Improving the Effectiveness of Digital Educational Tools in Increasing Student Achievement and Reducing Achievement Gaps

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Patterns in and Estimated Effects of StudentNest Online Tutoring in Milwaukee Public Schools (2016-2017)

- *Why:* Our research practice partnership with MPS supports informed decisions to improve programs, with the ultimate goal of improving K-12 student achievement and reducing socioeconomic and racial opportunity and achievement gaps.
- *Who*: Our research team has worked closely with the Office of Extended Learning and Office of Research and Evaluation in MPS for over 10 years, and is based at Vanderbilt University and the Wisconsin Center for Education Research (WCER) at the University of Wisconsin-Madison.
- *What*: Our work focuses on the implementation and impact of digital tools in MPS
- *How:* This summary focuses on StudentNest, an online tutoring program for primary school students. The analysis draws on the following methods (additional details available upon request):
  - Quantitative analysis of StudentNest data on students tutored combined with MPS records on student characteristics and achievement (over the school year);
  - Qualitative analysis of observations of StudentNest tutoring sessions, interviews with program staff and analysis of documents.
- *When*: This summary focuses on data collected from the Spring of 2016 through the Spring of 2017 (encompassing the 2016-17 school year).

What is StudentNest?

StudentNest (www.studentnest.com/student/tutoring) is a provider of online, synchronous tutoring delivered via a digital device (e.g. tablet) to students. Trained tutors interact with students live via a platform that has a digital whiteboard, chat function, and audio. In the case of MPS, StudentNest was made available to certain elementary-aged students in need of additional academic support, primarily in literacy. Students accessed tutoring at home via tablets provided by StudentNest, at times scheduled with the tutor. Caregivers or students have access to a Student Nest call center where they can ask questions, and that also calls homes to remind families of upcoming tutoring sessions.

Who used StudentNest in MPS?

A total of 166 students received tutoring from StudentNest in the 2016-17 school year. The majority of these students (60%) were in 3rd grade; another 35% were in 2nd grade and the remaining 5% were 4th grade students. (The 4th grade students receiving tutoring had not completed their maximum total hours in the previous school year). Table 1 compares the baseline characteristics of students (at the start of the 2016-17 school year) between those receiving StudentNest tutoring and all other 2nd-4th grade students in the district. There are some noticeable differences between StudentNest and other district 2nd-

4th graders. They were more likely to be black (86% vs. 53%) and less likely to be white or Hispanic. StudentNest participants were more likely economically disadvantaged (93% vs. 84% free/reduced price lunch eligible), but they were less like to be English language learners or to have special educational needs. Lastly, StudentNest participants were at lower grade level equivalents in reading and math achievement (on STAR assessments); this was expected, because students performing below their grade level were prioritized for tutoring. In light of these clear differences in who received tutoring from StudentNest, we adjust for these student characteristics when estimating the effects of tutoring from StudentNest on student spring reading and math achievement.

Table 1: StudentNest Participants Compared to Other MPS 2nd-4th Grade Students

Student Baseline Characteristics	All MPS 2nd-4th Grade Students			StudentNest Participants		
	N	Mean	Std. Dev.	n	Mean	Std. Dev.
Female	18,332	0.48	0.50	166	0.52	0.50
Black	18,332	0.53	0.50	166	0.86	0.35
Asian	18,332	0.07	0.25	166	0.05	0.21
White	18,332	0.12	0.33	166	0.02	0.13
Hispanic	18,332	0.27	0.44	166	0.07	0.25
Other race	18,332	0.01	0.08	166	0.01	0.08
ELL	18,332	0.15	0.36	166	0.04	0.20
Free/reduced lunch	18,332	0.84	0.37	166	0.93	0.25
Special needs	18,332	0.18	0.38	166	0.08	0.27
Absences (%)	16,310	0.08	0.08	150	0.07	0.07
Fall STAR Math (g.e.)	15,690	2.65	1.25	165	2.43	0.75
Fall STAR Math (s.s.)	15,690	-0.000276	1.003596	165	0.086360	0.613460
Fall STAR Reading (g.e.)	15,574	2.51	1.31	164	2.10	0.54
Fall STAR Reading (s.s.)	15,574	0.001708	1.003839	164	-0.128908	0.498310

