Supplementary Online Material Part A

Interventions

Treated Control Condition: Mathematics Intervention

In first grade, teachers in the mathematics condition were taught and trained to use first grade Math Pals (Fuchs et al., 1997) as a supplement to their core mathematics instruction, Saxon Math. The Math Pals protocol calls for the pairing of students with weaker mathematics skills with students with stronger mathematics skills for peer-learning activities. Opportunities to practice mathematics skills with their peer are offered after students receive a short lesson from the teacher.

In second grade, teachers were trained to use first through fifth grade Math Pals and researcher-developed materials to supplement their core, *Saxon Math*. Based on assessment data, students were grouped according to the grade-level of materials that matched their level of achievement. In small groups, teachers provided short lessons focused on content specific to the needs of each group. On subsequent days, students worked in small groups to practice skills presented in the teacher-managed lessons. Topics included numeration, measurement, problem solving, algebraic thinking, and geometry. Small groups were used in addition to the core math curriculum plan.

In third grade, teachers were trained on a series of mathematics activities that were designed by the research team to align with and differentiate content presented in the core

mathematics curriculum. For each week of the core curriculum, teachers provided alternate conceptual explanations of the topic for students who were on grade-level, prerequisite practice for students who were struggling, and advanced applications for students working above grade-level. These lessons were delivered in small groups where students were grouped based on pretest scores for each unit of study (i.e., place value, addition). This model of small group, differentiated math was provided in addition to the core curriculum, *Everyday Math*.

ISI – Treatment Condition

The ISI intervention is designed to be provided by regular classroom teachers and has several distinct components: (1) conceptualizing reading instruction across multiple dimensions; (2) taking into account child-by-instruction (CXI) interactions by making assessment-instruction links more salient; (3) professional development to support teachers' efforts to differentiate reading instruction in the classroom; and (4) implementation. These are described in the article with additional information on (1) and (2) provided below.

Studies of teachers' instruction in the classroom reveal that teachers use a variety of strategies and techniques to teach reading, even if their core literacy curriculum uses specific strategies predominantly. For example, teachers utilizing a whole language approach to teaching reading, with substantial amounts of time devoted to sustained silent reading, were still observed to provide explicit code-focused instruction (Chall, 1967; Connor, Morrison, & Katch, 2004). The ISI intervention uses a finer grain-size than curriculum by using a multi-dimensional conceptualization of literacy instruction to identify the reading strategies: Content, Management,

and Context (See Table 2). The dimensions operate simultaneously to define any evidence-based literacy activity.

Dimensions of Instruction

Content. Following the simple view of reading (Hoover & Gough, 1990) and other more complex theories (Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007), teachers were taught to identify strategies as either code- or meaning-focused instruction. Code-focused instruction was intended to teach children the alphabetic principle, phonological awareness, phonics, letter and word fluency and other skills children require to decode unfamiliar words (NICHD, 2000). Meaning-focused instruction was intended to help children extract and construct meaning from text (Snow, 2001) including discussion, questioning, reading text, explicit teaching of comprehension strategies, vocabulary and oral language skills, sentence and passage fluency, and so on (Connor, Morrison, et al., 2009).

Management. Teachers were also taught to consider whether instruction was teacher/child-managed (TCM) or child-managed (CM) instruction. This dimension identifies who is focusing the students' attention on the learning activity at hand – the teacher interacting with the students (TCM) or the student independently or with classmates (CM) (Connor, Morrison, et al., 2009).

Context/Grouping. Instruction could be provided to the entire classroom of students at one time (whole-class instruction), to small groups of children, or individually.

Assessment to Instruction (A2i) Software

A2i provides web-based support for teachers and may be described as a resource and planning tool. Teachers log on (the system is password protected) and are taken to their home page where

they can access text and video training materials and the planning components of A2i (See Figure S1). The Classroom View (see Figure S2) provides the recommended amounts of each type of literacy instruction (Teacher/child-managed Meaning Focused, Teacher/child-managed Code Focused, etc.) and recommended groupings based on children's word reading skills. Teachers may change recommended group membership. Mean recommended amounts are provided for each group. It is these amounts teachers were asked to provide, attending to content and student skill level using their professional judgment. Studies reveal that the more teachers used the A2i software, the stronger were their students' reading outcomes (Al Otaiba et al., 2011; Connor et al., in press).

