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GIFTED EDUCATION IN ARKANSAS: A LONGITUDINAL STUDY OF GIFTED STATUS AND ACADEMIC GROWTH

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I. ABSTRACT

This study assesses the effectiveness of gifted programs in Arkansas by leveraging student-level achievement and demographic data of students who scored at or above the 95th percentile on state assessments in third grade. We follow five independent cohorts of these high-achieving students through eighth grade and examine the difference between the longer-term academic performance of the students that were exposed to gifted and talented services compared to similarly high achieving peers that were not identified as gifted. Using regression analyses controlling for student and district characteristics, we find that students who received gifted services demonstrated statistically significantly greater academic growth on mathematics and literacy achievement across the time period examined than similarly high achieving peers that were not identified as gifted. The study is among the few research studies conducted on gifted education programs across the state. We discuss these findings in the context of the gifted programming literature and conclude with policy suggestions.

II. INTRODUCTION

Broadly, the purpose of gifted education programming is to help talented students learn something new each day and further their talent development (e.g., Subotnik et al., 2011). Lohman (2005a, 2005b) suggested that the core purpose of gifted and talented programs should be to provide appropriately challenging instruction for students who have exhibited high accomplishment in one or more skill and knowledge domains. Lohman (2005a) argued that "measures of academic accomplishments (which include, but are not limited to, norm-referenced achievement tests) should be the primary criteria for defining academic giftedness," noting that in many cases the symbol systems of numbers and words were important to school performance, but also that these developed abilities were an important product of schooling (p. 32). Using this lens of academic giftedness, we should expect gifted education programming to improve students' academic achievement. Supporting this idea is the accumulated empirical evidence in gifted education, suggesting a positive correlation between gifted and talented programming and gifted students' academic achievement (Assouline et al., 2015; Henfield et al., 2017; Kim, 2016; Steenbergen-Hu et al., 2016; Wai et al., 2010).

The Arkansas Department of Education, Division of Elementary and Secondary Education, focuses on development of potential ability of giftedness and talents. On their website, they define gifted and talented students as those with "high potential or ability whose learning characteristics and educational needs require qualitatively differentiated educational experiences and/or services." Furthermore, the identification of giftedness and talent "will be evidenced through an interaction of above average intellectual ability, task commitment and /or motivation, and creative ability" (Division of Elementary and Secondary Education, n.d.). Developed abilities in the symbol systems of words and numbers (verbal and mathematical aptitudes) through schooling or other means can be considered an important component of giftedness and talents (Lohman, 2005a), even if they are not the only conceptualization of giftedness (e.g., Renzulli, 1978; see Subotnik et al., 2011 for a review). The identification process for gifted and talented (G/T) services in Arkansas and the programming provided to identified students identified is varied. Overall, however, we reasonably hypothesize that G/T programming would benefit identified students academically, in some core ways. While our research focuses on the outcomes of performance on literacy and mathematics achievement tests, benefits of the programming likely expand beyond these outcomes.

With that expectation, this study leverages student-level achievement and demographic data to assess the association between gifted and talented programs and Arkansas students' academic growth between third and eighth grades. Particularly, using regression analysis and controlling for student characteristics and across district practices, we investigate the association of gifted services with academic growth on mathematics and literacy tests for gifted identified students who scored above the 95th percentile for mathematics or literacy relative to a similar ability group that did not access gifted services (gifted non-identified). We conducted the analysis for five independent cohorts to assess robustness and replication. In the following sections, we first present relevant literature, methodology, data, and sample selection. We then discuss our findings and provide policy suggestions from this study.

Review of Relevant Literature

Studies assessing the effectiveness of gifted and talented programs

One of the first significant studies on the potential effectiveness of gifted and talented (G/T) programming was conducted in 1932 when Unzicker examined academic outcomes for 22 accelerated students and 22 top students in the regular classroom and found no significant difference. Studies on the relationship between services for gifted students and academic achievement conducted across the ensuing years have produced different results, both negative (e.g., Bui et al., 2014;), positive (e.g., Aljughaiman & Ayoub, 2012; Assouline et al., 2015, Booij et al. 2017; Cohodes, 2020; Kim, 2016), and negligible or null (e.g., Adelson et al., 2012; Golle et al., 2018; Redding & Grissom, in press; Smith et al., 2017).   These studies, however, examined a wide array of outcomes so it is unclear whether the programming was intended to impact the exact outcomes studied (e.g., Lakin, in press; Makel & Wai, 2016), and in the gifted education research field there is a general consensus that programming is important to help students learn something new each day and develop their talents to the fullest (Assouline et al., 2015; Subotnik et al., 2011; Wai et al., 2010),

A rich literature that spans multiple subfields and methodological approaches comes with a wide array of "identification strategies" (meaning can we truly identify the G/T program as causing later achievement relative to counterfactuals) used in addressing the relationship between G/T programs and students' outcomes. Traditionally, researchers have conducted pre-post analyses (Aljughaiman & Ayoub, 2012; Gubbels et al., 2014; Jen et al., 2017). In recent years, researchers have ventured into using new methods including analysis of covariance (Smith et al., 2017), econometrics, and causal inference (Booij et al., 2017; Bui et al., 2014; Cohodes, 2020; Golle et al., 2018). Such differences in approaches can be reconciled by recognizing that a plurality of methods may be useful to understand the ways in which G/T programs may make a difference for students' outcomes (Wai & Benbow, in press).

Meta-analysis provides a collapsed view of results across multiple studies. Kim (2016) examined research on enrichment programs serving gifted students from 1985 to 2014 and found a positive association of the programs with both students' academic achievement and socioemotional development. Kim found that the largest effect size for academic achievement was observed for more educationally intensive programs like summer residential programs. Henfield et al. (2017) conducted another meta-analysis to explore gifted education programs' intervention effect on gifted minority student academic achievement. They found a positive overall intervention effect and heterogeneous effects regarding types of programs. The effect size was significantly larger for high school students compared to primary school students.

Steenbergen-Hu et al. (2016) conducted two second-order meta-analyses that synthesized a century of research on the effects of ability grouping and acceleration on K-12 students' academic achievement. They found that for grouping and acceleration there was "positive, near moderate, and statistically significant impact on accelerated students' academic achievement" (p. 890). Associations between educational programming or stimulation and longitudinal low base rate achievement have also been found among extraordinarily gifted and talented students tracked well into adulthood (e.g., Park et al., 2013; Wai et al., 2010).

In short, gifted programs do seem to help academic or other achievements, or at the very least are consistently linked with improved talent development. This conclusion is important because academic achievements are linked to performance in critical knowledge and skill domains (Lohman, 2005a). Mastery of knowledge and skill domains, such as in the symbol systems underlying the development of mathematical and verbal abilities, in turn indicate students' current developed abilities which highly correlate with both short-term and long-term outcomes on many aspects (Bernstein et al., 2019; Deary et al., 2008; Gubbels et al., 2014; Lubinski et al., 2014; Terman & Oden, 1959; Wai, 2013).

Gifted and Talented in Arkansas

In 2019-20, more than 473,000 students were enrolled in public schools in Arkansas, and 8% were identified as gifted and talented (Office for Education Policy). The Arkansas Department of Education states that Arkansas mandates all public schools to have a program for gifted and talented students. Selection criteria and services are district-dependent with guidance from the state.

