can take is 5: Math and Reading in 7th grade, and Math, Reading and Science in the 8th grade.

[13] The percentage of students who answer incorrectly does not include those who skip

skipping reinforces the importance of controlling for overall test taking performance. Once test scores are controlled for, this relationship could suggest that skipping behavior captures the lack of perseverance when the student faces challenges.

Third, there is mixed evidence on whether skipping captures tiredness at the end of the test. Figure 3 and Figure 4 display the relationship between the percentage of students who skip a question and the question number (or question order). It shows that while pupils skip more questions at the end of the reading exam, the same does not happen in the math exam, which is the subject with higher skipping incidence.

What are the characteristics of students who skip? Table 2 compares students who never skip questions (84% of the total) with those who skip at least one question. Among the 16% of students who skip at least one question, 10 percentage points correspond to students who skip only one question on a single exam during the 7th and 8th grades (column 2). The remaining 6pp correspond to students who skip multiple questions on a single exam (column 3) or those who skip questions in multiple exams (column 4).

We observe that the act of skipping even exactly one question in one examination (out of five potential exams) provides meaningful separation from students who never skip. The group of students skipping exactly one question is more likely to be black than the group who never skips (23% vs. 13%), be eligible for free or reduced lunch (45% vs. 35%) and belong to a special education program (16% vs. 10%). Further, this group has meaningfully lower baseline standardized test scores (0.1 vs. -0.2 standard deviations around the mean). These differences between skippers and non-skippers get even stronger when the incidence of skipping questions increases (columns 4 and 5).

Since the characteristics that separate skippers from non-skippers are likely to be correlated, we perform a regression analysis to predict skipping including all the mentioned characteristics as covariates. Table 3 shows the results for skipping one question in one exam only. The same calculations were done for skipping multiple questions (not presented here) and the results do not change significantly. The table reveals that race/ethnicity and student academic performance have the highest explanatory power on skipping. An African-American student is 4 percentage points more likely to skip, while a student who scores 1 standard deviation above the mean is 2pp less likely to do so, all other things equal. On the other hand, the strong correlation between skipping and poverty or special education status decreases significantly. For instance, controlling for race and

academic achievement, free/reduced lunch and special education students are only 0.5% and 1% more likely to skip questions, respectively[14].

Surprisingly, there is little evidence that suggests that females and males skip questions at significantly different rates. Although the literature suggests that the higher educational achievement of females is partially explained by differences in socio-emotional skills (Jacob, 2002; Cornwell, Mustard and Van Parys, 2013), we find that females are only 0.8% less likely to skip questions. This suggests that the socio-emotional skills associated with skipping questions in standardized exams are not gender specific.

5. Results

The objective of this paper is to study the relationship between the incidence of skipping questions on standardized statewide examinations and future educational outcomes. As it was stated in section 3, we accomplish this by running OLS regressions with future educational outcomes on the left hand side and skipping incidence on the right hand side, together with other covariates.

Table 4 presents the results of the regressions for on-time high school graduation (e.g. graduating after 4 years of first entering the 9^{th} grade). The model is built up by slowly adding the different sets of covariates. It starts with column 1, which includes only demographic variables as explanatory variables. This column confirms a well-established fact in the literature, that black and male students are less likely to graduate on-time from high school. However, when academic ability is added in column 2 (with a quadratic on random-guessing adjusted test scores), the coefficients in column 1 change dramatically. Conditional on cognitive skills, black students are more likely to graduate on-time from high school, confirming the findings in Cameron and Heckman (2001). The same is true for special education students.

Column 3 adds the main variable of interest, which is the incidence of skipping in exams. This variable is included by adding a set of indicators which define mutually exclusive groups of skippers: those who skipped exactly one question in one exam, those who skipped multiple questions in exactly one exam, and those who skipped at least one question on multiple exams, which we consider to be the

[14] This regression also suggests that skippers are more likely to be Asians and Hispanics. However, the representation of these races/ethnicities is very small in the sample, so we prefer to disregard these significant differences in skipping.

most severe measure of skipping. The omitted category consists on the group of students who do not skip a single question on any of the baseline examinations[15].

