The Academic Costs of 2020-21 Online Instruction in Ann Arbor Public Schools

Kai Schnabel Cortina, Ph.D.
Professor of Psychology
University of Michigan

Summary:

Ann Arbor Public Schools (AAPS) switched K-12 education to almost full online instruction via Zoom/Schoology for the school year 2020-21. Despite substantial investment in the online infrastructure, standardized tests (NWEA in Reading and Mathematics) document a substantial drop in learning progress compared to three years prior to the COVID crisis. The impact is most pronounced in elementary school (grades K-5), with an estimated average reduction in learning progress of 31% in mathematics and 17% in Reading. For the middle school years (grades 6-8), no reference data were available for the school district prior to the pandemic. Comparison with norm data suggest lesser impact for grades 6 and higher.

Author:

Kai S. Cortina, Ph.D., is a professor of psychology and education at the University of Michigan. His research focuses on school learning and social development in adolescence. From 2002-2008, he was part of the independent research group at the University of Michigan's School of Education that evaluated the effects of the Reading First Initiative in the state of Michigan.

Contact: schnabel@umich.edu

1. Introduction

Like most US school districts, the Ann Arbor Public Schools District (AAPS) was hit by the Coronavirus crisis in mid-March 2020. For the rest of the school year, students completed independent work at home, provided online by their teachers.

For the school year 2020-21, the school district provided chromebooks to every student. AAPS started fully virtual for all grade levels due to the continued COVID-19 public health threat. It transitioned to a "hybrid" mode in March/April 2021, with most students allowed into buildings for in-person instruction two partial days per week (unless their families chose to keep them in a fully virtual mode). All other general education instruction remained virtual until the end of the school year. Compared to other school districts in the state of Michigan, AAPS was an outlier in the sense that it prioritized remote schooling more than most – if not all – other district of the state.

Virtual schooling created significant challenges for everybody involved, including teachers, parents, students, and the school administration. From a scientific standpoint, the decision to go fully virtual provides a unique opportunity to investigate the impact of online schooling on students' cognitive and psychosocial development. While it is difficult to gauge the costs of the loss of social interactions in school (in particular peer contact) with sufficient scientific rigor to draw conclusions, the cognitive development of students can be reliably monitored, at least with respect to academic learning as it is structured by the school curriculum.

The goal of this report is to document the overall effects of virtual schooling on learning progress across grades K-8. The purpose is not to criticize the school district for its decisions in hindsight, as there was no precedent that could have provided guidance on how to weigh health risks for teachers and students on the one hand, and optimal learning conditions for the students on the other. However, the school district's data provide sufficient information to evaluate the academic costs of the decision to stay almost entirely remote for a full school year – in contrast to many other school districts in the state. These data can provide insights for the future, should the school district again be in a position to decide how best to deliver quality public education during a state of emergency.

In the following I will first explain the rationale of my analyses (trying to avoid scientific jargon). In a second step I will present a compilation of the relevant data and highlight the central results. In a last step, I will draw some tentative conclusions and recommendations from the vantage point of an educational researcher. Those are meant as starting points for discussion.

2. Monitoring Learning

As a formative tool to monitor learning progress of its students, AAPS administers the NWEA test for Reading and Mathematics on grade levels K-5 and, for the school year 2021-22 also for grades 6 to 8. NWEA tests are given in the fall, winter, and spring of each school year. They allow close monitoring of the learning progress of each student and provide information about aggregated learning gains for classrooms, schools, and the entire school district. For the following considerations, I focus on the average achievement level of the entire school district, as these data were presented to the public at the school board meeting on February 16, 2022.

NWEA publishes national norms that help school administrators, teachers, and parents compare their students' learning progress to that of a representative national sample of over 11 million students (Table 1).

Table 1: Current NWEA national norms.

