

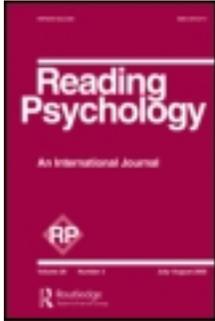
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### Estimating Reading Growth Attributable to Accelerated Reader at One American School in the Caribbean

David K. Foster<sup>a</sup> & Dean P. Foster<sup>b</sup>

<sup>a</sup> The International School of Sosua, Sosua, Dominican Republic

<sup>b</sup> Wharton Department of Statistics, University of Pennsylvania, Philadelphia, Pennsylvania

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## **ESTIMATING READING GROWTH ATTRIBUTABLE TO ACCELERATED READER AT ONE AMERICAN SCHOOL IN THE CARIBBEAN**

**DAVID K. FOSTER**

The International School of Sosua, Sosua, Dominican Republic

**DEAN P. FOSTER**

Wharton Department of Statistics, University of Pennsylvania, Philadelphia,  
Pennsylvania

*This article provides a statistical analysis of the reading gains observed at one American school in the Caribbean that was using Accelerated Reader. It provides an estimate of the number of hours students needed to read to advance their reading performance an additional year. The authors estimate how much Accelerated Reader contributed to the advancement and determine how many points per grade a student needs to earn to make a year of reading growth. When points are converted to hours of time, the data show that it takes about 800 hours of time each year for students in grade 3 through grade 12 to achieve a year of growth. It is the conclusion then that students who read this much would spend about 9,600 total hours reading during their first 12 years of schooling.*

### **Introduction**

There are hundreds of studies showing a positive correlation between strong readers and time spent reading. The Report of the National Reading Panel (NRP) acknowledged this correlation but recommended further research before endorsement because the evidence is correlational (National Institute of Child Health and Human Development, 2000). The purpose of this study, which is also correlational, is to evaluate the effectiveness of Accelerated Reader (AR) in improving student reading performance at one American school and also estimate how much of the reading growth the students achieved can be attributed to AR. AR is a supplementary program designed to build fluency, comprehension,

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Address correspondence to Dean P. Foster, Wharton Department of Statistics, University of Pennsylvania, 472 Huntsman Hall, Philadelphia, PA, 19104-6340. E-mail: dean.foster@gmail.com

and improve student reading performance through independent reading. The accredited school under study follows an American curriculum, uses American textbooks, and awards American diplomas.

Many of the students at this school are behind in reading when compared to the United States' norm. Evidence of this is found in the *Standardized Test of Assessment Reading* (STAR Reading) results, an American standardized test. On average, the students in grades 2 through grade 8 are testing 0.8 years behind the U.S. average. Twenty-five percent of the students in this study come from homes where neither parent speaks English. In addition, most of the children come from families where two languages are spoken. This is a factor in the results and undoubtedly exacerbates the students' English reading deficiency.

This study examines the correlation between the amount of independent reading students do as measured by AR points earned and their reading growth over the course of a year as measured by a standardized reading test. As one could predict, a positive correlation was found between strong readers and time spent reading.

The following three questions are addressed: (a) How much of the progress that the students make in reading over the course of a year is attributable to AR, and how much is due to the reading they do throughout the rest of their day? (b) How much independent AR reading do children need to do to advance their reading level by an additional year? (c) Finally, how much independent reading does a child at this American school need to do to bridge the 0.8 gap between the school's average and the U.S. average?

### **Review of the Literature**

The issue of encouraging students to read has been a hot one with lots of controversy ever since the NRP concluded in 2000 that there was not sufficient experimental data to suggest that reading practice raised achievement. The NRP pointed out that though the truth could be that the more children read, the more their reading skills improve, "it is also possible that better readers simply choose to read more" (National Institute of Child Health and Human Development, 2000, p. 12). Currently there is simply not enough research to support the idea that large amounts

of independent reading lead to improvements in reading achievement.