The coefficients on the skipping indicators are negative, statistically significant and have meaningful magnitudes. For instance, a student who skips only one question in one exam is 2.4 percentage points less likely to graduate on-time from high school than an observationally similar student who does not skip any question. The relationship gets stronger as the severity of skipping increases; a student who skips several questions in one exam is 4.6 less likely to graduate on-time than a non-skipper, while a student who skips at least one question on multiple exams is 6.9 pp less likely to do so.

The inclusion of the skipping indicators has negligible effects on the coefficients of other covariates, which suggests that skipping captures variation that was formerly embedded in the error term. This, however, does not imply that skipping adds explanatory power to the prediction of on-time high school graduation, since the R-squared does not change significantly when adding this variable.

Finally, columns 4 and 5 add 7^{th} and 9^{th} grade-school fixed effects. The results are largely unchanged by the inclusion of these fixed effects, which suggests that the relationship between skipping and graduation does not arise from specific school practices or resources, but it rather comes from differences between individual students.

In Table 4, we control for cognitive skills using the random-guessing adjusted test scores. This adjustment assumes that if the student had answered the questions he skipped, he would have gotten them right at random. As mentioned in section 3, other alternatives to control for academic ability include using actual test scores, using percent-correct adjusted test scores (e.g. assuming she would have gotten skipped questions right at the same rate she got right the rest of the exam) and all-correct adjusted scores (e.g. assuming she would answered skipped questions right). For comparison purposes, Table 5 presents the results with these alternative adjustments. The table displays the estimated coefficients on the skipped indicators for each adjustment, using our preferred specification, which is column (5) in Table 4.

As we move through the different adjustments (from column 1 – actual test scores, to column 4 – all-correct adjusted test scores), the estimated coefficients get higher in magnitude and more significant. For example, a student who skipped multiple questions in exactly one exam is 4.6pp less likely to graduate

[15] The incidence of skipping was also added using continuous measures of non-response, such us the percentage of questions skipped and the percentage of exams/years when the student skipped. The results, not presented here, are qualitatively the same and are available in the appendix/upon request.

from high school on-time, when actual test scores are controlled for. The coefficient increases to 5.2pp if we control for random-guessing adjusted scores, to 5.8pp if we control for the percent-correct adjusted scores and to 7pp if we control for all-correct adjusted scores (column 4). This increase in the magnitude of he coefficient is natural, because the adjustments correct any under-estimation of skippers academic ability, which implies comparing them with students of higher academic ability. Among these options, our preferred is random-guessing adjusted test scores, because it constitutes a middle point between assuming that the skipper would have gotten all the skipped questions wrong or all of them right.

Having presented the results for on-time high school graduation with different test scores adjustments, Table 6 proceeds to summarize the results for the rest of the outcomes. The outcomes, displayed in the columns, include high school drop out rates, grade repetition in high school (measured as continued enrollment after 4-years of starting the 9^{th} grade), college enrollment and performance in high school standardized examinations. In this table we control for academic ability using random-guessing adjusted test scores, but the results using optional adjusted test scores are available in Table 8 in the Appendix.

Table 6 shows that a student who skips questions in exams is more likely to drop out from high school, especially at higher levels of incidence of skipping. For instance, a student who skips several questions in one or more exams (rows 2 or 3 in the table) is between 1.4 and 1.8 percentage points more likely to drop out. This multiple skipper is also more likely to repeat grades in high school, at rates that range from 3.1 and 4.3pp, and, furthermore, less likely to enroll in any type of college, at rates that range from 2 to 2.5pp.

These results are all qualitatively the same and the magnitudes and significance of the coefficients reinforce the relationship between skipping and future educational outcomes. One exception, however, is the performance on high school examinations, since the evidence for these outcomes depends on the subject considered. Skippers perform worse in math exams regardless of the skipping incidence, from 0.02 to 0.1 standard deviations below non-skippers, which is consistent with the previous results. In contrast, students who skip multiple questions in exactly one exam (row 2) have *higher* reading test scores. These results are intriguing and encourage digging in further in the role of skipping questions in reading examinations in particular.