2020 Reading Student Achievement Norms						
	Fall		Winter		Spring	
Grade	Mean	SD	Mean	SD	Mean	SD
K	136.65	12.22	146.28	11.78	153.09	12.06
1	155.93	12.66	165.85	13.21	171.40	14.19
2	172.35	15.19	181.20	15.05	185.57	15.49
3	186.62	16.65	193.90	16.14	197.12	16.27
4	196.67	16.78	202.50	16.25	204.83	16.31
5	204.48	16.38	209.12	15.88	210.98	15.97
6	210.17	16.46	213.81	15.98	215.36	16.03
7	214.20	16.51	217.09	16.21	218.36	16.38
8	218.01	17.04	220.52	16.69	221.66	16.87
9	218.90	19.02	220.52	18.73	221.40	19.03
10	221.47	17.92	222.91	17.81	223.51	18.20
11	223.53	17.73	224.64	17.80	224.71	18.50
12	223.80	19.32	223.85	21.21	224.33	23.08

2020 Mathematics Student Achievement Norms						
	Fall		Winter		Spring	
Grade	Mean	SD	Mean	SD	Mean	SD
K	139.56	12.45	150.13	11.94	157.11	12.03
1	160.05	12.43	170.18	12.59	176.40	13.18
2	175.04	12.98	184.07	13.01	189.42	13.44
3	188.48	13.45	196.23	13.64	201.08	14.11
4	199.55	14.40	206.05	14.90	210.51	15.56
5	209.13	15.19	214.70	15.88	218.75	16.70
6	214.75	16.12	219.56	16.74	222.88	17.47
7	220.21	17.41	224.04	17.96	226.73	18.60
8	224.92	18.94	228.12	19.33	230.30	19.95
9	226.43	19.83	228.67	20.06	230.03	20.63
10	229.07	20.23	231.21	20.61	232.42	21.25
11	231.72	20.61	233.49	20.91	234.25	21.65
12	233.02	21.60	233.31	23.07	234.19	24.63

Because it becomes relevant later, I want to highlight some features of the NWEA assessment. First, the scale for the measurement of the Reading and Mathematics achievement is as arbitrary as measuring temperature in Fahrenheit or Celsius or any other unit. NWEA uses a convenient metric (RIT units) that has no logical minimum or maximum (e.g., zero is not defined), but is somewhat anchored by the average scores on each grade level. For example, second graders who take the Reading test in the fall have an average score of 172.35. A hypothetical student with a score of 185 would be above, a student with a score of 165 below average. But "how much" above and below are those two students, really?

One intuitive way to understand the skill level of a given student is to express deviations from the average in fractions of the school year. Our first hypothetical student with a score of 185 is very close to the norm value for the spring in second grade. That student, therefore, is almost one year ahead in Reading. In contrast, the hypothetical second grader with a score of 165 is close to the reading level of a first grader in the winter. Note that Table 1 also provides a solid measure of average learning gains over a school year, when we subtract the norms for the fall from the spring score. In our example, the average learning gain for grade 2 in Reading would be 185.57 – 172.35 = 13.22 RIT points. Note that the spring score for a given grade is very close to the fall score of the next grade level, which reflects the fact that children do not make much progress over the summer (sometimes showing slight losses). We can estimate the learning gains for each school year by simply subtracting the fall scores from the fall scores of the next grade. Going back to our example, to estimate the Reading gains for second graders, we would compute 186.62 – 172.35 = 14.27 RIT, which is very close to the 13.22 calculated above. Both numbers are estimates for the progress that was made during 1st grade, because the fall value of 2nd grade (186.62) was measured at the beginning of 2nd grade and is nearly identical to the 1st grade spring score (185.57). In scientific analysis, we use units of standard deviations (SD) to describe

learning progress, but they are not as easy to interpret and do not add information to the analyses discussed here.

2. NWEA Mathematics and Reading scores in AAPS

For each grade level, Table 2a and 2b show on the left side the national norms for the fall measure in Mathematics and Readings, respectively, and corresponding gain scores as fall difference between two grade levels. For instance, 19.28 is the gain from kindergarten to 1st grade in Reading (155.93 – 136.65 = 19.28).

Table 2a and 2b: NWEA Learning Gain across grades in AAPS and Reference Norms.

Mathematics			AAPS											
	NWEA (Fall)		Fall 2017		Fall 2018		Fall 2019		Fall 2021					
Grade	National Norms	Gain	Score	Gain	Score	Gain	Score	Gain	Score	Gain	Direct Loss 2021-2019	Comparative loss (%)		
K	139.56		142.49		144.27		146.45		150.64					
1	160.05	20.49	168.51	26.02	169.02	24.75	169.37	22.92	168.88	18.24	-0.49	-2.39		
2	175.04	14.99	190.76	22.25	189.56	20.54	191.31	21.94	182.53	13.65	-8.78	-58.57		
3	188.48	13.44	195.32	4.56	195.21	5.65	195.14	3.83	194.13	11.6	-1.01	-7.51	average loss per year:	
4	199.55	11.07	208.07	12.75	207.22	12.01	208.07	12.93	203.75	9.62	-4.32	-39.02	-31%	
5	209.13	9.58	219.34	11.27	219.87	12.65	218.78	10.71	214.11	10.36	-4.67	-48.75		
Elementary total		69.57		76.85		75.6		72.33		63.47				
6	214.75	5.62							218.25	4.14	-1.48	-26.33		
7	220.21	5.46							225.41	7.16	1.7	31.14	average gains per year:	
8	224.92	4.71							231.33	5.92	1.21	25.69	10%	
Middle total		15.79								17.22				