There have been more attempts to show that reading practice improves reading ability. Kim and Guryan have done work on this with mixed result (Kim & Guryan, 2010). They noticed that children lose reading skills during summer vacation. This is especially true in low-income, non-English-speaking families. For these children, summer vacation typically leads to a three-month gap in reading scores when compared to middle-income students from English-speaking families. Kim and Guryan designed a study to address this problem. The study utilized control groups and randomization. Children in the treatment group were encouraged to read books independently over summer vacation. Books were given to the children at their reading level. These books corresponded to the children's interests as determined by a reading inventory survey. Parents were urged to provide enough assistance to help the children succeed. The children in the treatment group reported reading more books than the control group, but there was no significant effect on reading achievement. The results of this experiment suggest that it is harder to get a payoff from increasing the amount of independent reading children do than was presumed earlier. The study found a positive correlation between the numbers of books read and increased reading comprehension scores. The students' vocabulary scores did not show a correlation. Kim and Guryan concluded that "children need massive exposure to print across multiple school years to enjoy vocabulary gains" (2010, p. 16).

Michael L. Kamil reviewed the research on how to improve the literacy of children in grades 4–12 (Kamil, 2003). Motivation turns out to be especially important for adolescents who are still developing their reading skills. If students are not motivated to read, they will not benefit from reading instruction. Kamil pointed to research showing that the number of words children encounter in their independent reading per year varies enormously. This enormous variation in the number of words read leads to huge differences in children's vocabularies as well as their comprehension abilities. Reading ability and vocabulary size seem to be related, but a causal link between increasing vocabulary and increasing reading comprehension has not been demonstrated. Kamil made no mention of improving reading through practice.

Nagy, Anderson, and Herman (1987) are frequently mentioned in the literature for the work they have done on vocabulary acquisition. In a study that focused on learning word meaning from context, they found that students learned the difficult words within a text when the text was not filled with too many difficult words. In other words, reading appropriately leveled texts is important for vocabulary acquisition. The more the students read in general, the more they picked up word meanings in context. They estimate that children add about 3,000 words annually to their reading vocabularies between grade 3 and grade 12. At most, only about 700 of these words are learned through direct vocabulary instruction. Clearly, vocabulary is being acquired another way, suggesting that children learn most new words incidentally from context while reading and from listening to spoken English.

Steven Pinker expanded on vocabulary acquisition in *The Language Instinct* (Pinker, 2007). He argued that the Nagy and Anderson estimate is probably an underestimate and suggested that the average high school graduate probably knows closer to 60,000 words. Children begin learning words at about 12 months old, so an 18-year-old high school graduate must have been learning an average of 10 new words a day since their first birthday, or about one new word every 90 minutes of time awake (Pinker, 2007, p. 145). Although 60,000 words sound like a lot, they are actually only 6% of English words. A study utilizing the data of Google's five-million-plus books estimated the number of words in English to be a million (Shea, 2012).

The What Works Clearinghouse (WWC) of the U.S. Department of Education was set up in 2002 to vet educational research to find and guide effective practices. In 2008, the WWC reviewed 100 studies on AR and issued a report (U.S. Department of Education, 2008). Only two of these studies met the WWC evidence standards: Ross, Nunnery, and Goldfeder (2004) and Bullock (2005). The WWC found the evidence for AR to be "medium to large for comprehension and small for reading fluency and general reading achievement" (U.S. Department of Education, 2008, p. 1).

Nunnery, Ross, and McDonald (2006) did a randomized and controlled field experiment to measure the impact of AR best practices on student reading achievement. The study examined the reading achievement of 978 urban students in grades 3 to 6 over the course of a year. They found that students in classrooms

using AR best practices exhibited significantly higher growth rates than students in the control where AR was not used. There was little relationship between fidelity of implementation and the achievement effects for the majority of the students using AR. However, high fidelity implementation of AR did have a positive effect on reading achievement for students with learning disabilities.

Jonathon Bullock (2005) investigated the effects of AR on student reading performance in Grade 3 through Grade 5 in one Oregon elementary school. His randomized study with a control group was set up to examine whether using AR would influence student reading fluency, comprehension, and vocabulary performance over a 10-week period of time. Bullock found no significant difference between the control group, students who did not use AR, and the treatment group of students who did.

Despite the fact that the Bullock study was one of the two studies that met the WWC evidence standards and found no significant effect, the WWC concluded that AR works. Perhaps the WWC dismissed the results of the Bullock study for the following reason: When looking at whole student effects (like fluency, comprehension, vocabulary, and grade-equivalent growth), it is important to make sure data are collected over a long period of time. The reason is that if one is looking at growth, one will have to measure it by the change in “after” scores compared to “before” scores. If these two scores are about equal, it will be hard to measure the difference. This sort of problem often comes up in medical studies. It is typically quantified by talking about years on test. One can watch a few people for a long period of time, or a large number of people for a short time. For example, in the current study at the Caribbean International School, 299 student-years are followed. The Nunnery, Ross, and McDonald (2006) study had 978 student-years. However, the Bullock (2005) study under consideration only had 23 student-years (114 students times 10 weeks equals 1,140 weeks or 23 student years). This small sample size makes it difficult to generate an accurate measurement.