Comparison to the Borghans-Schils Drop-off

In this paper we have proposed an objective proxy for socio-emotional skills that can be derived directly from item-response level test scores. Borghans and Schils (2012) – BS now on - propose a decomposition of test scores in cognitive and

non-cognitive skills, which is also based in item-response level data. In this section, we compare our proxy for socio-emotional skills with their non-cognitive skills measure. As it was mentioned in section 1, BS measure consists on the decline (drop-off) in performance throughout the exam, provided that the order of the question is random. The authors explain that, conditional on cognitive skills (controlled for with the performance in the 1st question), this drop-off is likely to capture student's motivation, persistence, among other personality traits.

Since the regression-estimated drop-off is imprecisely measured at the student level[16], we operationalize BS measure by calculating the change in the percentage of correct questions from the first half to the second half of the exam. For each student, we then obtain the mean percentage drop-off over all exams taken in the 7th and 8th grade.

In order to compare our skipping variable with BS drop-off, we study their relationship with educational outcomes, both including them separately and jointly. Table 7 displays three columns of coefficient estimates from our preferred model, which controls for demographics, random-guessing adjusted test scores, and grade 7 and grade 9 school fixed effects. Column 1 includes our three mutually exclusive measures of skipping severity. Column 2 replaces these measures with the operationalized version of the drop-off, and Column 3 includes both measures.

The inclusion of each measure has no impact on the estimated coefficient of the other, and the R-squared statistic is essentially unchanged for any of the outcomes. Since both higher skipping and higher drop-off should translate into lower levels of socio-emotional skills, we expected both estimated coefficients to be negative. The estimated coefficient of the skipping variable has indeed the expected negative sign. However, the drop-off coefficient is not as expected, since it is positive and significant for some outcomes (high school graduation and 2-year college enrollment) and insignificant and negative for other outcomes.

These results reveal that the BS drop-off measure is difficult to obtain at the student level, since the estimated coefficients change signs and are noisy. Our skipping variable, on the contrary, allows having a measure of socio-emotional skills at the student level, that has consistent results across outcomes.

6. Conclusions

The incidence of skipping questions on standardized examinations in Michigan is related to reduced rates of on-time high school graduation, increased high school

[16] The large standard errors in the regressions at the student level prevented BS to have a measure of socio-emotional skills by student.

drop-out and repetition rates, and reduced rates of college enrollment. This relationship holds under a wide range of model specifications, different controls for baseline academic achievement, and definitions of the variable of interest. Further, more severe definitions of skipping incidence are related to more severe educational outcomes.

In this Michigan examination, there are no penalties for guessing, the test is multiple choice, and students are not bound by a time constraint. Thus, students are always weakly better off guessing than leaving questions blank and should not be constrained by time or ability from doing so. Further, even if there was an effective time constraint (students wishing not to take the "extra time" they are given), it would take them only minimal effort to fill in the blanks randomly at the end of the exam. This structure of the exam, combined with our controls for baseline test scores, lead us to believe skipping incidence is capturing something different than intelligence and academic ability, unobserved socio-emotional skills which are important for academic success.

We have proposed a low-cost objective measure of socio-emotional skills that may prove useful for evaluating the performance of programs designed to target such skills. Moreover, this measure may allow us to get at mechanisms through which other programs work to increase overall test scores and we believe this makes a good starting point for additional research to identify which socio-emotional skills are important to academic success.

This study does have the limitation of increasing only slightly the R-squared statistic, when the skipping incidence is included as a predictor of educational outcomes. As a result, skipping does not help to better identify students who are at risk of dropping out from high school, which would be useful for schools and policy-makers. More research is needed to identify if there exists a population of students for which skipping incidence does add predictive value.

In addition, it is difficult to untangle the bundle of socio-emotional skills skipping incidence may represent: for example, perseverance, motivation, attention to instructions, competitiveness, or composure. Fortunately, the availability of rich administrative databases allows for a deeper investigation into student test taking than just a simple observation of the final score. Patterns of answers and non-response may offer opportunities for researchers to develop a richer understanding of the relationship between test taking and future academic achievement.

One area of future research is to identify which socio-emotional skills are dominant or lacking through patterns of skipping behavior. For example, skipping difficult questions might reflect a lack of perseverance or composure. On the other hand, skipping a string of questions at the end of the exam may reflect a lack of competitiveness or poor attention to directions as these students easily

could have filled in answers randomly in the final minute of the examination. Once identified, researchers could test whether some of these socio-emotional skills are more or less related to future academic success or whether some behaviors are more or less persistent across examinations. Further, applying measures of socio-emotional skills on the field using standard psychological metrics, would allow to study how skipping incidence relates to this measures and, therefore, which socio-emotional skills is it likely to apply. Finally, explicit models of test taking behavior may also lead to predictions that can be tested with administrative data.