Arkansas' G/T identification process follows the tradition that looks at giftedness and talents as multifaceted and should be accommodated with appropriate educational services (Renzulli, 1978). Arkansas Department of Education defines gifted and talented students as those with "high potential or ability whose learning characteristics and educational needs require qualitatively differentiated educational experiences and/or services." Particularly, the identification of giftedness and talent "will be evidenced through an interaction of above average intellectual ability, task commitment and /or motivation, and creative ability" (Division of Elementary and Secondary Education, n.d.).

The G/T identification process can occur at any grade level from Kindergarten to 12th grade, however, almost all school districts in our sample (96%) identify the majority of G/T students by the fourth grade (Tran et al., 2020). Typically, students must be nominated for consideration as qualifying for G/T. The nomination can come from various sources, including teachers, parents, or counselors. Data must be collected on the nominated students using, per state requirement, at least two objective and two subjective measures with at least one of the measures being a creativity assessment. A committee consisting of at least five professional educators chaired by a trained specialist in gifted education then decide to place the student in appropriate programs based on the collected information. This committee can be per campus within the districts and/or at the district level with representatives from each campus (Robinson et al., 2014). There is no consistently applied standard across the state to identify a student as G/T, and districts have the autonomy to determine whether they will honor the gifted identification of a student transferring from another district.

In terms of servicing students that are identified, districts must meet the minimum requirements of services and G/T teachers have to pass the Gifted Education Praxis Examination and meet licensing standards for an add-on endorsement/licensure in gifted education (Robinson et al., 2014, p. 351). From Kindergarten through second grade, districts generally provide weekly whole-group enrichment classes to meet the needs of gifted students. Between 3rd and 12th grade, students identified as G/T are required to receive a minimum of 150 minutes of services per week. A district's gifted program must have an annual evaluation through a state program approval report (Robinson et al., 2014, p. 351), but local decisions lead to the implementation of services and there is no uniform way that districts meet the needs of Arkansas' G/T students.

This study

This study evaluates the association of gifted services with academic growth on mathematics and literacy achievement tests for high-achieving students across the state of Arkansas. This study is among the limited research studies on the effectiveness of gifted education across the state of Arkansas and adds to the literature on efficacy of G/T programming or services. Research on the effectiveness of gifted services to increase Arkansas' students' longer-term academic growth is limited, although there have been studies focused on training for gifted and talented teachers and early interventions in Arkansas (Robinson et al., 2018; Robinson et al., 2009; Robinson et al., 2014). Acknowledging that the identification process or the programming goals of G/T in Arkansas may not be mathematics and literacy achievement focused, using such test scores as outcomes is an important step to understanding if the programs are associated with developing these core aptitudes for schooling (Lohman, 2005a).

III. METHODS

Data and sample

Anonymized student-level data for all Arkansas students from 2008-09 through 2017-18 were provided through the Arkansas Department of Education. Data include mathematics and literacy achievement on the state assessments as well as student demographic characteristics. Data at the district level are publicly available at the Office for Education Policy at the University of Arkansas' website (http://www.officeforeducationpolicy.org/).

Our sample was limited to students that scored in the top 5% in the state on mathematics and, separately, literacy assessments from third grade[1]. We matched these top students with their fourth grade demographic characteristics[2] and followed individual students as they progressed in their education through eighth grade. Our sample includes five independent cohorts of students from 2008-09 through 2017-18 (see Table 1).

[1] We begin with 3rd grade because it is the first grade in which statewide assessments are required to be administered.

[2] We used 4th grade demographics because 96% of school districts in Arkansas identify the majority of G/T students by the 4th grade.

Table 1: Cohort Grade by Academic Year

Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Cohort 1	3rd	4th	5th	6th	7th	8th				
Cohort 2		3rd	4th	5th	6th	7th	*8th*			
Cohort 3			3rd	4th	5th	6th	*7th*	8th		
Cohort 4				3rd	4th	5th	*6th*	7th	8th	
Cohort 5					3rd	4th	*5th*	6th	7th	8th
Assessment	Arkansas Benchmark Tests						*PARCC*	ACT Aspire Tests		

All high achieving third grade students who were consistently enrolled in progressive grades and had general Arkansas state assessment scores through eighth grade were retained in the analytical sample. In order to conclude that this limitation didn't result in differential attrition of certain populations of students from our analytical sample, we conducted descriptive analyses for each of our cohorts to study the proportion of students identified G/T, by gender, participation in the Federal Free and Reduced Lunch Program (FRL) which we use as a proxy for economic disadvantage, special education status, English Language Learner status, and ethnicity. Table 2 presents summary information for Cohort 5, the most recent group of top 5% students, for the initial third grade sample and the final third through eighth grade analytic sample. Information for other cohorts is presented in Tables A1 and A2, and more detailed demographic breakdowns are included in Tables A3-A7. Although the analytic sample limitation results in the reduction of the sample (approximately a 15% decrease), we did not observe significant changes in the proportion of students across cohorts and grades, and concluded there were no systematic changes in student characteristics from the original third grade sample to the analytical sample.

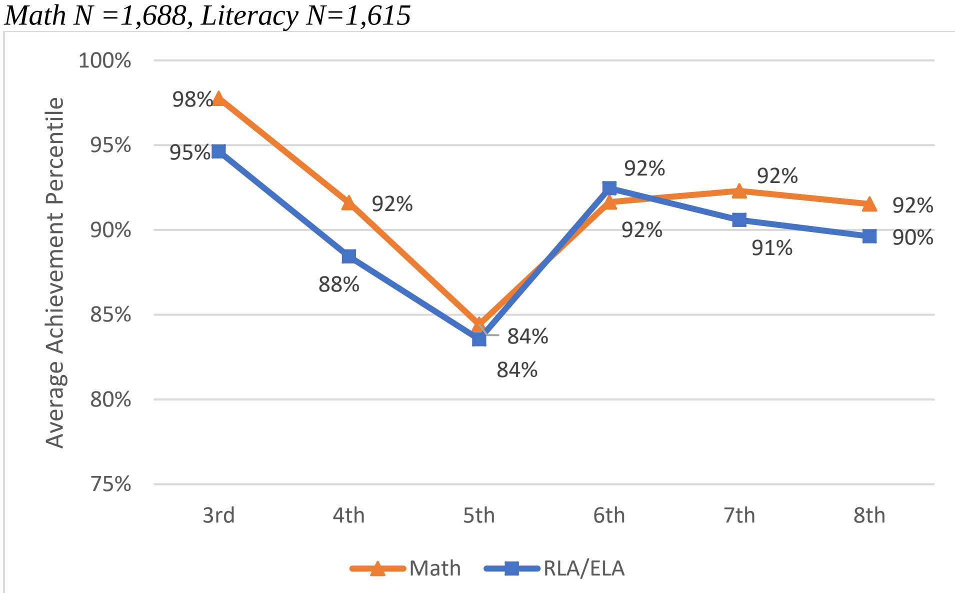
Table 2: Descriptives of students in the 3rd grade top 5% sample and 3rd through 8th grade analytic sample, by subject, Cohort 5