Reading			AAPS											
	NWEA (Fall)		Fall 2017		Fall 2018		Fall 2019		Fall 2021					
Grade	National Norms	Gain	Score	Gain	Score	Gain	Score	Gain	Score	Gain	Direct Loss 2021-2019	Comparative loss (%)		
K	136.65		144.31		143.87		145.58		145.08					
1	155.93	19.28	167.83	23.52	168.09	24.22	168.11	22.53	163.47	18.39	-4.64	-24.07		
2	172.35	16.42	185.75	17.92	185.8	17.71	187.09	18.98	180.67	17.2	-6.42	-39.10		
3	186.62	14.27	194.4	8.65	195.47	9.67	194.59	7.5	195.01	14.34	0.42	2.94	average loss per year:	
4	196.67	10.05	205.01	10.61	205	9.53	205.06	10.47	204.08	9.07	-0.98	-9.75	-17%	
5	204.48	7.81	210.85	5.84	212.37	7.37	211.56	6.5	210.48	6.4	-1.08	-13.83		
Elementary total		67.83		66.54		68.5		65.98		65.4				
6	210.17	5.69							217.07	6.59	0.9	15.82		
7	214.2	4.03							221.4	4.33	0.3	7.44	average gains per year:	
8	218.9	4.7							225.43	4.03	-0.67	-14.26	3%	
Middle total		14.42								14.95				

Gains scores are additive: From kindergarten to grade 5, children gain a total of 69.57 RIT points in Mathematics and 67.83 in Reading (national average). Note that the NWEA scores are available for all grade levels and are provided here up to grade 8, because AAPS tested middle school grades for the first time in 2021. To the right of the NWEA data, the AAPS average fall data for the three school years prior to the pandemic year are listed (2017, 2018, 2019) as

comparison for the critical year, namely fall 2021. The data for the fall 2020 were omitted because that year the test was voluntary and home-administered and is hence not comparable to the other years. As mentioned above, the fall scores are very similar to the prior spring score. Therefore, the observed difference of the fall scores reflects the learning (= gain) of the preceding school year. For example, the Mathematics gain of 26.02 RIT points for 1st grade in the fall of 2017 reflects the learning success of the school year 2016-17, when the children attended Kindergarten. This is important because this means that the gain scores reported for the fall 2021 reflect the learning progress made in the prior school year, which was the mostly virtual 2020-21 year.

2.1. Direct comparison

In order to estimate and compare the learning progress during the critical year, different strategies can be used. A good start is the direct comparison of the average scores per grade of the fall 2021 with the last year before the pandemic, fall 2019. The score difference is calculated in the column labeled "Direct Loss". These comparisons are only possible for K-5 because higher grades were not part of the assessment in 2019. As the column shows, the numbers are all negative for Mathematics and Reading (exception: Reading 3rd grade). The most pronounced losses occurred for both subjects in grade 2, which reflects the learning of the prior grade level (1st grade). Compared to the scores in 2019, the 2021 scores are 8.78 lower for Mathematics and 6.42 RIT point lower for Reading. In scientific terms, these numbers reflect the "opportunity costs," in this case the costs of virtual school instead of fully in-person school. A glance at the additional years 2017 and 2018 confirms that the 2019 numbers are close to the numbers we usually see for AAPS, as they are very stable within each grade level (maximum +/- 2 RIT points difference). It is the stability over the three years prior to the 2020-21 school year that make the overall losses in 2021 so meaningful. For Reading, the difference has consistently been substantially favoring AAPS, with a 7.66 advantage in 2017 which went up to 8.43 in 2011; this reflects the higher educational level of Ann Arbor parents compared to the national average.