There is also a page for scheduling the literacy block, another for daily lesson planning, and a third for accessing assessment information. Additionally, on the classroom view, clicking the child's name brings the teacher to the specific child's test scores and progress-monitoring charts (see Figure S3). Finally, there are online professional development resources, including video of master teachers (see Figure S2). Modules included, "Using Assessment to Guide Instruction," "Planning to Individualized Instruction using Stations or Centers," and video with descriptions of the dimensions of instructions (e.g., teacher/child managed meaning-focused activities).

A2i Algorithms

In first grade, the amount of TCM code-focused instruction recommended increased exponentially as first graders' skills fell farther and farther below grade level expectations. The recommended amount of CM meaning-focused instruction was smaller for students with weaker

vocabulary skills and greater for students with stronger vocabulary skills. For students with weaker vocabulary skills, the recommended amount of CM meaning-focused instruction increased each month until by the end of the year, all students were provided substantial amounts of CM meaning-focused instruction (Connor, Piasta, et al., 2009). Using data from these studies, we developed algorithms for CM code-focused and TCM meaning-focused instruction. Analyses revealed a main effect for TCM meaning-focused instruction thus algorithms recommended fairly consistent amounts for all children using the following equation where TCM MF Rec is the computed recommended minutes/day of TCM meaning-focused instruction, PCGE is passage comprehension grade equivalent and Yij is the target outcome, which was set at 2.1 or PCGE + .9, whichever is greater (see also Figure 2).

$$\text{TCM MF Rec} = (1.2 * \text{PCGE}^2) + (0.2 * \text{Yij}^3) + 25 - (3 * \text{PCGE}) \quad (1)$$

if (TCM MF rec > 45), TCM MF rec = 45

Results for CM code-focused instruction revealed a CXI such that time spent in these instructional activities (e.g., phonics worksheets) were associated with greater reading gains for students with weaker fall reading skills but with weaker gains for students with stronger fall reading skills (see Equation 2 and Figure 3).

$$\text{CM code-focused Rec} = 2*\text{Yij} + 0.6*\text{LWGE} - 8*\text{LWGE}^3 + 27 \quad (2)$$

Where LWGE is the Letter-word identification grade equivalent score and Yij is the target outcome.

The original evidence for CXI interactions was weaker for second grade compared to first grade. Only three correlational studies provided information for the original second grade A2i algorithms (Connor, Jakobsons, Crowe, & Meadows, 2009; Connor, Morrison, & Underwood, 2007; Foorman et al., 2006). The studies, with very different samples of children, revealed surprisingly similar findings. Both the Foorman et al., study and the Connor et al., studies showed that generally teachers decreased the amount of TCM code-focused instruction provided to students as they moved from first to second grade. At the same time, children continued to show greater reading skill gains when provided TCM code-focused and meaning-focused instruction.

A previous randomized control study using these algorithms and revealed no intent-to-treat effect although there was evidence of a treatment-effect-on-the-treated effect (Connor, 2011). We used the data from this study to develop new second grade algorithms. To compute the recommended number of minutes per day of small group TCM meaning focused instruction (TCMMF Rec) the equation is as follows:

$$\text{TCMMF Rec} = (1.2*\text{PCGE}^2 + .2*(\text{Yij})^3 + 25 \quad (3)$$

$$- 3*\text{PCGE}) - 15.$$

Where TCMMF Rec is the recommended amount in minutes/day of TCM-meaning focused small-group instruction for a particular student, PCGE is the grade equivalent (GE) on the WJ-III Passage Comprehension test, and Yij is the target outcome GE, which is 2.9 or, for students on grade level, their fall GE + 0.9.

By third grade, algorithm-recommended amounts of TCM code-focused instruction were minimal, except for students with reading comprehension skills well below grade expectations. At the same time, TCM meaning-focused recommended amounts of instruction increased as third graders' reading comprehension scores decreased with a minimum amount of time set for all students since previous findings revealed a main effect of third grade TCM meaning focused small group literacy activities (Connor et al., 2011; Connor, Morrison, & Petrella, 2004). For this study, we used the same algorithms as were used in Connor et al., 2011.