	Mathematics			Literacy		
	3rd Grade (Initial)	3rd-8th Grade (Analytic)	*Difference*	3rd Grade (Initial)	3rd-8th Grade (Analytic)	*Difference*
N	1,990	1,688	*-302*	1,916	1,615	*-301*
% G/T	56.0	55.8	*-0.2*	56.0	56.3	*0.3*
% Female	54.6	54.6	*0.0*	69.8	70.3	*0.5*
% FRL	34.7	34.9	*-0.2*	34.0	33.2	*-0.8*
% SPED	2.2	2.1	*-0.1*	1.7	1.4	*-0.3*
% ELL	4.5	4.6	*0.1*	2.4	2.5	*0.1*
% White	79.9	80.5	*0.6*	80.7	81.5	*0.8*
% Black	5.4	5.2	*-0.2*	6.2	6.1	*-0.1*
% Hispanic	7.0	7.3	*0.3*	5.7	5.7	*0.0*
% Other race	7.6	6.9	*-0.7*	7.4	6.7	*-0.7*

Instrumentation

Arkansas students completed three different types of assessments during the time period examined in our study (see Table 1); through 2013-14, students completed the Arkansas Benchmark Exams, in 2014-15, Arkansas switched to the PARCC (Partnership for Assessment of Readiness for College and Careers) assessment, and in 2015-16 students began taking ACT Aspire assessments. To account for differences in assessment scales, we standardized test scores within grade, subject, and year, to a statewide mean of 1 and a standard deviation of 0 (Z-score). Systematic differences in performance are, however, persistent for our sample under the PARCC assessment. For example, Figure 1 presents the average state percentile in mathematics and literacy for Cohort 5, the most recent group of students included in the study. Students in our sample score, on average, at or above the 95th percentile in both mathematics and literacy in third grade, which is expected given our sample construction. The average percentile rank of students in our sample declined somewhat in fourth grade, which is not unexpected given regression toward the mean for high achieving students. In fifth grade however, students in this cohort were administered the PARCC assessment, and demonstrated performance that was 14 and 11 percentage points lower in mathematics and literacy, respectively, compared to third grade performance. While this might be seen as further regression toward the mean, in sixth through eighth grade, the sample returned to an average score of the 90th percentile or higher. Similar patterns were present in the other four cohorts for the year in which PARCC was administered (Figures A1-A8).

Figure 1: Mean average percentile on mathematics and literacy assessment, by grade, Cohort 5. Math N =1,688, Literacy N=1,615



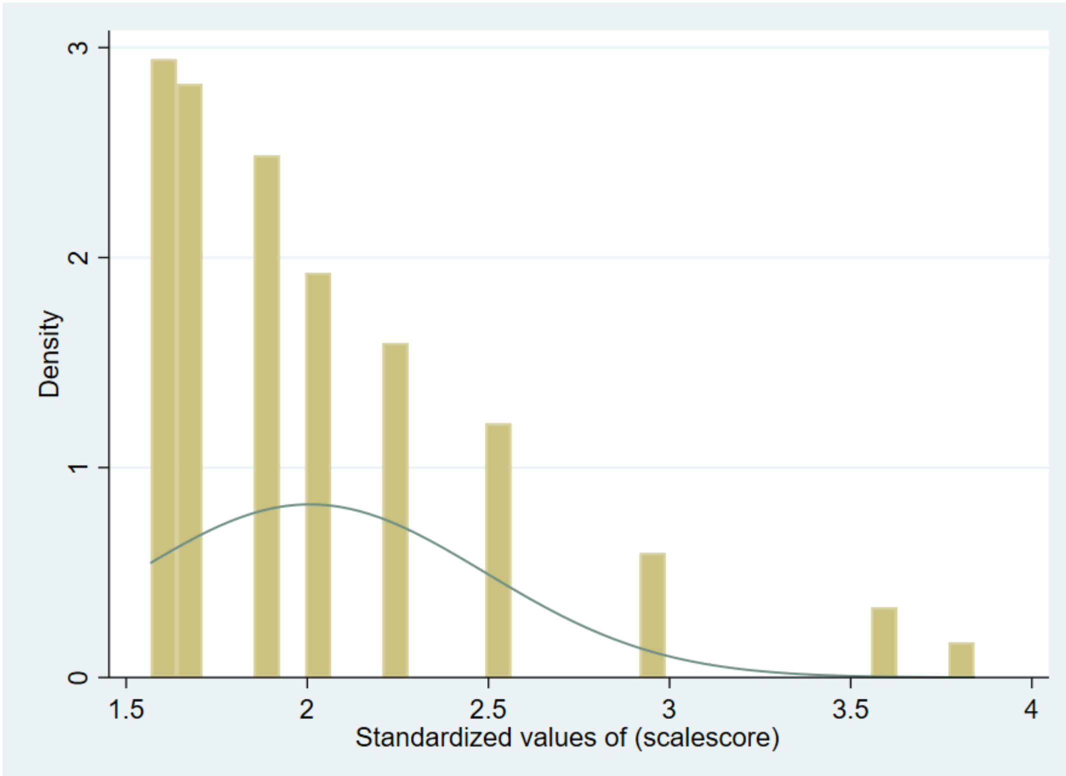
The changes in assessments posed a particular challenge to the mathematics analyses in our study because expectations for testing varied under the different assessment systems. Through 2013-14, all students in grades 3-8 were required to complete their grade-specific mathematics Benchmark assessment, even if they were enrolled in advanced courses such as Algebra or Geometry (Division of Elementary and Secondary Education, 2011). In 2014-15, under PARCC, students who were enrolled in Algebra I or Geometry took those course-aligned assessments *instead of* the grade-specific mathematics assessments. We did not include the sample tested in eighth grade under PARCC because it is not representative of G/T students in Cohort 2, as only 83% of eighth graders participated in the grade-level PARCC mathematics assessments (Arkansas Department of Education, 2015). Under ACT Aspire assessments, all students in again took grade-specific mathematics assessments regardless of course enrollment (Division of Elementary and Secondary Education, 2020). Benchmark, PARCC, and ACT Aspire tests differ slightly in their Literacy tests. Benchmark tests reported scores for Literacy, while PARCC reported scores as English Language Arts/ Literacy, and ACT Aspire report scores for English Language Arts. For clarity and consistency, we use literacy as the general term to represent all three assessments.

Empirical approach

Although the G/T identification and programming in Arkansas may not be designed to specifically increase student achievement in mathematics and literacy, it makes sense to examine whether such programming might be associated with such achievement. Additionally, because much program evaluation research not limited to gifted education focuses on test score changes or growth, this approach is useful to apply to gifted education to examine comparability of program evaluation. Therefore, we leveraged the data that was collected on state assessments with the aim of using mathematics and literacy achievement growth as a first step in evaluating G/T programming in Arkansas, while fully acknowledging that some impacts of such programming may not be detectable on such tests. We used a top 5% cutoff on these mathematics and literacy achievement tests not because this is a clear cut score for who is truly gifted or not-gifted, but simply because this is a reasonable cut score for students who are high achieving academically and are likely ready for advanced educational programming.