Topping, Samuels, and Paul (2007) did a study that involved over 45,000 student-years. Their post-hoc analysis of AR archival data collected over one year on 45,670 students from 139 schools in 24 of the states concluded that teachers who effectively monitored student reading practice by guiding students toward

successful comprehension made more gain with their students. Students who spent time reading without proper guidance from the teacher made modest gains, but students who read a lot and did well on the reading practice quizzes made the most growth. This suggests that teachers should pay attention to the AR best practices that are described in the “Instruments” section of this article.

### **Research Design**

This study involves post-hoc analysis of archival data collected over the course of three years (2008–2011). Data were collected on the number of AR points earned by each student, as well as pre-test scores in August and post-test scores in June on the STAR Reading test. Each year of data for a student was considered independently. Students who were in the school all three years were treated as three independent observations. A total of 299 observations were obtained. Some students joined, and some students left during the years. Partial data were ignored if there was no way to measure difference (see Appendix: Statistical Methodology and Results).

#### *Sample Selection*

Data for this study were collected for three years from approximately 100 students each year in grades 2 through 8. There is no data on race, income, or special needs. The school costs about \$7,000 USD per year to attend. To put this in perspective, according to The World Factbook (Central Intelligence Agency, 2011), the GDP/capita in this Caribbean country is \$8,600. There are 26 different nationalities represented at the school and a large population of English language learners.

#### *Data Collection Instruments*

AR is a computer-based reading program designed to build comprehension and improve reading performance by providing immediate feedback. Students choose a book from one of the 150,000 titles for which AR reading practice quizzes are available, and after they finish reading the book, they take a quiz. The library at the American school where this study was conducted has

over 5,000 books with AR quizzes. The school also buys the rights to all of the AR quizzes that have been written. This gives students the option of reading AR books from other sources. The reading practice quizzes assess literal comprehension to ensure that the student has read and understood the book. Each book has a point value based on its length and text difficulty. The program awards points according to the proportion of correct responses. For example, Joseph Conrad's *Heart of Darkness* is a 10-point book. If a student were to receive a 60% on that quiz, the student would earn 6 points. If a student were to receive a score below 60%, the student would receive no points. In a sense, points are a measure of words read successfully.

There is always a concern about the fidelity of implementation. Built into the AR program are six key principles of best practices. The first principle suggests that 30 to 60 minutes of time be set aside every day for reading. This daily block of time could be divided into three segments: reading texts to a child, reading texts with the child, and reading texts independently by the child. The second principle is that students learn the most when they score 85% correct or better on the quizzes. The third principle is based on the work of Vygotsky (1896–1934). He believed practice needed to be at the right level of difficulty in order for it to be productive. Practice that is too easy or too difficult does not lead to much learning. In between lies what Vygotsky called the zone of proximal development (ZPD), the level of difficulty that leads to the most learning and growth. This differentiated approach to guided independent reading fits nicely with modern educational theory. Teachers administer the STAR Reading Test two to three times a year to help determine the students' ZPD. Fourth, teachers monitor student quizzes and conference with students about the books they are reading and the results of their quizzes. The fifth principle is that the students should have a personal goal for the amount of AR reading they will do (or points they will earn), a book level range to read within (ZPD), and a performance goal on quizzes (85% or better). The sixth principle is that teachers should closely monitor the data provided by the program and use this data to guide instruction.