A direct comparison can also be made with the NWEA norm data. As would be expected for a highly educated population like Ann Arbor, the scores for both subjects and each grade level are above the national average. Note that this is already true for kindergarten, which indicates an above average academic focus in the home and preschool environment in our community. In fact, the initial difference between the fall kindergarten score and the national average in Mathematics has continuously increased from a mere 2.93 point advantage for AAPS in 2017 to an 11.08 advantage in 2021. The initial advantage in Mathematics became more pronounced through the elementary years in 2017 (from 2.93 in kindergarten to 10.21 in 5th grade), 2018 (from 4.71 to 10.74), and 2019 (from 6.89 to 9.65). That advantage, however, drops to less than half for the year 2021 from kindergarten to 5th grade (from 11.08 to 4.98). Because these are not longitudinal data, the pandemic is probably not the only cause for this trend, but it goes counter to what would be expected: An affluent community with a highly educated population like Ann Arbor usually expands its advantage over the national average along the educational school career.

2.2. Analysis of gains

As mentioned in the beginning, the absolute numbers of the NWEA RIT scores have no inherent meaning unless there is a logical reference point. For the following argument, I refer to the grade

specific gain scores based on the NWEA national norms. It is important to note that the annual gains become smaller for every grade level, in mathematics from 20.49 points for the kindergarten year to a gain of 4.71 points for 7th grade (as reflected in the score difference from spring 7th to spring 8th grade). Similarly, for Reading the gains drop from 19.28 for kindergarten to 4.70 for 7th grade. This does not mean that the actual learning tapers off over the years. Instead, it reflects the measurement focus of the scales that are designed to measure learning progress in the early years more fine-grained than in later years. In fact, as Table 1 shows, learning gains in 10th grade and up are minimal, underscoring the fact that the NWEA is not designed to reliably measure learning progress at those grade levels. But the general shift, in particular during the middle school years, needs to be factored in as it means that a direct loss of 1 point is not as important for first grade as the same loss in 8th grade.

In Tables 2a and 2b, I include a line that adds up the expected learning gains from K-5, the years we have data available for four years (2017, 2018, 2019, 2021). For Mathematics, the total (normed) gain is 69.57 RIT points for this period, and the equivalent for Reading is 67.83. It is very instructive to compare these national norms to the numbers for AAPS over the years since 2017. As you can see, AAPS showed substantially stronger gains prior to the COVID crisis in Mathematics, roughly hovering around 75. This underscores the notion that a school district like Ann Arbor with its demographics can be expected to increase is advantage over time, with learning gains roughly 10% higher each school year compared to the national average. This effect does not extend to Reading, however, where the average gains are comparable to the national average which means that AAPS just carries its initial intake advantage through the elementary school years.

For the year 2021, we note for the first time that the total learning gain in Mathematics estimate is substantially *below* the national average which is – at first glance – alarming. To understand what that means we must remember that these are the observed learning gains for every grade (separately) during the remote 2020-2021 year. Summing those up reflects the average learning gain of a hypothetical student who was taught remotely from kindergarten through 5th grade. While hypothetical, this analysis underscores the problem inherent in continued remote education for elementary school children.

To make this very clear, consider the following scenario: A kindergartener moves to Ann Arbor and starts in the fall of 2021 with a Mathematics score of 139.56 (the national average). That student is taught exclusively remotely for the next five years. The projected gain (based on AAPS 2021 numbers) in Mathematics would be 63.47 RIT points until fall of 5th grade, with an expected score of 139.56 + 63.74 = 203.3. This would be more than 6 points below the national average for 5th grade, roughly two-thirds of the learning gain for this grade level. Compared to the usual learning gains in AAPS, the drop is even more pronounced: The difference between 75 for the usual AAPS gains to projected remote gains of 63.47 means a net loss of about 12 points (compared to 2017, it would be13.38 points). **As a ballpark estimate, this means that students lose approximately one year of schooling when instruction is entirely online throughout their elementary years.** In other words, 5th graders score on the level of regular 4th graders. But again, this is a hypothetical student who experiences nothing but online schooling from K through 5th grade.

For Reading, the losses are less pronounced, in part because the district has learning gains around the national average, which means that it carries the intake advantage of kindergarten through the end of elementary school without widening the distance from the national average. The learning gains in elementary school years are comparable to the ones observed in the years prior to the pandemic, with the exception of 2nd grade. The 2nd grade score reflects the learning rate of 1st grade in online mode, and underscoring the difficulty to secure learning progress via remote instruction for 6- to 7-year-old children.