We selected on the top 5% of achievement in mathematics or literacy with the assumption that students within the top 5% of students statewide are comparable in their developed ability at the time of selection. Measures of gifted student achievement can be limited by ceiling effects or headroom issues, meaning that gifted students cannot distinguish themselves from other high-ability students because of the lack of headroom on the measure to capture the full range of individual differences (Lubinski & Benbow, 2000; Warne, 2012). As shown in Figure 2, however, we did not observe significant ceiling effects in our analytical samples.

Figure 2: Distribution of standardized third grade mathematics achievement for Cohort 5 analytical sample.



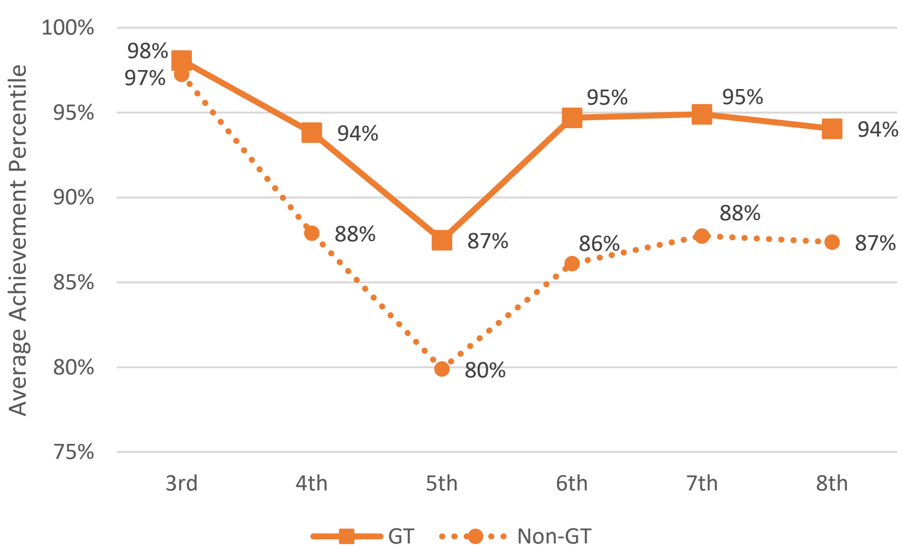
IV. RESULTS

To measure academic performance over time and on different exams, we have standardized students' test scores within the state, by grade, subject, and academic year, to z-scores. This transforms test scores from scale scores to units of standard deviation, where the average score becomes 0 with a standard deviation of 1. Z-scores represent whether and to what extent a student scores above or below average.

Descriptive trend analyses

For ease of interpretation, we translate the z-scores into percentile ranks for the descriptive analysis comparing the achievement of high achieving students who were identified G/T, and the similarly high achieving peers who were not identified as G/T. Figure 3 illustrates the average percentile ranks for students who scored in the top 5% on third grade assessments in mathematics. We present the average achievement percentiles through eighth grade for students who received G/T services as well as for those who did not.

Figure 3: Average percentile on mathematics assessment, by grade and G/T status Cohort 5 N =1,688



As shown in Figure 3, the analytic sample who received G/T services had an average third grade achievement percentile of 98 compared to an average of 97 for those students who did not receive G/T services. These high percentiles are expected given the sample was limited to students scoring at or above the 95th percentile on the third grade assessments. Note that the average percentile declines in fourth grade for both G/T and Non-G/T students, which is not surprising as such high achieving students generally experience downward regression to the mean. In fifth grade, students took the PARCC exam, and G/T students scored at the 87th percentile on average, while Non-G/T students scored at the 80th percentile on average. These scores represented a decline of 9 and 17 percentage points, respectively, compared to third grade performance. In sixth and seventh grade, G/T students scored at the 95th percentile on average, while Non-G/T students score at the 86th and 88th percentiles, respectively. By eighth grade, G/T students scored 6 percentage points higher, on average, than students who performed similarly in third grade mathematics but did not receive G/T services in fourth through eighth grades.

Figure 4: Average percentile on literacy assessment, by grade and G/T status Cohort 5 N=1,615

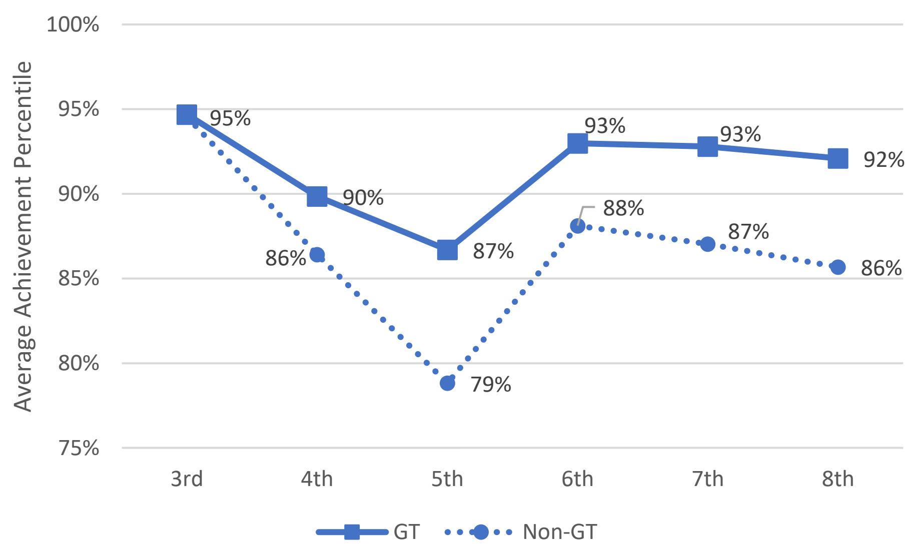


Figure 4 illustrates the average percentile ranks for students who have scored in the top 5% on third grade assessments in literacy. As shown here, the analytic sample who have received G/T services as well as the students who did not receive G/T services had an average of third grade achievement percentile of 95. This high percentile is expected given the sample was limited to students scoring at or above the 95th percentile on the third-grade literacy assessments. Like the mathematics performance, the average percentile declines in fourth grade for both groups, which is not surprising as such high achieving students generally experience regression to the mean. In fifth grade, students took the PARCC exam, and G/T students scored at the 87th percentile on average, while Non-G/T students scored at the 79th percentile on average. In sixth and seventh grade, G/T students scored at the 93rd percentile on average, while non-G/T students score at the 88th and 87th percentiles, respectively. By eighth grade, G/T students scored 6 percentage points higher on average than students who performed the same in third grade Literacy but did not receive G/T services.

Results are similar for other cohorts examined, and are presented in Figures A1-A8 in the Appendix. While we consistently find that students who were provided access to G/T services score relatively higher on later grade assessments than similarly high-achieving students who were not identified as G/T, these are purely descriptive patterns. To determine the unique contribution of G/T programming to academic outcomes, we must look to the multivariate regression analysis that controls for demographic characteristics of students as well as district characteristics.