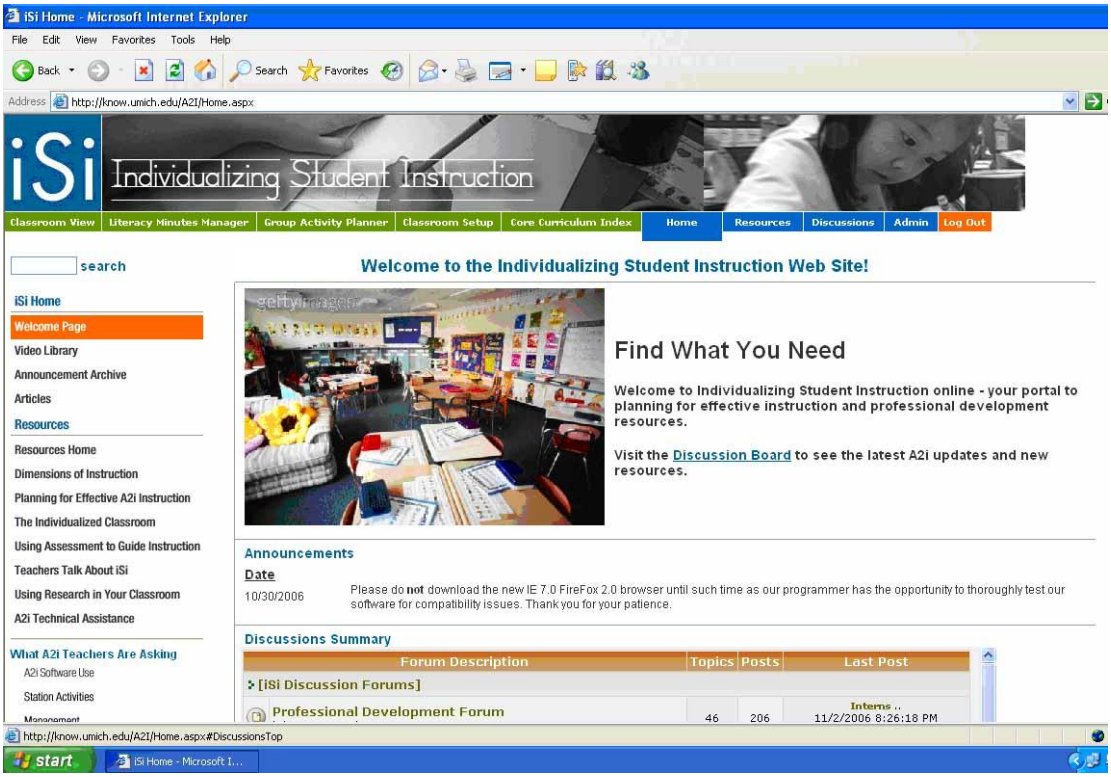

Figure S1.

The A2i homepage allows teachers to access key components of A2i, including the classroom view, classroom planning tools and professional development resources. The resources available

for teachers include video training modules of experienced teachers. Modules cover, “Using Assessment to Guide Instruction,” “Planning to Individualized Instruction using Stations or Centers”, and explicit descriptions of the dimensions of instruction.