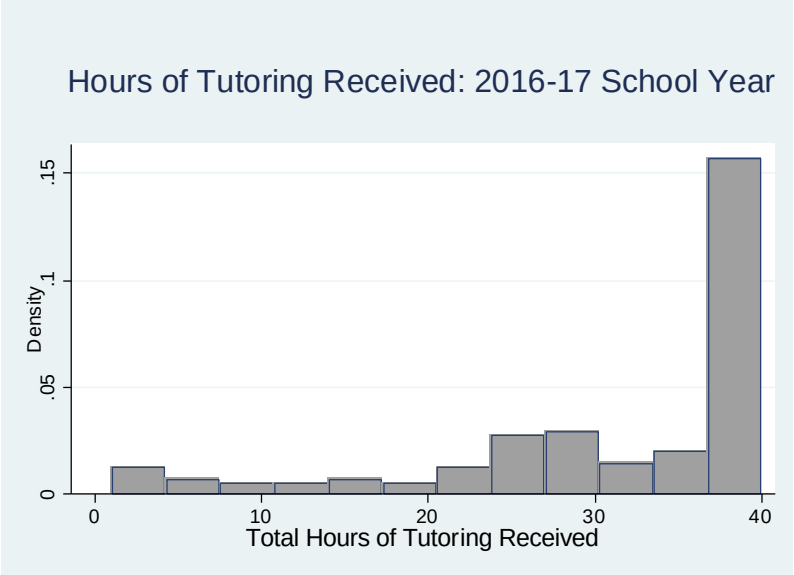
How much StudentNest tutoring did MPS students receive?

StudentNest was made available to MPS students from 22 different schools. Drawing on evidence from MPS' past tutoring program efforts, the program had a goal of serving each student with at least 40 hours of tutoring in a school year with no more than 2-3 hours of tutoring per week. The expected tutor to student ratio was 1:2, although some tutoring sessions provided 1:1 tutoring (as requested by the parent). There was no set schedule for student tutoring or tutor rotation; students could schedule their tutoring sessions at their convenience. In general, tutors were assigned to work with a particular group of students, but this could also fluctuate depending on scheduling needs.

Analysis of the data from StudentNest records showed that the large majority of students received 40 hours of tutoring or close to 40 hours; more than half of the students tutored received greater than 37 hours of tutoring. Not all students used the full hours of tutoring available to them, although more than three-quarters of students received more than 26 hours of tutoring. Among the 4th grade students, two-thirds (6 of 9) received 40 hours of tutoring; the other three students received 25-35 hours of tutoring from StudentNest.

Figure 1 shows graphically the distribution of tutoring hours among MPS 2nd-4th grade students in 2016-17.

Figure 1: Distribution of Total Tutoring Hours Received by MPS Students through StudentNest



What patterns in academic outcomes did we identify with StudentNest use?

As discussed above, when assessing the effects of StudentNest tutoring, it is important to adjust for student characteristics that differ between those who received tutoring and those who did not participate. We did this by using propensity score matching techniques, in which we matched each StudentNest participant with one or more students not participating in StudentNest but who had similar observed characteristics (i.e., on those measures shown in Table 1). Because of the large pool of available comparison students and the fact that the criteria (student achievement levels) that prioritized student participation were known, we achieved very close matches (i.e., after-matching statistical equivalence) that allow us to have more confidence in the results. (Appendix Figures A.1-A.4 present graphics showing the performance of the matching analysis). Using the matched samples, we assessed how the reading and math achievement changes from the beginning to the end of the school year for students tutored by StudentNest compared to the changes in test scores experienced by similar students who did not receive tutoring. The results are presented in Table 2 (measured in both grade equivalents and scaled scores from the STAR assessments); p-values equal to or less than 0.05 correspond to statistically significant estimated effects.