Multivariate regression analyses

We have used ordinary least squares regressions to examine the relationship between identified as gifted and achievement in subsequent years for students who have scored in the top

5% statewide on their third-grade assessments. We control for student characteristics and we have added district fixed effects to account for possible differences in district policy and program differences. The model approach we have used is described as follows:

$$achievement_{igc} = \beta_0 + \beta_1 gifted_{ic} + \beta_2 l\_achievement_{ic(g-1)} + \boldsymbol{X'}_{ic} + \emptyset_{ic} + \varepsilon_{ic} \quad (1)$$

Where

- $achievement$ is mathematics or literacy standardized achievement for student i in grade g in cohort c.
- $Gifted$ is an indictor if the student was identified as gifted in their fourth grade year
- $l\_achievement$ which is previous content area achievement from the prior grade $(g-1)$ to account for all past time-varying factors including student and school inputs.
- $\boldsymbol{X'}_{ic}$ is a vector of student characteristics including indicators for free and reduced-price lunch status, special education status, limited English proficiency status, race/ethnicity indicator, and gender indicator from fourth grade.
- $\emptyset_{ic}$ represents school district fixed effects. Robust standard errors were clustered at the district level to account for random changes within the district.

We report the regression estimates of the relationship between G/T status and student academic achievement measured by standardized state tests, for students in the top 5% on their third- grade state assessments, controlling for student and district characteristics. Throughout all five cohorts, we have consistently found that as these high-achieving students progressed from one grade to another, students identified as G/T scored statistically significantly higher on standardized state assessments in both mathematics and literacy than their peers that were not identified as G/T.

Table 3 presents the regression estimates of the relationship between G/T status and mathematics achievement for students who have scored in the top 5% on their third grade mathematics assessment. For example, from third to fourth grade, Cohort 5 students who were identified as gifted scored 0.31 SD higher on the fourth grade state standardized mathematics assessment than the Cohort 5 who were not identified as gifted (Table 3). G/T students scored 0.18 SD higher from fourth to fifth grade, and 0.26 SD higher from fifth to sixth grade compared to their non-identified peers. From sixth to seventh grade, G/T students scored 0.19 SD higher, and from seventh to eighth grade, they have scored 0.10 SD higher than non-G/T students. All results were significant at the 99% confidence level.

Table 3:OLS regression estimates of the relationship for high-achieving students between gifted status and student achievement on standardized mathematics assessment

	3rd-4th grade	4th-5th grade	5th-6th grade	6th-7th grade	7th-8th grade	N
Cohort 1	0.320*** (0.044) [0.277]	0.343*** (0.039) [0.448]	0.175*** (0.031) [0.442]	0.240*** (0.034) [0.575]	0.121*** (0.034) [0.625]	1,596
Cohort 2	0.340*** (0.038) [0.320]	0.211*** (0.033) [0.439]	0.247*** (0.031) [0.516]	0.169*** (0.031) [0.563]	N/A	1,660
Cohort 3	0.316*** (0.045) [0.272]	0.279*** (0.032) [0.418]	0.220*** (0.037) [0.513]	0.090*** (0.017) [0.234]	0.392*** (0.055) [0.434]	1,635
Cohort 4	0.296*** (0.044) [0.271]	0.283*** (0.044) [0.413]	0.127*** (0.020) [0.512]	0.139*** (0.037) [0.652]	0.142*** (0.033) [0.648]	1,578
Cohort 5	0.310*** (0.033) [0.260]	0.176*** (0.020) [0.517]	0.256*** (0.041) [0.539]	0.193*** (0.041) [0.581]	0.100*** (0.029) [0.619]	1,688

N/A: Not available due to lack of representative sample due to change in state testing protocol.
Robust standard errors clustered at district level in parentheses.
R-squared values in brackets
*** p<0.01, ** p<0.05, * p<0.1

The correlations were somewhat smaller for literacy achievement but were still statistically significant, with students who have scored in the top 5% on their third grade literacy assessment and were provided G/T services outpaced their similarly high-achieving but un-serviced peers (Table 4). For example, in Cohort 5, from third to fourth grade, students identified as gifted have scored 0.19 SD higher on the fourth grade state standardized literacy assessment than the students who were not identified as gifted. G/T students have scored 0.24 SD higher from fourth to fifth grade, and 0.24 SD higher from fifth to sixth grade compared to their non-identified peers. From sixth to seventh grade, G/T students scored 0.19 SD higher, and from seventh to eighth grade, they scored 0.17 SD higher than non-G/T students. All results but one were significant at the 99% confidence level, and that was significant at the 95% confidence level.

Table 4:OLS regression estimates of the relationship for high-achieving students between gifted status and student achievement on standardized literacy assessment

	3rd-4th grade	4th-5th grade	5th-6th grade	6th-7th grade	7th-8th grade	N
Cohort 1	0.200*** (0.028) [0.239]	0.125*** (0.022) [0.346]	0.092*** (0.020) [0.322]	0.069*** (0.020) [0.320]	0.040** (0.017) [0.411]	1,461
Cohort 2	0.134*** (0.023) [0.231]	0.059*** (0.019) [0.276]	0.096*** (0.019) [0.349]	0.059*** (0.017) [0.301]	0.163*** (0.046) [0.220]	1,460
Cohort 3	0.163*** (0.021) [0.257]	0.114*** (0.016) [0.281]	0.149*** (0.024) [0.383]	0.097*** (0.036) [0.336]	0.299*** (0.060) [0.439]	1,558
Cohort 4	0.129*** (0.018) [0.248]	0.056*** (0.017) [0.351]	0.228*** (0.024) [0.433]	0.191*** (0.030) [0.527]	0.173*** (0.028) [0.580]	1,612
Cohort 5	0.194*** (0.021) [0.282]	0.237*** (0.032) [0.299]	0.238*** (0.051) [0.348]	0.191*** (0.031) [0.518]	0.172*** (0.027) [0.584]	1,615

Robust standard errors clustered at district level in parentheses.
R-squared values in brackets.
*** p<0.01, ** p<0.05, * p<0.1

V. DISCUSSION

As noted from the beginning of our paper, Arkansas provides the definition of giftedness and talents as students with high potential or ability, who likely need qualitatively differential services. The process of identification relies on three components: intellectual ability, task commitment and /or motivation, and creative ability. This model, we argue, largely follows Renzulli's (1978) theory of giftedness and talents, where he defines giftedness and talents as multifaceted and should be accommodated with appropriate educational services. This study, therefore, looked at academic achievement as a demonstration of one facet of giftedness and talents: developed mathematical and literacy achievement. We note that this approach does not address the creativity aspect of the Renzulli model and thus the associations we pick up may not necessarily capture those aspects of identification and programming. Regardless, academic growth and program evaluation typically is of broad interest to education scholars and policymakers on mathematics and literacy achievement tests (e.g., Redding and Grissom, in press; Wai & Allen, 2019), and so we have leveraged the sample we had access to in order to start our G/T evaluation using these outcome metrics.

G/T programming evaluation and G/T programming evaluation in Arkansas

Evaluations of gifted and talented programs in Arkansas are rare. Limited studies have looked at training for teachers and early interventions (Robinson et al., 2014; Robinson et al., 2018). An evaluation of early intervention for first grade students from low-income households through an engineering curriculum suggests positive gains on both out-of-level science content and engineering knowledge (Robinson et al., 2018). Our study looked at a different group of students and a different question, and is the first to evaluate the actual G/T designation effects on students from the third to eighth grade.