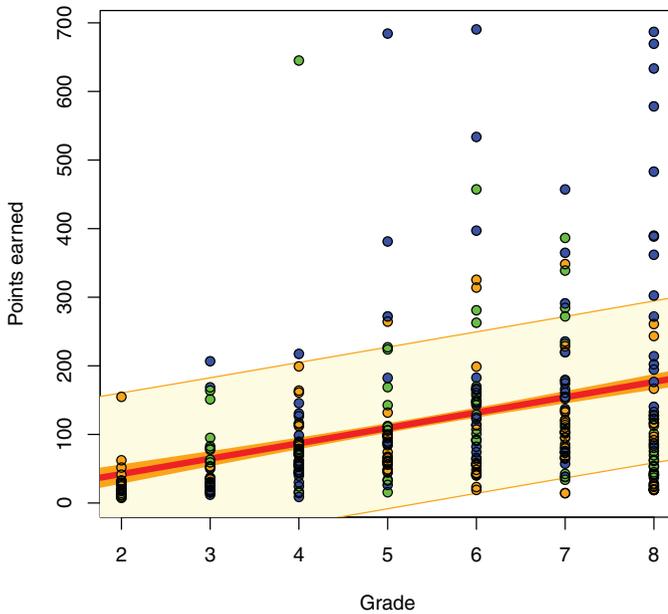
STAR Reading is a computerized, norm-referenced reading test used to assess a student's reading ability. The program continuously adjusts the test level based on the student's response to previous test items. When the student gets a question correct,

the next question gets harder, and when the student gets a question wrong the next question gets easier. After 25 questions, a result is delivered. STAR Reading exhibits a moderate-to-strong correlation with the following standardized reading tests: the California Achievement Test, the Comprehensive Test of Basic Skills, the Stanford Achievement Test, and the Iowa Test of Basic Skills (Nunnery et al., 2006, p. 7). STAR Reading pre-test and post-test scores from the beginning and end of the academic year provided the measure of growth.

## Results

AR points earned over the course of a year were correlated with reading growth scores determined by a standardized test. A positive correlation was found in the data between the amount of independent reading students did and the amount they grew their reading performance. Typical students at this school advanced their reading level about one year during each school year of this three-year study. A further look at the data shows that students in the higher grades read more than students in lower grades (see Figure 1).

Students in grade 8 read four times as much as students in grade 2. Thus the amount of reading done by a second grader looks very different than the amount of reading done by an eighth grader. Therefore, the data cannot be mixed together as is. However the data can be mixed together by correcting for this difference. If one takes the number of points students in second grade earned divided by two, it looks similar to the number of points students in eighth grade earned divided by eight. When the points each student earned are divided by their grade level in school, the resulting variable is what we call *points per grade*. This adjustment produces one large data set where all the grades look similar (see Figure 2). After this correction, it is possible to determine the number of *points per grade* (i.e., our main variable) a student needs to read to make a year's growth. A look at the data that has been adjusted shows that the school average is 20 *points per grade*, or about 160 hours of reading. AR is getting the students in grades 3 through 8 at this school to do about an hour of reading per class day.



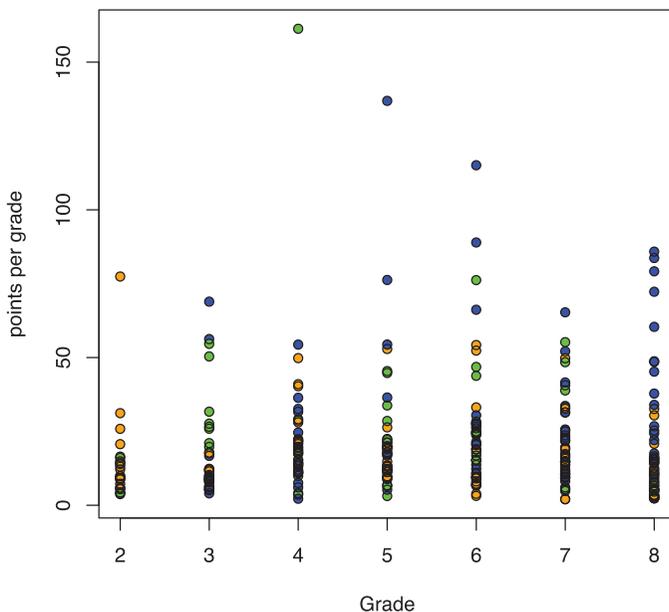
**FIGURE 1** Accelerated Reader points earned sorted by grade level. Students in higher grades read more and thus earn more points. The yellow region is the area where two-thirds of the students are predicted to fall. Each dot represents a single student in a single year. The three different years are coded, with green being the first year, blue being the second year, and orange being the third year (color figure available online).

## Discussion

Question 1: How much reading progress made over the course of a year is attributable to AR, and how much is due to the amount of reading done in their classes throughout the rest of the students' day?

As in any observational study, answering questions of this nature will require making some assumptions. That data used to answer the question are: (a) the intercept, (b) the slope as shown in Figure 3, and (c) the average number of *points per grade* earned. First the assumptions will be discussed. Then we will be in a position to answer this question.