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8. Figures and Tables

Figure 1 Percentage of students skipping at least one question, by subject and grade

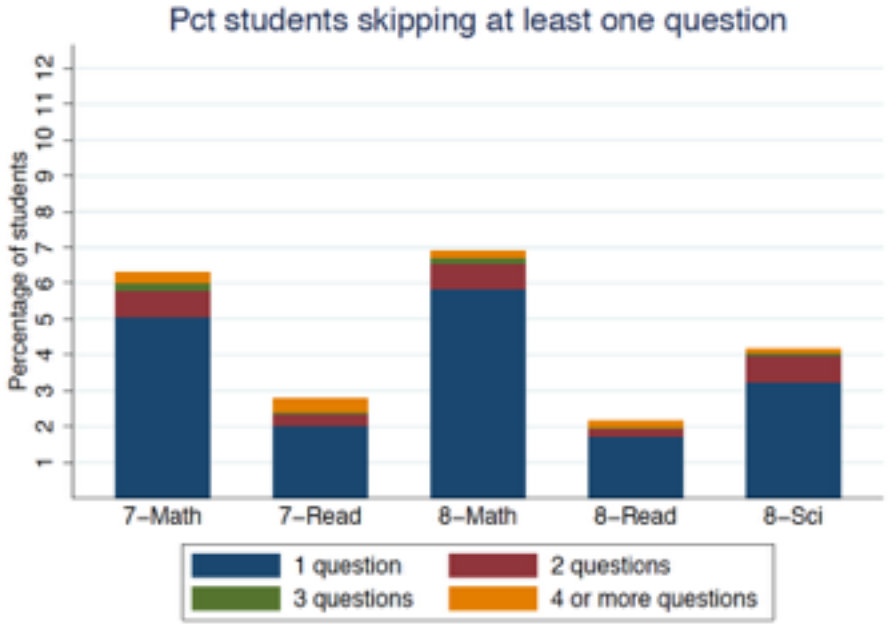
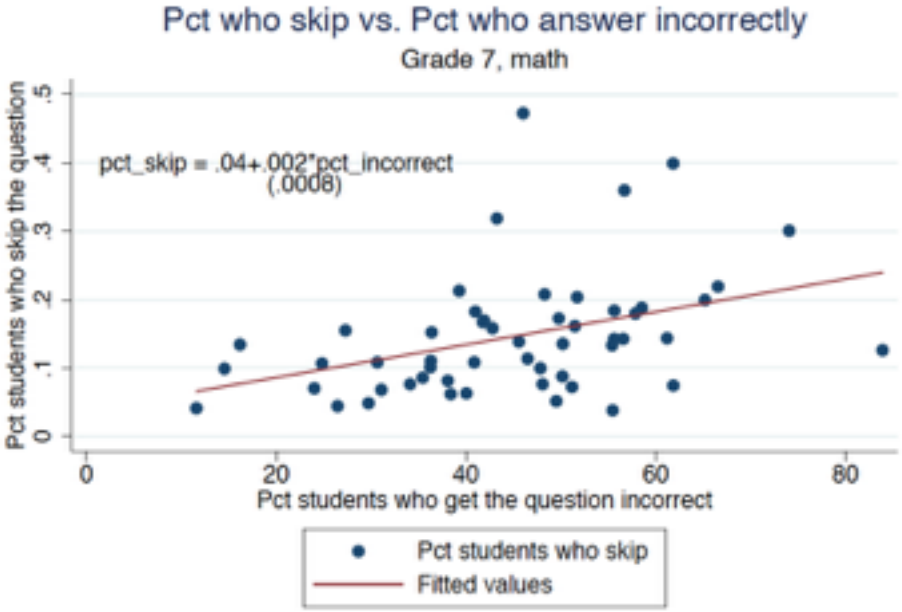