Particularly, we have investigated the relationship between G/T status and student academic growth after accounting for various selection bias factors, including prior ability or achievement. We have defined a cohort as top performers from their third grade state assessment, separately for mathematics and literacy, and longitudinally followed them as they have progressed in their grades. We first found that there were no systematic changes of the proportion of students identified as G/T in each cohort as the students progressed. Second, by following same cohort of top performers from their third to eighth grade, separately for mathematics and literacy, we have found a consistent statistically significant positive relationship between the G/T status and student academic growth. Our findings resonate with the majority of research on the association of gifted education with student achievement and academic growth (e.g., Aljughaiman & Ayoub, 2012; Assouline et al., 2015, Booij et al. 2017; Cohodes, 2020 Kim, 2016;). We found positive correlations between gifted status and subsequent academic achievement measured by standardized state assessments in mathematics and literacy among the top 5% of third grade students even when controlling for prior achievement, student characteristics, and district differences.

Overall, we have found greater gains in mathematics compared to literacy across all cohort analyses. This pattern of academic gain is similar to the national trend in mathematics and literacy achievement (Hasen et al., 2018). We suspect that greater gains in mathematics are a function of many factors including school and non-school aspects. At the school level, it could be that the teaching of mathematics is consistently associated with more universally agreed upon principles whereas the teaching of literacy may be more dependent upon the local context. At the non-school level, although we controlled for participation in the Federal Free/Reduced Lunch Program as a proxy for socioeconomic status, the teaching of literacy outside of classroom context may be a more complex function of socioeconomic background, which remains an important variable in academic achievement. For example, wealthier parents may have the opportunities to help their children with literacy compared to parents from disadvantaged backgrounds. Finally, the overemphasis on STEM may shift the attention from literacy at all levels, which further exacerbates the amount of attention placed on the teaching of literacy.

Limitations and future directions

Even though the purpose of this study was not to parse out causal effects of gifted education in Arkansas given our research design and tools used here cannot determine causality, with the demonstrated consistency of findings across many cohorts, we can broadly conclude that being identified as G/T and receiving G/T services have a positive association with students' academic achievement in mathematics and literacy and growth over time. The black box of gifted education is not yet fully explained, particularly in this study. The treatment of gifted education may range from curriculum, peer effects, to teachers' ability to identify the right students who are most likely to benefit from gifted services provided (Lakin, in press), and the motivational or labeling effect of being identified as gifted, in addition to the basic set of individual differences characteristics or aptitudes that selected students may bring (Lubinski, 2020; Snow, 1990). While we cannot identify what aspects of gifted education in Arkansas casually contribute, individually or in combination, to increased student achievement, our findings are valuable because they provide an academic window into what happens from the third through eighth grade to high achieving students across Arkansas who are and are not identified as G/T.

In addition, creating and examining instruments for measuring a wide range of outcomes in gifted education is challenging (Callahan et al., 2020). Academic achievement measured by state standardized tests is limited in some respects. This is a limitation in our study as well as in many other studies of talented students (e.g., Makel and Wai, 2016; Park et al., 2007). This study shows that although gifted education varies considerably in its implementation across the state, we still identify positive associations. Thus, more studies like ours should be done using such tools, especially when tests have been shown to be one objective and fair method to pick up low income and disadvantaged talent broadly as part of universal screening in identification (Card & Giuliano, 2016; Grissom & Redding, 2016).

Much research has been conducted on the potential positive academic, achievement, or other benefits of acceleration for gifted students (Assouline et al., 2015; Plucker & Callahan, 2020). Perhaps more fine-grained analyses of the interaction between Arkansas students' and districts' characteristics can be explored to disentangle the context in which gifted programming is and is not beneficial for students, which may lead to possible improvement of the G/T identification and programming process across the state as well as informing gifted education more broadly. In addition, perhaps outcome measures, such as those that may be used to tap creativity, might be linked to such data to examine the role that the current identification and G/T programming practice in Arkansas is aligning its identification to services provided (Lakin, in press) and also capturing creative outcomes that may have been missed in this analysis.

VI. CONCLUSION

It should be noted that there have been many gifted students who are largely invisible in the public school system (Lakin & Wai, 2020; Makel et al., 2016). There is limited consistency in gifted education policy at the federal, state level, and local school district levels (NAGC, 2020). In many cases, gifted students do not get sufficient attention from policymakers, perhaps because of their extraordinariness and the tension between equity and excellence in education (Benbow & Stanley, 1996; Gallagher, 2015; Wai & Worrell, 2020). However, gifted students are important intellectual engines of societal development (Lubinski & Benbow, 2020).

We started this paper asking about the correlation between gifted designation and student academic growth. The short answer from our study is yes, in Arkansas, there is a strong positive correlation between receiving G/T services and academic achievement. Even though this study does not provide causal inferences, it highlights a consistent positive association between gifted services and longer-term student academic achievement for those students that perform in the top 5% on third grade state assessments of literacy and mathematics. This is in contrast to other studies that have found little to no impacts (e.g., Adelson et al., 2012; Redding and Grissom, in press).

We did not look into the black box of gifted and talented services, nor can we specifically address the possible labelling effect. Yet, it seems like the current G/T process in Arkansas is working, as supported by findings from Gentry et al. (2018) and this paper. School districts at the minimum should keep their G/T practices to help high potential and ability students until any causal mechanism is detected. Though this process is working, this does not rule out improvements or expansions to the identification or programming processes that might be useful, especially when thinking about using mathematics and literacy measures as selection tools not just as evaluation tools (e.g., Tran et al., 2021). Additionally, the success of Arkansas, in a sense, may illuminate useful strategies that may lead to more effective educational opportunities for high achieving students in other states and regions.

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APPENDIX

Tables

Table A1:
Comparison of demographic composition of top 5% in third grade mathematics achievement at the third grade (full sample) and eighth grade (analytic sample), by cohort

	Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5	
Grade	3rd	8th	3rd	7th*	3rd	8th	3rd	8th	3rd	8th
% G/T	51.9	51.3	52.2	51.8	56.8	57.1	54.4	54.2	56.0	55.8
% Female	54.5	54.6	52.8	52.6	47.2	47.7	53.1	49.9	54.6	54.6
% FRL	34.9	35	34.9	34.4	32.8	31.7	34.7	36.7	34.7	34.9
% SPED	1.8	1.8	2.2	2.0	2.9	3.1	2.6	2.7	2.2	2.1
% ELL	2.7	2.5	3.4	3.7	3.8	3.8	3.8	4.0	4.5	4.6
% White	84.1	86.5	82.4	83.2	83.6	85.3	80.6	81.5	79.9	80.5
% Black	6.4	5.9	6.2	6.3	4.8	4.5	5.2	5.3	5.4	5.2
% Hispanic	5.0	4.9	6.0	5.8	6.9	6.7	7.2	7.3	7.0	7.3
% Other race	4.5	2.6	5.4	4.7	4.6	3.5	7.0	6.0	7.6	6.9
N	2,030	1,596	1,922	1,660	2,013	1,635	1,897	1,578	1,990	1,688