Student gains in reading through StudentNest tutoring are statistically significant. Those who received tutoring from StudentNest had reading gains of 0.178 grade equivalents higher than similar students who did not participate. In terms of the standardized (scaled score) gain measure, the effect size of 0.122 corresponds closely with the average tutoring effect in reading estimated for the T4U tutoring program in 2014-15 (Heinrich and Good, 2018). The estimated effect of StudentNest in math is smaller than in reading—0.103 grade equivalents and 0.092 on the scaled score measure—but higher than the 2014-15 T4U estimated effect in math, and the latter estimate is very close to attaining statistical significance.

Table 2: Estimated Effects of StudentNest Tutoring on Student Achievement

Student Outcome	Estimated effect	Standard error	p-value
Reading (g.e.) gain	0.178	0.081	0.028
Reading (s.s.) gain	0.122	0.059	0.039
Math (g.e.) gain	0.103	0.089	0.250
Math (s.s.) gain	0.092	0.047	0.053

The identification of these positive tutoring effects should be expected given prior research on MPS tutoring programs (Heinrich and Good, 2018). MPS insisted on the implementation of best practices identified in its own research: low student to teacher ratios, limiting the number of tutoring hours in a given week, and requiring that students be offered 40 hours of tutoring.

What patterns emerge from observations of in tutoring in practice?

Student-centered instruction

Adjusting pace, sequence, etc.

As in observations of online tutoring in previous school years, a minority of observed sessions contained evidence of authentically student-centered or personalized instruction. When there were modifications and accommodations observed they tended to include: readability of text, pacing and flexibility, creating incentives (e.g. playing a game at the end of the session) and accountability, individualized assessments, and individualized instruction (both via technology and instructors).. Each is discussed in greater detail below. This component overlaps with that of individualized assessment, as quizzes and associated progress reports often enabled teachers to target students in need of assistance. At the most basic level, we observed tutors individually grading and providing feedback to students, something expected in a traditional classroom setting that is not always received in an online or blended learning environment. Similarly, StudentNest allowed students to interact with a teacher as they would in a classroom setting but provided more targeted attention, with only one or two students per tutor.

> *Students started the lesson by writing a complete sentence about their day, identifying and reading definitions of abstract and common nouns, and then they read sentences and put the correct missing word in the sentence. The last third of the lesson was adjectives and adverbs, same format. While the students claimed they had done this before, they needed help with the content. It seemed appropriately challenging for at least one student. The other student seemed to answer whatever the teacher gave as an example about 75 percent of the time, if she had to come up with an organic answer. The tutor adapted significantly by*

activating prior knowledge, asking questions, providing context clues etc. for each student.

Making content relevant

An important element of student-centered instruction is making the content and pedagogical approach relevant and responsive to students' own contexts and lives. In the following StudentNest observation, the teacher used a book the student was reading as a reference for a lesson on character development, providing concrete examples and centering discussions on a topic the student presumably finds interesting.

The curriculum was software-driven and included a lesson on describing characters delivered online through the StudentNest platform… The teacher did a good job of giving the student an opportunity to figure things out herself, waiting for the student to ask for help or a long silence from the student before jumping in to offer assistance. The teacher asked the student to describe her favorite book or comic book. She couldn't think of one, so the teacher asked about and referred to the book she's currently reading, adapting the content to the student's interests.

In another StudentNest session, it was observed that:

Questions are open-ended enough that the student can bring in her own experiences. Stays engaged throughout the lesson - is talking about events/interests in her life to practice reading/writing skills.

Instructor role and capacity

Those involved in introducing and implementing digital instructional tools should be skilled in the use of them and have ongoing and consistent support to make sure it is working for all students. Building instructor capacity for effectively using digital tools means ongoing access to professional training for the planning and use of the technology, as well as time for practicing with the tools and communicating with others on effective strategies for their use. The following are excerpts from observer notes (of StudentNest tutoring):

Teacher using tools very effectively - using pointer to help student sound out words, guiding student through lesson. Student has occasional difficulty getting some features to work but the teacher is able to guide her through it.