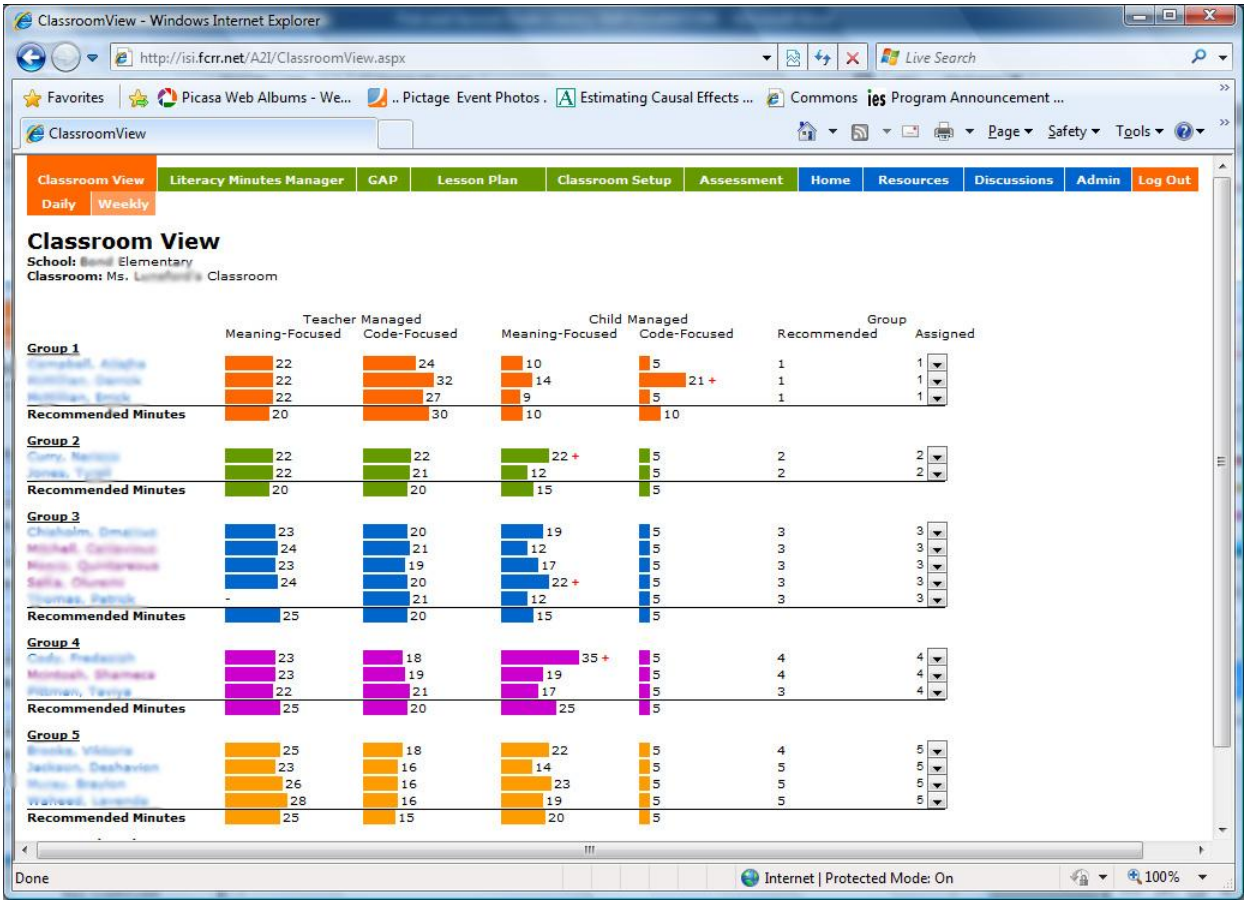

Figure S2.

The colored bars on the Classroom View display the recommended amounts and types of instruction a student should receive based on algorithm results which have been computed using students' assessment results. The group function displays the recommended group for each student and allows teachers to change the recommended group by using a drop down menu; the teacher may also add groups. Student names can be clicked on to view test scores and graphs depicting the student's actual scores compared to their target scores.