Figure 2 Skipping rates and difficulty of the question



Note: The pct of students who answer incorrectly does not include those who skip

Figure 3 Skipping rates and question order in Math

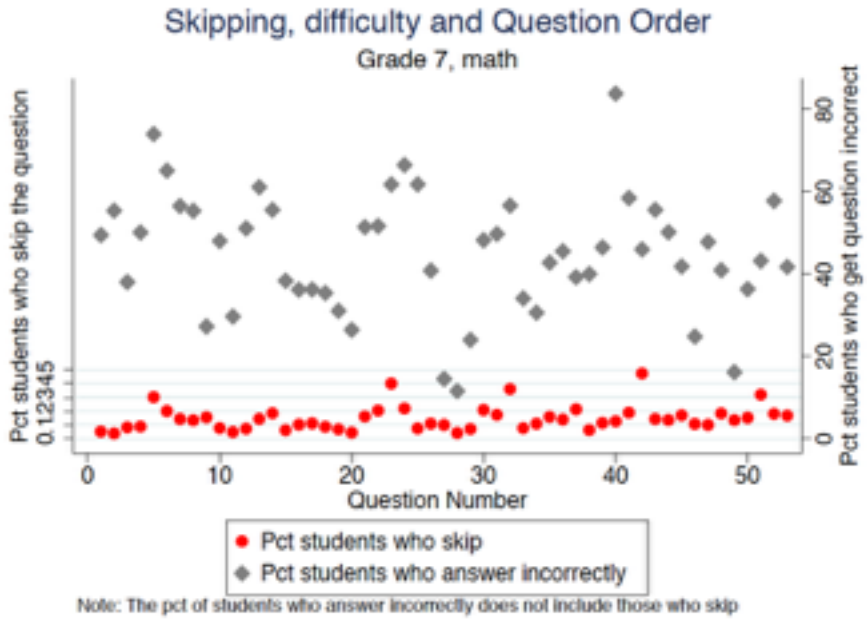


Figure 4 Skipping rates and question order in Reading

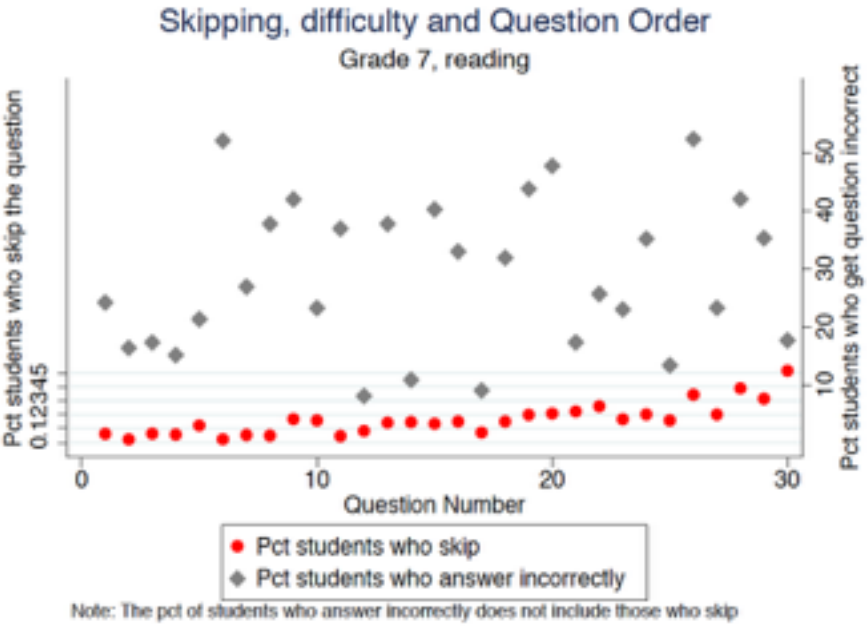


Table 1 Skipping frequency: Number of exams where students skip

N. Students who skip at least one question in:	Freq.	Percent
0 exams	84,012	83%
1 exam	13,966	14%
2 exams	2,220	2%
3 exams	386	0%
4 exams	75	0%
5 exams	15	0%
Total	100,674	100%

Table 2 Characteristics of students who skip questions, by different skipping incidences