All functional, and instructor is skilled at teaching students how to take advantage of technology to get what they need out of it.

StudentNest tutors, with a few exceptions, appeared to have difficulty, however, understanding and addressing technical difficulties:

In the first 9 minutes, students were logged on and trying to get in touch with the tutor who had not joined the session yet. The students had almost 38 minutes of technical difficulties with audio, visual or both. Parents could be heard in the background, but not necessarily supporting their students through these struggles. One parent tried to intervene twice in locating the tutor and helping her child get connected. The other parent helped their student spell gymnast, but didn't appear

to have any role in technical difficulties and could be heard in the background. The tutor was primarily the support for learning and technical issues, but she had her own technical issues and didn't provide much support either.

The student had almost 8 minutes of tech issues, but the tutor claimed they were not having the same issues. When the student said she couldn't hear, the tutor said everything was fine on her end and went on in spite of the student's struggles.

The only technical issues were due to the instructor not knowing how to use the whiteboard, which caused several delays. She got better as the lesson went on.

There were several times the video seemed spliced and I don't know what was missed during those times. The student used a Samsung tablet to access the virtual whiteboard that also had a wireless card provided by StudentNest. It is unknown if the student or tutor used a microphone. Everything appeared safe and operable. The only issues observed were due to the tutor's unfamiliarity with the whiteboard environment.

[See a related research brief on instructor capacity in digital tools initiatives here: https://my.vanderbilt.edu/digitaled/files/2016/08/DT_ResearchBriefInstructorCapacity_Sept-2016.pdf]

Access

Equitable access to digital instructional tools means that all students have equal opportunity to instruction regardless of income, disability, or language status. We not only examine equitable access, but also the reliability of access to digital instructional settings. This is important as it directly affects the amount of instructional time provided to students and the quality of the interactions between the student and the instructor and/or technology. Below we present some excerpts from observations highlighting particular access issues, specific to technical challenges and surrounding environment to the session.

Technical issues

There are significant issues with the technology from the observer side. The screen often doesn't match the discussion, but the tutor and student seem to be on the same page. There was a constant 30 sec delay on the observer's end, but only in visual. There appeared to be an occasional delay in audio between the tutor and student because she would sometimes correct the student when the student had already auto-corrected orally and apparently was not heard.

There seems to be a delay, so the student is never exactly on the same page as the tutor. The tutor goes back to the problem and talks through it, but the students seem confused because they seem to moving on while tutor seems to move backwards. The other lessons did this too, but this one seems more delayed than the others.

One student often texted a lot of emoji's in the chat box. The other student had significant technology issues, such as not being able to hear, for over half the lesson. The tutor was not much help when students had technology issues. The students were more efficient at addressing when they had an issue, such as

typing in the text box, etc. When one student stated she couldn't hear, she often just talked to her more and louder, which didn't help. When the tutor herself couldn't hear, she would keep talking, but noted she hoped it would get better soon. No one made any attempt to identify a specific strategy to address the issues they were facing, other than the students using the chat box to communicate with the tutor. The platform seemed safe, but all involved had issues with both operability and accessibility of the technology. One student also mentioned at one point that there should be a green audio light if it is working properly. Tutor said her light was blue.

The student occasionally indicates she has trouble hearing, asking the teacher to repeat what she said. When there were three excerpts on the screen, the student said she had trouble reading them, but the teacher was unable to zoom in to assist her. The teacher also could not read the passages, so she let the student skip them.

The only difficulties are technical, including slow typing and the appearance of some sentences in a vertical column instead of a horizontal row, which made it challenging for the teacher to read and provide feedback.

Audio was creating problems, so there was an echo and it was difficult to hear one of the students. The instructor… wished the audio would not sound like they were in a tunnel.

Student gets some time to practice using the tools. Has some trouble getting tools to work. Not clear if it is student error or technology problem. Student has difficulty seeing a pre-test that was made available via download. Instead of using the downloaded version the teacher has to write out the pretest in the whiteboard format.