2.3. Comparative loss perspective[1]

Arguably, some costs of online learning were to be expected, so the practically important question is less whether they exist but rather how severe they are. There are different ways to approach this question and they all have strengths and weaknesses. The approach I present here is to use the projected gains per grade level based on the national norms, as introduced in the scenario above of a child taught exclusively remotely in elementary school. The advantage of referring to the national gain scores is that the national scores are based on a very large number of children and therefore fluctuate less by chance, compared to corresponding estimates from AAPS data. It also allows an analysis of the middle school data even though AAPS data are unavailable for the years prior to 2021.

The idea here is to determine the opportunity costs calculated in the "Direct Loss" column in terms of projected learning gains for the respective grade level. For example, the score difference for Reading from kindergarten to 1st grade (-4.64) is expressed as a percent loss with regards to the projected gains of 19.28 for this grade level based on the NWEA national norms. -4.64/19.28 = -0.2407, or -24.07% of "Comparative Loss" (CL). **This mean that the cost of virtual learning compared to the last year of in-person learning is the equivalent of almost a quarter of a school year.**

CL results reveal substantial learning losses in Mathematics across the grade levels, and in Reading for grades 1 and 2. Most pronounced are the losses of 58.57% in Mathematics and 39.10% in Reading for 2nd grade. This reflects the diminished learning gains of instruction during the prior year (1st grade) under remote instruction conditions. These particular students lost the equivalent of over half a year of instruction in Mathematics and more than a third in Reading. As the table shows, the comparative losses vary across grade levels and subjects (larger for math than reading). But the general trend is clear: **online instruction came with non-trivial costs in the elementary school years. In AAPS, the average elementary student lost nearly a third of a school year in mathematics (-31%) and one fifth of a year in reading (-17%).**

2.4 Middle school analysis

Because the data base is weaker for grades 6-8, the analysis is limited to the comparison of the AAPS fall 2021 to the national average data. In Mathematics, we see for 6th grade (which reflects 5th grade learning) a loss (-26.33% in the "Comparative Loss" column) similar to the average for grades K-5 (-31%). Noticeable is a significant recovery for grades 7 and 8.

As a caveat, I want to highlight that in middle school, the learning gains for the national average become rather small (around 5 points), which means that minor fluctuations are amplified in the CL calculations; one RIT point difference (which would be a random fluctuation to be expected) accounts for 20% gain or loss. Note also, that these numbers are prone to an "optimistic bias"

because, different from K-5, we cannot calculate the direct loss in comparison to 2019. It is reasonable to assume that these data would have been higher for AAPS than the national average, and therefore the small numerical gains (.9 and .3 for 6th and 7th grade, respectively, in the "direct loss" column in Table 2a) might turn into losses.

With these caveats in mind, it seems defensible to conclude that the learning in the middle school grades was less affected by one year of remote education, as the learning gains in Mathematics and Reading do not systematically differ from the national average.

3. Conclusions

The goal of this report was to provide a basis for an open discussion of the lessons learned from a year of schooling that was primarily virtual. The following conclusions assume that the school district pulled out all the stops to make virtual schooling work to the best quality level possible under the circumstances, including providing computers to all students, hot spots to students who needed them, and training for teachers on how to turn their in-person classrooms into remote ones. It is also worth reminding that the analyses were confined to the academic progress students made with respect to mathematics and reading as it is measured by a standardized national test. The psychosocial costs are beyond the scope of this report but appear to be substantial, based on the little research evidence that exists up to this point.

3.1. Impact on Elementary School Learning

The negative impact of remote instruction is substantial and of pedagogical concern. The efficiency, measured by the amount of observed learning gains compared to in-person learning in school, is roughly 70% averaged across grade levels for mathematics; for 1st grade probably down to 50%. For reading, the impact might be less severe (efficiency around 80%, 1st grade: 60%) but still substantial. It is plausible to assume that caregivers were more successful in compensating the weaker school instruction for reading at home than replacing the specific didactics of mathematics. While the impact has been severe for learning in grades 3 and 4 as well, the progress of students who entered 1st grade in the critical school year 2020-21 demands special monitoring and potentially additional support. The risk is that initial deficits will accumulate over the course of elementary school years without counteracting measures (summer programs, free tutoring etc.).