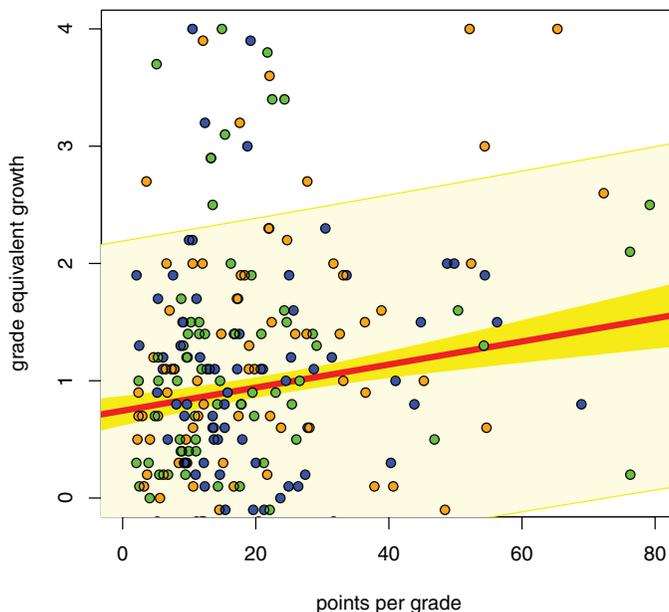
The advantage of points is that they are easy to measure. Hours spent reading would be difficult to measure since students are encouraged to read at home and they would be self-reporting.



**FIGURE 2** Accelerated Reader *points per grade* sorted by grade level. When the total number of points earned is divided by the grade level, each grade looks fairly similar. You can see this by the fact that all grades read about 20 *points per grade*. This is particularly true if you remove the second grade from the data. Each dot represents a single student in a single year. The three different years are coded, with green being the first year, blue being the second year, and orange being the third year (color figure available online).

Ideally, we would use hours spent reading, but since we cannot measure that variable, points earned per grade is a good proxy. One reason the points-per-grade formula works is that AR gives longer books more points. A book targeted at older students will be worth more points than a book targeted at students in grade 2. AR has set up the point structure to be almost linear by grade level. The points-per-grade correction is in line with AR's goal setting formula, a function discussed in more detail in the Methodology section in the appendix (see Figure A1 in the appendix).

Students don't only read for AR. They also read for other academic reasons. All of this reading and all of the spoken English the students experience work toward their advancement in reading. In other words, even if AR were not used, the students would still progress in reading. It is the progress above and beyond that



**FIGURE 3** Accelerated Reader *points per grade* and corresponding grade equivalent growth. The more students read, the more they advanced their reading level. In fact, a student who reads 102 *points per grade* would advance an extra year of reading. The yellow region is the area where two-thirds of the students are predicted to fall (color figure available online).

we attribute to AR. How much of the progress is due to AR and how much is due to the rest of their education, and how does the researcher separate out this growth into that which is due to AR and that which is due to the rest of their day?

In an ideal world half of the students would earn 0 points in the control group and half of the students would earn 10 points in the AR group. Then the difference between the two groups could be measured to get a feel as to how much AR helped. If the AR group advanced a half a grade level more than the control group, the researcher could say that 10 *points per grade* equaled half a grade level reading advancement. In this clean situation, the researcher would say that it takes 20 *points per grade* to advance an extra year. The data aren't as clean as this, but regression can be used to make a best effort approximation to the above ideal world.

From the data, we have learned two important pieces of information. How much reading growth is achieved each time a point

per grade is earned? In other words, how much growth is achieved when eight hours of time is spent reading AR material? We also know how many *points per grade* the students earned. Multiplying these two numbers generates the amount of growth attributable to the AR system at this school. This works out to about 0.2 years of growth. This sounds small since the students actually progressed about a year of growth. All it means is that from their other studies and the rest of their day they made 0.8 years of growth in reading. Putting this all together, the current usage of AR along with the current academic program led to about one year of reading growth over the course of the academic year. If all the students earned zero AR points, the school would fall behind about 0.20 reading levels per year. If they earned 20 AR *points per grade* (which is the school average), then the school will advance about 0.20 reading levels per year beyond what it would do without AR and thus make one year's growth. Therefore, about 0.8 of the year's growth that was made at this school is attributable to other reading and the rest of their day and about 0.2 of it is attributable to the AR program.

Question 2: How much independent AR reading do the children need to do in order to advance their reading by an additional year?