Students had technical issues or were waiting for the tutor for almost 80% of the observation. First 9 minutes, students were logged on and trying to get in touch with the tutor who had not joined the session yet. The students. had almost 38 minutes (80% of observation) of technical difficulties with audio, visual or both. The students seemed to mostly have access to the lesson in spite of the audio complications.

It should be noted that there are many possible reasons for internet connectivity problems during a session, not all of which are under the control of either StudentNest or MPS. Families who expressed a need for assistance with internet access were provided by StudentNest with a MyFi (mobile hotspot) device to connect to tutoring sessions.

Impact of surrounding environment

Due to the location of most sessions (in the child's home), StudentNest environments often included environmental barriers (or distractions) to learning:

Lots of feedback in the background - student says that she is having trouble hearing the teacher, having some trouble getting some of the tools to work. Feedback continues. Can hear TV or radio in the background.

[See related research brief on equitable access in digital tools initiatives here: https://my.vanderbilt.edu/digitaled/files/2016/08/DT_ResearchBriefAccess_Sept-2016.pdf

What are some emerging questions for consideration?

The implementation of digital educational tools is likely to always be a "work in progress," as the capabilities of instructors, students and the technology itself are continually evolving. The results presented in this research summary reflect both the potential of online tutoring to improve student achievement and the challenges in implementation that may constrain its effectiveness. We offer the following questions for further consideration as MPS continues to improve the learning tools and opportunities it makes available to students.

- What level of self-regulation should be a prerequisite of online tutoring, or is it a skill that be taught during the program itself?
- How does access to real time data on student progress impact the experience (and practice) of both tutors and students?
- What skills are particularly important for tutors to have?
    - Content
    - Online pedagogy
    - Managing online and tech platforms
    - Multilingual
    - Accommodate students with special education needs
- What factors determine whether instructional technology "facilitates" versus "impedes" or "stops" instruction and learning?

Reference:

Heinrich, Carolyn J. and Annalee Good. 2018. Research-Informed Practice Improvements: Exploring Linkages between School District Use of Research Evidence and Educational Outcomes over Time. *School Effectiveness and School Improvement*, https://doi.org/10.1080/09243453.2018.1445116.

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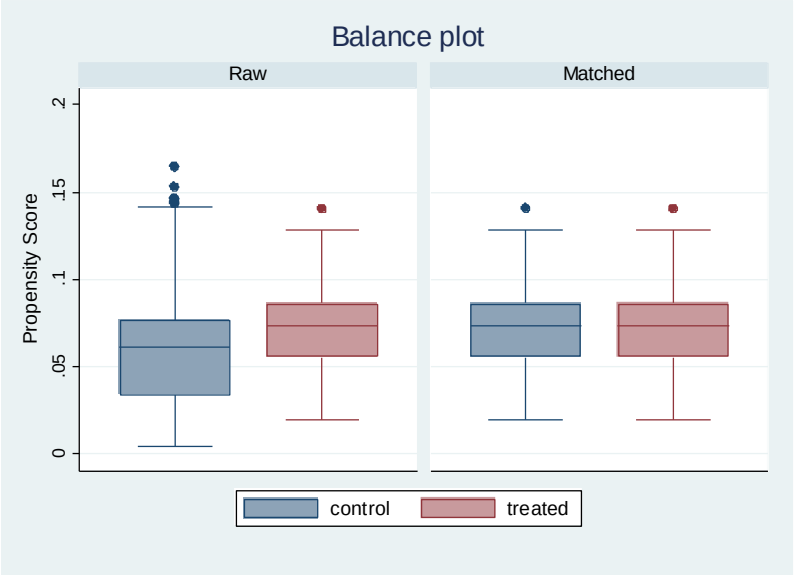
Appendix

Figure A.1: Balance Plot (Before and After Matching) for Reading Outcomes



The box plot on the left hand side of Figure A.1 shows the imbalance in the summary measure of student characteristics (propensity scores) before the matching process. After matching, the mean characteristics are precisely balanced, with nearly identical means and distributions. This is also reflected in the complete overlap of the propensity scores (for StudentNest participants-treated and nonparticipants-control) in the right hand graph plotting the after-matching propensity scores in Figure A.2 below.