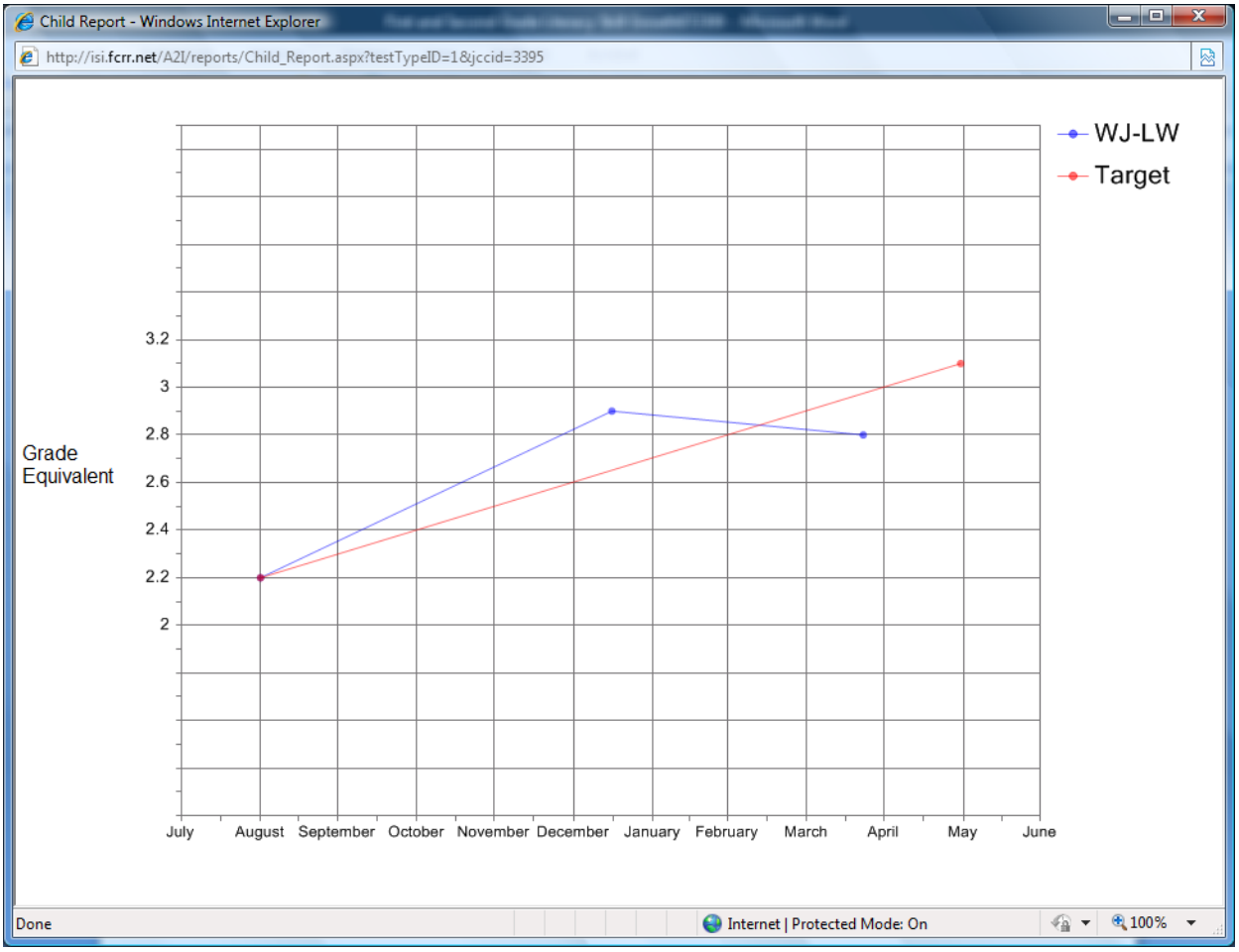

Figure S3

The graphs available for each student's assessment results provide a view of the student's observed growth (blue) and target growth (red) based on students' scores at the beginning of the school year. Based on a student's initial performance in August, the target growth (red) aims for a one school-year gain in achievement. If the student begins the school year below grade expectations the target outcome (red) would set be to reach grade level expectations by the end of the school year and, hence, more than a one school-year gain in achievement.

Supplementary Online Materials Part B

Analytic Strategies

Reading Outcomes

Students received three different reading assessments, the WJ-III Passage Comprehension (PC), the WJ-III Letter-Word Recognition (LW), and the Gates-MacGinitie Reading Test (MacGinitie & MacGinitie, 2006). The latter was administered only in the fall and spring (see results below) and so was not included in the factor analysis. Using principal component analysis, we created one variable utilizing PC and LW because they were administered three times per year. Both assessments loaded on one factor (PC=.968; LW=.968), which explained 93.62% of the variance. The factor z-score was computed using the regression option of SPSS v. 19. The mean of 0 (SD=1) can be contextualized as a W score of 476 (SD=15) on the PC assessment or beginning of second grade grade-level achievement (i.e., a standard score of 100 [SD=15]).

Within Classroom Analyses

Using hierarchical linear modeling (HLM, Raudenbush & Bryk, 2002) we examined within-grade treatment effects using the following model for each grade with the spring score as the outcome and controlling for the fall score.

Level-1 Model

$Y_{ij} = \beta_{0j} + \beta_{1j}*(fall\ reading_{ij}) + r_{ij}$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(\mathrm{ISI}_j) + u_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

Where Y_{ij} is the fitted spring reading W score for child i in classroom j and ISI_j represents the teacher's assignment to the ISI-reading intervention (coded 1) or the mathematics intervention (coded 0). Fall reading was grand mean centered. γ_{00} represents the mean spring reading score for students in the control group and γ_{01} represents the effect of assignment to the ISI-reading intervention.