*Due to changes in mathematics testing requirements under PARCC, analysis was conducted on 7th grade sample for Cohort 2

Table A2:
Comparison of demographic composition of top 5% in third grade literacy achievement at the third grade (full sample) and eighth grade (analytic sample), by cohort

	Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5	
Grade	3rd	8th	3rd	8th	3rd	8th	3rd	8th	3rd	8th
% G/T	57.3	57.2	54.5	54.9	54.4	54.5	52.8	53.0	56.0	56.3
% Female	67.5	67.8	71	70.5	63.7	63.7	69.7	69.2	69.8	70.3
% FRL	30.0	28.0	29.8	29.7	32.7	32.5	35.1	35.1	34	33.2
% SPED	1.4	1.0	1.5	1.6	1.6	1.6	1.6	1.4	1.7	1.4
% ELL	1.0	1.1	2.1	2.4	2.2	2.2	3.7	3.9	2.4	2.5
% White	85.1	86.5	84.3	84.7	82.7	83.2	80.7	82.1	80.7	81.5
% Black	5.6	5.1	6.0	6.2	6.7	6.9	5.8	5.8	6.2	6.1
% Hispanic	4.1	3.8	4.6	4.4	6.0	6.0	7.2	6.9	5.7	5.7
% Other race	5.2	4.6	5.1	4.7	4.5	3.9	6.3	5.1	7.4	6.7
N	1,818	1,461	1,742	1,460	1,843	1,558	1,935	1,612	1,916	1,615

Table A3: *Cohort 1 student characteristics in for students in the top 5% in grade 3 mathematics and literacy*

Cohort 1	Mathematics		Literacy	
	G/T students	Non-G/T students	G/T students	Non-G/T students
% Female	57.0	52.4	67.0	69.1
% FRL	30.0	40.1	26.0	31.2
% SPED	1.0	2.6	1.0	0.8
% ELL	2.0	3.5	1.0	1.4
% White	86.0	86.9	86.0	87.2
% Black	6.0	5.5	6.0	4.2
% Hispanic	4.0	5.7	3.0	4.3
% Other race	3.0	1.9	5.0	4.3
Mean Z-score at 3^{rd} grade	1.990	1.852	1.820	1.751
Mean Z-score at 8^{th} grade	1.530	1.093	0.970	0.888
Total N	819	777	860	625

Table A4: *Cohort 2 student characteristics in mathematics and literacy for students in the top 5% in grade 3*

Cohort 2	Mathematics		Literacy	
	G/T students	Non-G/T students	G/T students	Non-G/T students
% Female	56.0	49.4	69.0	71.8
% FRL	29.0	40.2	26.0	34.6
% SPED	2.0	2.0	2.0	1.5
% ELL	3.0	5.0	2.0	2.7
% White	83.0	82.9	85.0	84.5
% Black	7.0	5.6	6.0	5.8
% Hispanic	5.0	7.5	3.0	5.8
% Other race	5.0	4.0	6.0	3.9
Mean Z-score at 3^{rd} grade	2.140	1.946	1.850	1.799
Mean Z-score at 8^{th} grade	1.550	1.068	0.950	0.750
Total N	860	800	801	659

*Score was calculated using seventh grade because of the change in testing

Table A5: *Cohort 3 student characteristics in mathematics and literacy for students in the top 5% in grade 3*

Cohort 3	Mathematics		Literacy	
	G/T students	Non-G/T students	G/T students	Non-G/T students
% Female	49.0	45.5	62.0	65.9
% FRL	26.0	38.9	28.0	38.1
% SPED	2.0	4.7	1.0	2.1
% ELL	3.0	5.1	2.0	2.5
% White	86.0	83.9	82.0	84.3
% Black	5.0	4.3	8.0	5.8
% Hispanic	5.0	8.7	5.0	6.6
% Other race	4.0	3.1	4.0	3.2
Mean Z-score at 3rd grade	1.970	1.853	1.780	1.697
Mean Z-score at 8th grade	1.690	1.225	1.420	1.069
Total N	934	701	849	709

Table A6: *Cohort 4 student characteristics in mathematics and literacy for students in the top 5% in grade 3*

Cohort 4	Mathematics		Literacy	
	G/T students	Non-G/T students	G/T students	Non-G/T students
% Female	53.0	53.4	66.0	72.3
% FRL	27.0	43.7	29.0	42.1
% SPED	2.0	3.5	1.0	1.6
% ELL	2.0	6.8	2.0	5.9
% White	84.0	78.8	84.0	79.8
% Black	6.0	4.7	7.0	4.7
% Hispanic	5.0	10.2	4.0	10.4
% Other race	6.0	6.2	5.0	5.0
Mean Z-score at 3rd grade	1.950	1.802	1.610	1.601
Mean Z-score at 8th grade	1.610	1.159	1.430	1.061
Total N	855	723	854	758

Table A7: *Cohort 5 student characteristics in mathematics and literacy for students in the top 5% in grade 3*

Cohort 5	Mathematics		Literacy	
	G/T students	Non-G/T students	G/T students	Non-G/T students
% Female	56.0	53.5	69.0	72.5
% FRL	29.0	43.0	29.0	38.9
% SPED	2.0	1.9	0.2	1.3
% ELL	3.0	6.3	0.2	2.8
% White	81.0	79.8	81.0	82.3
% Black	6.0	4.8	6.0	5.9
% Hispanic	6.0	9.2	6.0	5.8
% Other race	8.0	6.2	7.0	5.9
Mean Z-score at 3rd grade	2.070	1.923	1.620	1.602
Mean Z-score at 8th grade	1.560	1.144	1.410	1.066
Total N	942	746	909	706