	Never Skip Any Questions	Skip Exactly 1 Question Ever	Skip Multiple Questions on Exactly 1 exam	Skip at least 1 question on Multiple Exams
Number Students	84,012	10,656	3,308	2,696
Number Schools	860	842	735	696
White	79.6%	68.8%	61.0%	50.2%
Black	13.4%	22.9%	30.7%	43.1%
Hispanic	3.5%	4.8%	5.0%	4.0%
Asian	2.1%	2.0%	1.7%	1.6%
Ever Free/Reduced Lunch Status	34.5%	45.4%	51.9%	59.7%
Limited English Proficiency	2.6%	3.4%	3.8%	3.6%
Special Education	10.0%	16.3%	18.3%	22.8%
Female	51.0%	47.9%	46.2%	44.4%
Age	12.47	12.49	12.50	12.53
Avg Standardized Test Scores	0.19	(0.21)	(0.40)	(0.66)

Table 3 Who skips? Predictors of skipping only one question in one single exam

	Skip only one question ever	**Skip only one question ever**
Black	0.028***	0.030***
	(0.003)	(0.004)
Hispanic	0.022***	0.019***
	(0.005)	(0.006)
Asian	0.028***	0.027***
	(0.007)	(0.007)
Ever Free/Reduced Lunch Status	0.005**	0.005**
	(0.002)	(0.002)
Female	-0.008***	-0.007***
	(0.002)	(0.002)
Special Education	0.011***	0.009**
	(0.003)	(0.003)
Limited English Proficiency	-0.008	-0.007
	(0.006)	(0.007)
Age	0.000	-0.000
	(0.002)	(0.002)
Average Standardized Test Scores	-0.040***	-0.041***
	(0.001)	(0.001)
Observations	100,418	100,418
R-squared	0.018	0.028
Grade 7 School Fixed Effects		X

Table 4 The relationship between skipping incidence and on-time high school graduation

Dependent variable: On-time high school	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Skip Exactly 1 Question Ever			0.024***	0.022***	0.022***
			(0.004)	(0.004)	(0.004)
Skip Multiple Questions on Exactly 1 Exam			0.057***	0.056***	0.052***
			(0.008)	(0.008)	(0.008)
Skip At Least 1 Question on Multiple			0.069***	0.066***	0.065***
			(0.009)	(0.009)	(0.009)
Black	0.032***	0.037***	0.042***	0.052***	0.055***
	(0.007)	(0.006)	(0.005)	(0.006)	(0.006)
Hispanic	0.039***	-0.021**	-0.020**	-0.010	-0.009
	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
Asian	0.060***	0.034***	0.035***	0.042***	0.043***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Ever Free/Reduced Lunch Status	0.163***	0.121***	0.121***	0.114***	0.111***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Female	0.049***	0.046***	0.045***	0.044***	0.044***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Average Standardized Test Scores		0.120***	0.116***	0.114***	0.112***
		(0.003)	(0.002)	(0.002)	(0.002)
Average Standardized Test Scores Squared		0.038***	0.037***	0.035***	0.034***
		(0.001)	(0.001)	(0.001)	(0.001)
Observations	100,674	100,674	100,674	100,674	100,674
R-squared	0.092	0.140	0.141	0.164	0.181
Grade 7 Fixed Effects				X	X
Grade 9 Fixed Effects					X

Notes: Indicators for Limited English Proficiency, special education, and a quadratic in age are included. Missing variables were set to zero and an indicator for missing was included in the specification.

Table 5 Skipping and 4-Year High School Graduation Under Alternative Adjustments to Baseline Test Scores

	No Score Adjustment	Random Guess Score Adjustment	Percent Correct Score Adjustment	All Correct Score Adjustment
	(1)	(2)	(3)	(4)
Skip Exactly 1 Question Ever	-0.022***	-0.022***	-0.023***	-0.025***
Skip Multiple Questions on Exactly 1 Exam	-0.046***	-0.052***	-0.058***	-0.070***
Skip at least 1 question on Multiple Exams	-0.058***	-0.065***	-0.070***	-0.083***

Notes: Coefficient Estimates correspond to the same specification as in column 5 in Table 4 above