Testing the Longitudinal Cumulative Effects

The longitudinal data have a nested and cross-classified structure (Raudenbush & Bryk, 2002). This is because in first grade, children attend one classroom with a specific teacher and classmates, and then, in second grade, attend a different classroom with a different teacher and a different set of classmates (although some may be the same) and then in third grade, again with a different teacher and classmates. Failing to take into account the different nesting in first, second, and third grade may lead to misestimated standard errors and, hence, computed effects of treatment. Therefore we used cross-classified random effects growth curve modeling (Raudenbush & Bryk, 2002) where the repeated measure over time was modeled at level 1, students as rows, and teachers as columns.

We built the model systematically first testing the linear and quadratic trends with Time (T), in months, representing the month in which the specific test was administered, centered at the end of second grade. The linear, quadratic and cubic trends were significant.

Level-1 Model

$$LW_{ijk} = \pi_{0jk} + \pi_{1jk}*(T_{ijk}) + \pi_{2jk}*(T^2_{jk}) + \pi_{3jk}*(T^3_{ijk}) + e_{ijk}$$

Level-2 Model

$$\pi_{0jk} = \theta_0 + b_{00j} + c_{00k} + (\gamma_{01})*TotalISI_j$$
$$\pi_{1jk} = \theta_1 + b_{10j} + (\gamma_{11})*TotalISI_j$$
$$\pi_{2jk} = \theta_2$$
$$\pi_{3jk} = \theta_3 + (\gamma_{31})*TotalISI_j$$

Where θ_0 is the fitted mean reading z-score at the end of second grade for children in the control group (i.e., the intercept); θ_1 is the slope in z-score points per month; β_{01} is effect of receiving the ISI intervention on children's end of second grade reading Score (i.e., the intercept); β_{11} is the effect of the ISI intervention on the slope; b represents the random effect at the child level (row) and c represents the random effect at the teacher level (columns). *TotalISI* represents the number of years the student was in an ISI classroom (0 to 3 years). Results were computed using a cumulative z-structure as recommended by Raudenbush & Bryk (2002). In the unconditional model, the intraclass correlation (ICC), which is the proportion of variance explained by classrooms, was .06 for intercept (column variance/total variance). For the final model, the intercepts were removed and all potential configurations were entered into the model (3 years treatment = TTT; three years control = CCC, etc.).

Growth curves cross-classified random effects models using the Gates-MacGinitie Reading Test (MacGinitie, MacGinitie, Maria, & Dreyer, 2002) ESS scores (similar to W scores)

revealed significant linear and quadratic trends but no significant cubic trend. In this group-administered assessment, students read a passage and answered multiple-choice questions about the passage. When *TotalISI* was entered into the model, the results replicated those presented in the manuscript (see Table S1) with an effect of 3.55 (p=.037) ESS for each year students were in ISI classrooms (d 0 compared to 3 years = 0.45).

Table S1

Cross-classified Random Effects Model Results for Gates-MacGinitie Reading Test – Comprehension (ESS) student outcomes

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTERCEPT,θ_0	451.144452	2.365684	190.704	729	<0.001
TOTALISI, γ_{01}	3.557085	1.698846	2.094	756	0.037
For Time, π_1					
INTERCEPT,θ_1	2.778385	0.245280	11.327	729	<0.001
TOTALISI, γ_{11}	0.050652	0.095315	0.531	756	0.595
For Time^2, π_2					
INTERCEPT,θ_2	-0.031268	0.009847	-3.175	729	0.002
For Time^3, π_3					
INTERCEPT,θ_3	-0.002170	0.001425	-1.523	729	0.128

Random Effect	Standard Deviation	Variance Component	*d.f.*	*p*-value
INTRCPT1/ICPTROW,b_{00j}	33.84595	1145.54828	608	<0.001
Time/ ICPTROW,b_{10j}	0.79994	0.63990	608	<0.001
level-1, *e*	23.47526	551.08762		

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1/ ICPTCOL,c_{00k}	3.32824	11.07716	66	135.39342	<0.001
Time/ ICPTCOL,c_{10k}	0.34845	0.12142	66	112.69527	<0.001

Deviance = 23799.64. Note. Students were modeled as rows (ROW) and classrooms as columns (COL). Time is in months centered at the end of second grade. Time^2 is the quadratic trend; Time^3 is the cubic trend.

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