Remote schooling might have been the right answer at the start of the pandemic, but it should not be considered a full alternative for in-person schooling, because it creates an unsustainable cumulative learning deficit of the equivalent of one year of instruction. Moving forward, it might be best to think of it as a vehicle for instruction on days (or weeks) when school would be cancelled otherwise (e.g., snow days). But it simply cannot replace in-person schooling. Some have argued that the deficits are merely due to teachers' unfamiliarity with the internet and zoom as the new modes of teaching. As a developmental psychologist, I am very skeptical about this argument. The phenomenon of direct human encounter is not easy to replace, and the data presented suggest that this missing interaction is the more detrimental the younger the students are. At least for elementary school, remote learning is not a positive vision of the future of education, but a crutch that can help minimize impacts of emergency circumstances that necessitate school closure.

3.2. Impact on middle school

A more positive picture emerges from the data analysis for middle school. There are no consistent discernable learning losses for six grade and up based on the data available. While the data basis was considerably weaker than for elementary school, it stands to reason that middle school children were able to learn mathematics and reading skills sufficiently well to avoid falling back behind the national average (though they might have disliked virtual school and the social isolation that came with it). In fact, the learning gains were slightly above national norms for 6th and 7th grade in mathematics and reading, preserving the roughly one school year advantage that AAPS students usually enjoy. Note that an eighth grader at the beginning of the school year was only affected during one of their K-8 years, so the impact of the remote year creates a small footprint on accumulated achievement. Contrast that to the experience of a second grader, for whom one-year remote equals one third of their total schooling experience.

3.3. What the school district can do

1. It is clear, and hopefully already happening, that the school must be in close contact with parents/caregivers of all students affected by the mostly virtual year, in particular students who were in first grade in 2020-21. This student cohort was most severely affected by the switch to remote learning. However, monitoring the learning progress and being transparent with the parents regarding the long-term impact of the virtual year seems to be imperative overall, because the (negative) consequences of online learning might have been more pronounced for children's psychosocial development than the cognitive side which is the focus of this report.

2. From the vantage point of learning for the future, it would be wise to start a conversation across school districts within the state of Michigan and beyond. All school districts were facing the same unprecedented challenges and dealt with them differently. Much could be learned collectively from the decisions and their overall repercussions on the learning and lives of students and parents across school districts. Some districts, for example, retained a "corridor" of in-person instruction for families that were dependent on their children reliably attending school five days a week. This seems like a very good idea for early elementary school years, in light of this report's findings. Other school districts and local private schools were much more reliant on behavioral control (masking and social distancing) rather than school closure as a pandemic response. Many school districts in Michigan administer NWEA on a regular basis like AAPS. Comparing policies and impacts could provide valuable insights.

4. Limitations

When a social situation occurs without planning that allows for direct causal conclusions, we call this a "natural experiment" in the social sciences. The COVID 19 crisis has element of a natural experiment but does not fully allow direct causal explanations. On the one hand, we have strong evidence that students' achievement scores were substantially affected by the exceptional school year 2020-21. On the other hand, a lot of changes and disruptions in the lives of the students and their families came with the COVID crisis. Therefore, it can be argued that the observed underachievement of the student in the fall 2021 compared to the reference group in the fall of 2019 may not be (or at least not in full) attributable to the switch to remote schooling. However, school districts have more data available to rule out alternative explanations. At this point it seem

a reasonable hypothesis that the extended period of remote teaching was a strong, if not the major factor.

[1] The CL perspective is helpful because it avoids the pitfalls of the NWEA scoring method (based in item response theory [IRT] or Rasch scoring). As mentioned above, the origin of the scale (the zero point) is not defined, which means that percentages cannot sensibly be calculated with respect to the absolute score. For example, the drop of -4.32 point for fourth grade Mathematics may not seem notable when expressed as a percentage of the absolute score of 208.07 (reference score in 2019), equaling a decline of 2.1%. If we added 1,000 to the score, the corresponding score for 2019 would be 1208.07. The calculated drop would still be -4.32 but now only a mere -4.32/1208,08 = 0.3% of decline. When we instead make the zero point the national average for Mathematics in kindergarten (which mean subtracting 139.56 from all scores), than the reference score changes to 208.07 – 139.56 = 68.51 and the observed decline in RIT points would still be 6.3%. Since the zero point cancels out in the calculation of the gain scores and the gain score has a concrete meaning (learning gains over one year), the CL score is robust to this kind of scale transformation.