The number of hours the students read was not measured in this study, so we cannot answer this question directly. However, we can use the data collected by the AR program to answer it. The AR goal-setting chart lists how many points a student should be able to earn during a certain amount of time spent reading. Using AR goal setting information, we determined how much time it takes to earn one point. From the plot of points earned and growth made (Figure 3), we figured out how many points it takes to earn a year's reading growth. Multiplying these two numbers together provides the number of hours needed to earn a year's growth in reading. There would be a different equation for each age or reading level except that students earn more points at higher grades in an hour's time. Basically, it is the case that a fourth grader earns twice as many points in an hour as a second grader. Therefore, the equation provides a fixed number of hours for all students at every grade level.

Regression shows that 102 *points per grade* level will lead to an extra year of reading advancement and will take about 830 hours

of time for each student to achieve (see Figure 3). In other words, each increase of 83 hours of AR reading students do will increase their measured reading level by 0.1.

Question 3: How much independent AR reading does a child at this American school need to do in order to bridge the 0.8 gap between the school's average and an average U.S. school?

If the current usage of AR doubled and the students earned 40 *points per grade*, the school would advance about 0.2 grade levels per year. Since the school as a whole is about 0.8 grade levels behind the U.S. norm, it would take four years of AR usage at the 40 *points per grade* level for the students to catch up. Given that it takes 800 hours of extra reading for a student to earn an extra year's reading growth, and given the fact that this American school is only behind by 0.8 years, students would need to read an additional 664 hours in order to bridge the gap. This translates into an hour and 10 minutes of additional reading outside the school day, 180 days per year, in order to bridge the 0.8 gap within three years.

### Conclusions

The data show that a student who does no additional AR reading will continue to fall behind the U.S. average each year. A student who earns 20 *points per grade* will gain one full year's growth in reading. Students at this school need to double the amount of reading they are doing in order to bridge the 0.8 gap between the school's average and an average U.S. school within a three-year time frame.

How can we convince teachers, parents, and students to make the commitment to read more? Perhaps the answer lies in exploiting the fifth and sixth principles of AR best practices. The fifth principle is that the students should have a personal goal for the amount of AR reading they will do (or points they will earn), a book level ZPD range within which they will read, and a performance goal on quizzes (85% or better). Gone are the days where the teacher kept the student's progress a secret. Now students, beginning as low as the kindergarten level, are being taught to set academic goals, monitor their own progress, and celebrate their successes. In helping students set their own personal goals, it is not enough to look at how many AR points it takes to make one

year's growth in reading. Rather, students should be looking at setting goals that will help them get on grade level.

The sixth principle is that teachers should closely monitor the data provided by the program and use this data to guide instruction. Piggybacking this principle with the fifth principle, students need to be included in monitoring their own progress. As goals are achieved, new goals need to be set. If goals aren't being met, the student, teacher, parent, and community need to become involved in creating ways to assist the students in meeting their goals. Students need to be at grade level by the time they complete their high school education in order to be successful in college without needing to take remedial classes.

Most people would agree that reading is one of the key factors determining the success of students in school. A recent longitudinal study of reading found that a student who cannot read on grade level by third grade is four times less likely to graduate by age 19 than a student who can read on grade level by third grade. When poverty is added to the mix, the student is 13 times less likely to graduate on time (Lesnick, George, Smithgall, & Gwynne, 2010). The most recent data from the National Assessment of Educational Progress (NAEP) show that students in eighth and 12th grades have not improved in reading over the 17-year period since the test was first administered. Clearly a new approach is needed.

School time, which is productive time, cannot be sacrificed in order to make space for the additional amount of required reading that is necessary in order to bridge the gap. Homework time, however, could be sacrificed. Alfie Kohn (2006) reviewed the research on the effectiveness of homework and concluded that homework has little value for children below the age of 15. Therefore, elementary and middle schools could drop all traditional homework for children younger than age 15 and add, instead, an hour's worth of independent reading.

Kim and Guryan pointed out that children need a "massive exposure to print across multiple school years to enjoy vocabulary gains" (2010, p. 28). In this study, statistical processing was utilized to quantify the actual number of hours students would in fact need in order to advance their reading performance an additional year. The number, 830 hours, is indeed massive. During the first 12 years of schooling, if students followed this recommendation, they would spend 9,960 total hours reading. Interestingly,

this number is reminiscent of the 10,000 hours of time Malcolm Gladwell argues one must invest to master anything (Gladwell, 2008).