Table 6 The relationship between skipping and several educational outcomes

	4-Year HS Dropout	4-Year HS Continued Enrollment	Enrolled in any college Conditional on HS Grad	Standardized High School Math Scores	Standardized High School Reading Scores
Skip Exactly 1 Question Ever	0.001	0.020***	-0.008	-0.023***	0.005
	(0.002)	(0.004)	(0.005)	(0.008)	(0.007)
Skip Multiple Questions on Exactly 1 Exam	0.014***	0.031***	-0.020**	-0.034**	0.054***
	(0.004)	(0.007)	(0.010)	(0.015)	(0.014)
Skip At Least 1 Question on Multiple Exams	0.018***	0.043***	-0.025**	-0.101***	0.005
	(0.005)	(0.008)	(0.012)	(0.020)	(0.016)
Observations	100,674	100,674	84,257	91,890	92,330
R-squared	0.084	0.130	0.168	0.608	0.612
Grade 7 Fixed Effects	X	X	X	X	X
Grade 9 Fixed Effects	X	X	X	X	X

Notes: Specifications match Model (5) in Table 4 above.

Table 7 Comparison of skipping with Borghans and Schils drop-off

	On-time HS Grad			Conditional 4-Year College			Conditional 2-Year College		
Skip Exactly 1 Question Ever	-0.022		-0.022	-0.008		-0.008	-0.000		-0.000
	(0.004)		(0.004)	(0.005)		(0.005)	(0.005)		(0.005)
Skip Multiple Questions on	-0.052		-0.053	-0.007		-0.007	-0.012		-0.013
	(0.008)		(0.008)	(0.009)		(0.009)	(0.010)		(0.010)
Skip At Least 1 Question on	-0.065		-0.064	-0.033		-0.033	0.007		0.008
	(0.009)		(0.009)	(0.010)		(0.010)	(0.012)		(0.012)
Average Dropoff on		0.110*	0.111*		-0.072	-0.072		0.105*	0.107*
		(0.037)	(0.037)		(0.046)	(0.046)		(0.045)	(0.045)
Black	0.055*	0.052*	0.055*	0.105*	0.104*	0.105*	0.001	0.002	0.001
	(0.006)	(0.006)	(0.006)	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)
Hispanic	-0.009	-0.010	-0.009	-0.035	-0.035	-0.035	-0.019	-0.019	-0.019
	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)
Asian	0.043*	0.042*	0.043*	0.055*	0.055*	0.055*	-0.040	-0.040	-0.040
	(0.007)	(0.007)	(0.007)	(0.014)	(0.014)	(0.014)	(0.009)	(0.009)	(0.009)
Ever Free/Reduced Lunch	-0.111	-0.111	-0.111	-0.087	-0.087	-0.087	-0.007	-0.007	-0.007
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Female	0.044*	0.044*	0.043*	0.060*	0.061*	0.061*	0.012*	0.012*	0.012*
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Average Standardized Test	0.112*	0.117*	0.113*	0.232*	0.232*	0.231*	-0.070	-0.068	-0.068
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Average Standardized Test	-0.034	-0.034	-0.033	0.011*	0.010*	0.011*	-0.031	-0.030	-0.030
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Constant	-4.634	-4.628	-4.608	-2.305	-2.324	-2.325	-2.510	-2.485	-2.480
	(0.739)	(0.738)	(0.739)	(0.867)	(0.867)	(0.867)	(0.845)	(0.845)	(0.845)
	100,67	100,67	100,67	84,257	84,257	84,257	84,257	84,257	84,257
	0.181	0.180	0.182	0.247	0.247	0.247	0.086	0.086	0.086
Grade 7 Fixed Effects	X	X	X	X	X	X	X	X	X
Grade 9 Fixed Effects	X	X	X	X	X	X	X	X	X

Notes: Specifications match Model (5) displayed in Table 4 above, except for inclusion or exclusion of the skipping and drop-off variables as displayed

9. Appendix

Table 8 Coefficients on Skipping Incidence Indicators Under Alternative Adjustments to Baseline Test Scores