Figure A.2: Graphical Summary of Propensity Score Balance for Reading Outcomes

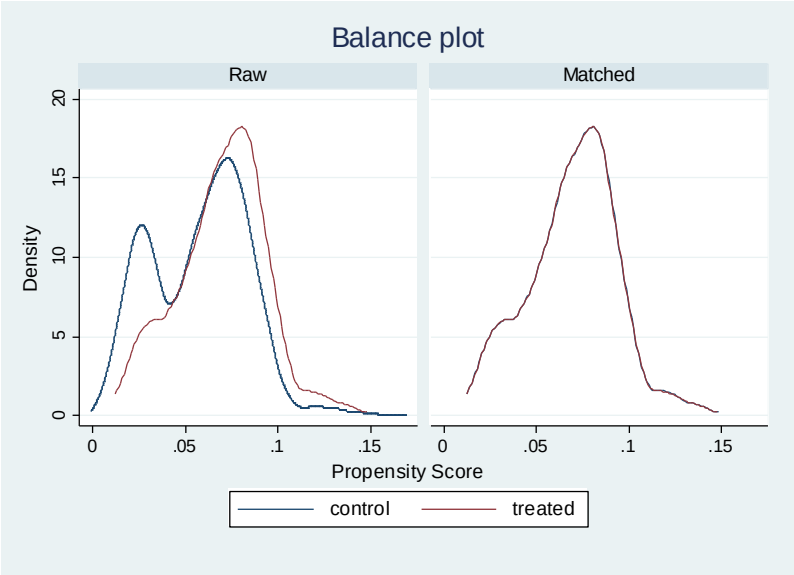
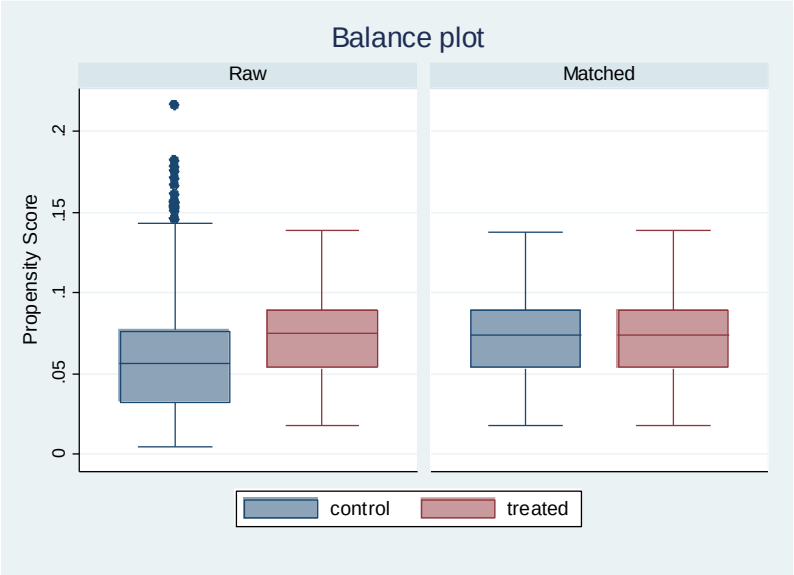


Figure A.3: Balance Plot (Before and After Matching) for Math Outcomes



Similarly, the box plot on the left hand side of Figure A.3 shows the substantial imbalance in the summary measure of student characteristics (propensity scores) before the matching process. After matching, the mean characteristics are again precisely balanced, with nearly identical means and distributions. This is likewise reflected in the complete overlap of the propensity scores (for StudentNest participants-treated and nonparticipants-control) in the right hand graph plotting the after-matching propensity scores in Figure A.4 below.

Figure A.4: Graphical Summary of Propensity Score Balance for Math Outcomes