Studies have shown that students do not actually spend much time reading during the school day, and after school teachers have no control over what happens. Our study simply uses statistical processes to determine how many hours a student needs to read to grow their reading ability by one year. The number turns out to be huge and the implications are staggering. A practitioner aware of this could advocate for more reading practice time in school and at home. Students need to be reading as much as possible. Hopefully teachers and administrators will be motivated to provide the necessary time when they understand the data. If students are not reading much in school and they are not reading much at home, it is understandable that, despite scripted interventions, shifting approaches from phonics-based instruction to whole language-based instruction, and a combination of approaches, reading scores have remained flat for years. Getting children to learn to read and to love to read is possibly the most important task of parents and teachers. It is an investment of time that we cannot afford to neglect.

## References

- Bullock, J. C. (2005). *Effects of the Accelerated Reader on reading performance of third, fourth, and fifth-grade students in one western Oregon elementary school* (doctoral dissertation). Available from ProQuest Information and Learning Company. Retrieved from <http://search.proquest.com/docview/305405743>
- Central Intelligence Agency. (2011). *The World Factbook*. Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/>.
- Gladwell, M. (2008). *Outliers: The story of success*. London, UK: Penguin Book.
- Kamil, M. L. (2003). *Adolescents and literacy: Reading for the 21st century*. Washington, DC: Alliance for Excellent Education: Retrieved from <http://www.all4ed.org/publications/AdolescentsAndLiteracy.pdf>.
- Kim, J., & Guryan, J. (2010). The efficacy of a voluntary summer book reading intervention for low-income Latino children from language minority families. *Journal of Educational Psychology* (102)1, 20–31.
- Kohn, A. (2006). Abusing research: The study of homework and other examples. *Phi Delta Kappan*, 88(1), 8–22.
- Lesnick, J., George, R., Smithgall, C., & Gwynne J. (2010). *Reading on grade level in third grade: How is it related to high school performance and college enrollment?* Chicago, IL: Chapin Hall at the University of Chicago.

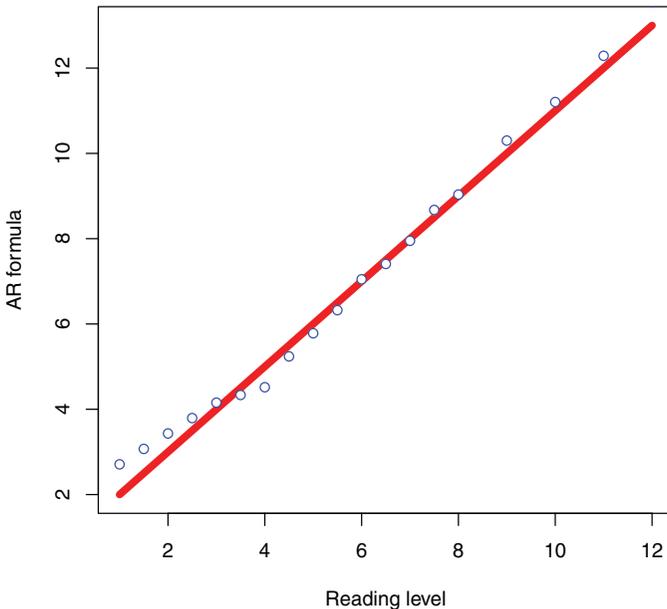
- Nagy, W. E., Anderson, R. C., & Herman, P. A. (1987). Learning word meanings from context during normal reading. *American Educational Research Journal*, 24(2), 237–270.
- National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction*. Retrieved from <http://www.nationalreadingpanel.org/publications/summary.htm>.
- Nunnery, J., Ross, S., & McDonald, A. (2006). A randomized experimental evaluation of the impact of Accelerated Reader? Reading Renaissance implementation on reading achievement in grades 3 to 6. *Journal of Education for Students Placed at Risk*, 11(1), 1–18.
- Pinker, S. (2007). *The language instinct: How the mind creates language*. New York, NY: Harper Perennial.
- Ross, S. M., Nunnery, J., & Goldfeder, E. (2004). *A randomized experiment on the effects of Accelerated Reader/Reading Renaissance in an urban school district: Preliminary evaluation report*. Memphis, TN: The University of Memphis, Center for Research in Educational Policy.
- Shea, C. (2012, March 16). The new science of the birth and death of words: Have physicists discovered the evolutionary laws of language in Google's library? *The Wall Street Journal*. Retrieved from <http://online.wsj.com/news/articles/SB10001424052702304459804577285610212146258?mg=reno64-wsj&url=http%3A%2F%2Fonline.wsj.com%2Farticle%2F%2FSB10001424052702304459804577285610212146258.html>
- Topping, K. J., Samuels, J., & Paul, T. (2007). Does practice make perfect? Independent reading quantity, quality and student achievement. *Learning and Instruction*, 17, 253–264.
- U.S. Department of Education. (2008). *What works clearinghouse intervention report: Accelerated Reader*. Princeton, NJ: Institute of Education Sciences. Retrieved from <http://ies.ed.gov/ncee/wwc/reports/beginning-reading/arr/>