	Panel A. No Score Adjustment			Panel B. Random Guessing Score Adjustment		
Outcome	Skip Exactly 1 Question Ever	Skip Multiple Questions on Exactly 1 Exam	Skip at least 1 question on Multiple Exams	Skip Exactly 1 Question Ever	Skip Multiple Questions on Exactly 1 Exam	Skip at least 1 question on Multiple Exams
Enroll in 2-Year College within 5 Years Conditional on 4-Year HS Grad	-0.001	-0.014	0.006	0	-0.012	0.007
Enroll in 4-Year College within 5 Years Conditional on 4-Year HS Grad	-0.006	0.002	-0.025**	-0.008	-0.007	-0.033***
Enroll in Any College within 5 Years Conditional on 4-Year HS Grad	-0.007	-0.013	-0.019	-0.008	-0.020**	-0.025**
Enroll in 2-Year College within 5 Years	-0.004	-0.020***	-0.01	-0.004	-0.021***	-0.011
Enroll in 4-Year College within 5 Years	-0.010**	-0.007	-0.018**	-0.011**	-0.015**	-0.025***
Enroll in Any College within 5 Years	-0.014***	-0.027***	-0.028***	-0.015***	-0.036***	-0.037***
4-Year HS Dropout	0.001	0.012***	0.017***	0.001	0.014***	0.018***
4-Year HS Continued Enrollment	0.020***	0.026***	0.038***	0.020***	0.031***	0.043***
4-Year HS Graduation	-0.022***	-0.046***	-0.058***	-0.022***	-0.052***	-0.065***
High School Grade Repetition	0.017***	0.029***	0.036***	0.018***	0.034***	0.041***
Middle School Grade Repetition	0.006***	0.011***	0.031***	0.007***	0.012***	0.031***
Standardized ACT Composite	-0.009*	0.063***	0.011	-0.014***	0.029***	-0.016*
Standardized HS Math Scores	-0.019**	0.001	-0.069***	-0.023***	-0.034**	-0.101***
Standardized HS Reading Scores	0.01	0.091***	0.038**	0.005	0.054***	0.005
Standardized HS Science Scores	-0.027***	-0.003	-0.024	-0.031***	-0.038**	-0.056***

Notes: Specifications match Model (5) displayed in Table 4 above

Table 8 Coefficients on Skipping Incidence Indicators Under Alternative Adjustments to Baseline Test Scores (cont)

	Panel C. Percent Correct Score Adjustment			Panel D. All Correct Score Adjustment		
Outcome	Skip Exactly 1 Question Ever	Skip Multiple Questions on Exactly 1 Exam	Skip at least 1 question on Multiple Exams	Skip Exactly 1 Question Ever	Skip Multiple Questions on Exactly 1 Exam	Skip at least 1 question on Multiple Exams
Enroll in 2-Year College within 5 Years Conditional on 4-Year HS Grad	0.001	-0.008	0.01	0.001	-0.005	0.012
Enroll in 4-Year College within 5 Years Conditional on 4-Year HS Grad	-0.010*	-0.020**	-0.041***	-0.012**	-0.036***	-0.056***
Enroll in Any College within 5 Years Conditional on 4-Year HS Grad	-0.009*	-0.028***	-0.031***	-0.011**	-0.041***	-0.044***
Enroll in 2-Year College within 5 Years	-0.004	-0.019**	-0.01	-0.003	-0.020***	-0.013
Enroll in 4-Year College within 5 Years	-0.013***	-0.027***	-0.034***	-0.015***	-0.043***	-0.049***
Enroll in Any College within 5 Years	-0.017***	-0.046***	-0.044***	-0.019***	-0.063***	-0.062***
4-Year HS Dropout	0.001	0.015***	0.019***	0.001	0.018***	0.022***
4-Year HS Continued Enrollment	0.021***	0.035***	0.046***	0.022***	0.043***	0.056***
4-Year HS Graduation	-0.023***	-0.058***	-0.070***	-0.025***	-0.070***	-0.083***
High School Grade Repetition	0.019***	0.039***	0.045***	0.020***	0.049***	0.057***
Middle School Grade Repetition	0.007***	0.012***	0.032***	0.007***	0.014***	0.033***
Standardized ACT Composite	-0.023***	-0.021**	-0.050***	-0.032***	-0.083***	-0.108***
Standardized HS Math Scores	-0.029***	-0.071***	-0.130***	-0.037***	-0.135***	-0.195***
Standardized HS Reading Scores	-0.002	0.011	-0.027*	-0.011	-0.056***	-0.094***
Standardized HS Science Scores	-0.038***	-0.079***	-0.087***	-0.046***	-0.144***	-0.153***

Notes: Specifications match Model (5) displayed in Table 4 above