## Appendix

### Statistical Methodology and Results

Each year of data for a student was considered independently because each year students are put in classes with different teachers. These teachers push usage of the AR system with different amounts of pressure, so usage of AR differs by class and grade level. Hence it makes sense to treat the teacher as a weak instrument and analyze performance over each year when exposure is the same for each student during the whole year. Tracking students over years is possible but doesn't lead to more power in the testing since the treatment effect is different each year.

The AR goal-setting formula recommends how many points a student should be able to earn for a set amount of time for a corresponding reading level. The AR goal-setting formula is based on many students and is a complex function. But at its heart, it simply says that more-advanced students will read more and need to read more than less-advanced students. This rule can be approximated reasonably well by a straight line. For a picture of how well this linear approach approximates the AR goal setting formula, see Figure A1. Clearly it is better to use the existent AR formula when one can, but for ease of communication the simplicity of the straight line outweighs its lack of accuracy.



**FIGURE A1** Accelerated Reader (AR) goal setting formula and corresponding reading level. This shows a plot of the AR formula versus reading level. (The formula is shown as a straight line for simplicity; color figure available online).

Looking at Figure 1, one sees that students in higher grades earn more points than students in lower grades. Table A1 shows the means for each grade, but to generate a simpler relationship, one can fit a line through the data. The best slope for this

relationship is found through regression. The results from the regression are shown in Table A1.

**TABLE A1** Predicting Points Earned

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	6.4	25.9	0.2	0.8043
Grade	21.0	4.3	4.8	0.0000

After we have normalized the data by the grade level, Table A2 does not show much relationship between *points per grade* and the grade the student is in. This can be tested statistically by the regression in Table A2.

**TABLE A2** Points Per Grade Earned

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	21.0	4.4	4.8	0.000
Grade	0.2	0.7	0.2	0.829

A fixed level of *points per grade* for all students is not a bad approximation to the data. The primary model, Table A3, predicts the growth (measures as grade equivalents over one year) on the points earned (measured in *points per grade* level). The slope is 0.01 grade levels per point per grade. In other words, a student reading 1/0.01 *points per grade* will advance an extra grade level that year above and beyond what they otherwise would advance. So the take-home number of 102 *points per grade* level will translate into an extra year of reading growth.

**TABLE A3** Growth Prediction Based on Points Per Grade

	Estimate	Std. error	t value	Pr(> t )
(Intercept)	0.745	0.127	5.9	0.000
EarnedPerGrade	0.010	0.004	2.3	0.020

### **Limitations of Study**

This study is an observational study. Therefore, the researcher can never prove causation but merely suggest it. The reason is that there could always be other variables that explain both the X and Y variables. For example, in many educational settings, students from wealthier families are known to study harder and get better grades. So if in this school having wealthier parents leads to more use of AR and also leads to growth in reading, researchers would be falsely attributing the growth in reading to AR when it should correctly be attributed to parental income.

An alternative extraneous variable could be the child's interest in reading. Probably students who like to read will advance faster, read more books, and earn more AR points. Again, under this simple alternative model, reading more will not change their interest in reading and so will not lead to additional reading growth. These and other similar models are hard to disentangle from the model proposed without doing a randomized clinical trial. Unfortunately, such studies are expensive and, hence, have rarely been done.

Another concern is that the time spent during the school day for AR could have been more productively spent using a traditional reading approach. The alternative model would be that all students would have advanced more with a traditional approach. But there would still be motivated and unmotivated students. The motivated students earn a lot of AR points and advance more, whereas the unmotivated students do not. So if both groups advanced more under a regular program, the researcher could not detect this using the collected data.