Figures

Figure A1. Mean standardized mathematics scores for Cohort 1

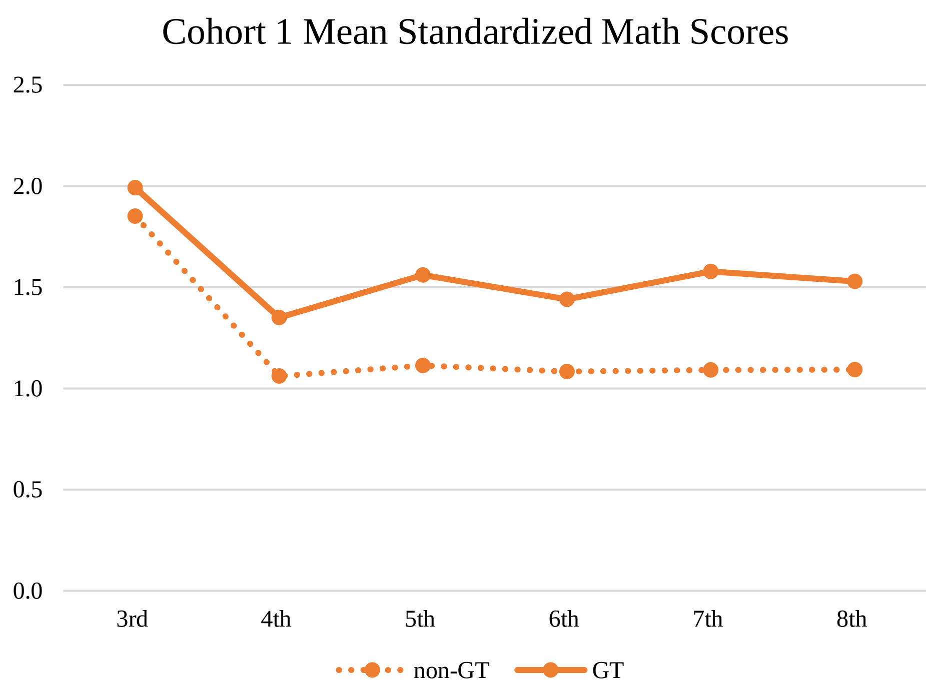

Figure A2. Mean standardized literacy scores for Cohort 1

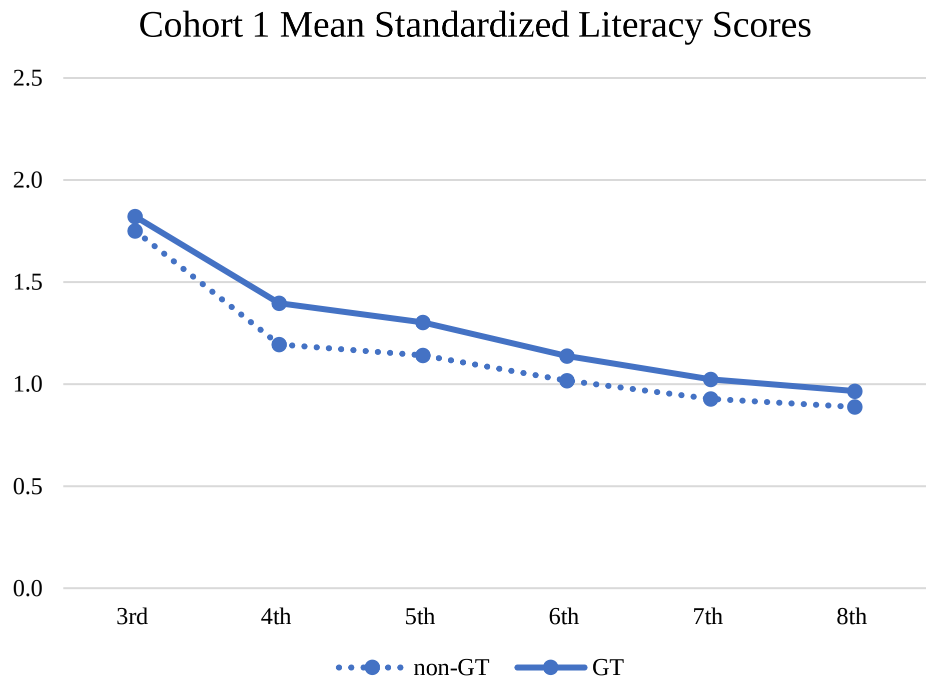

Figure A3. Mean standardized mathematics scores for Cohort 2

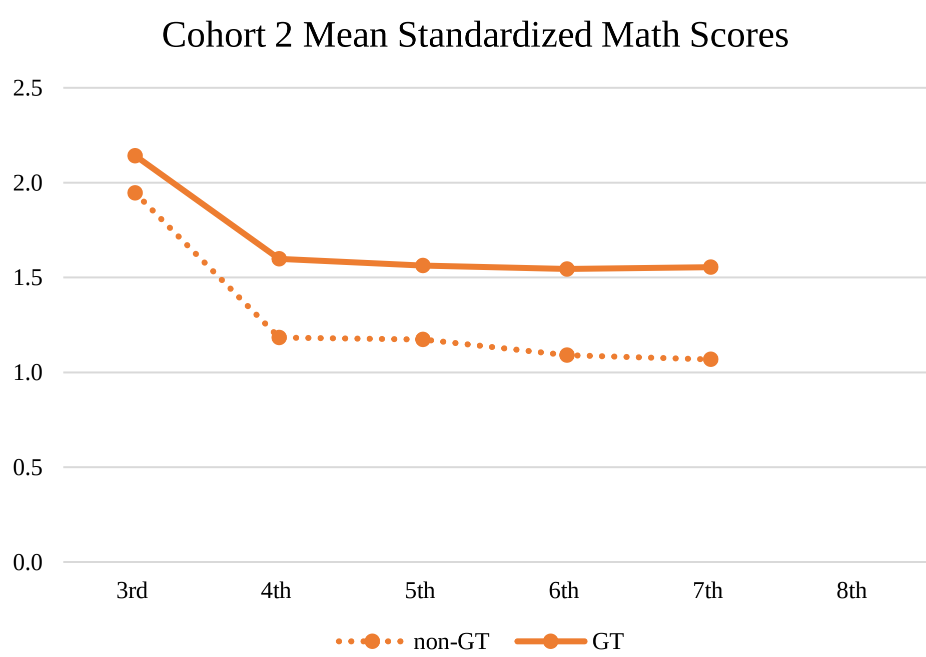

Figure A4. Mean standardized Literacy scores for Cohort 2

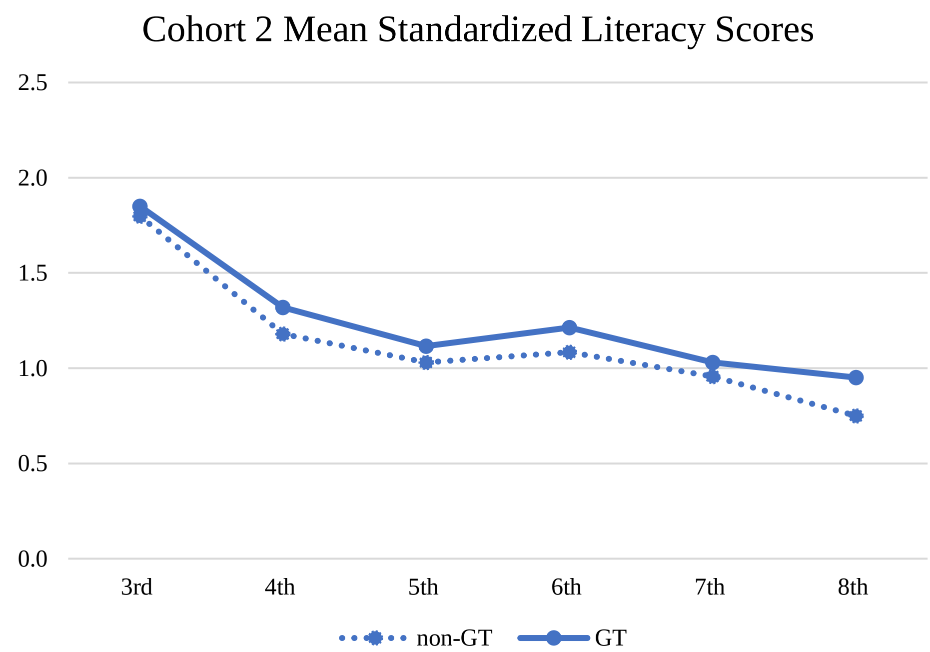

Figure A5. Mean standardized mathematics scores for Cohort 3

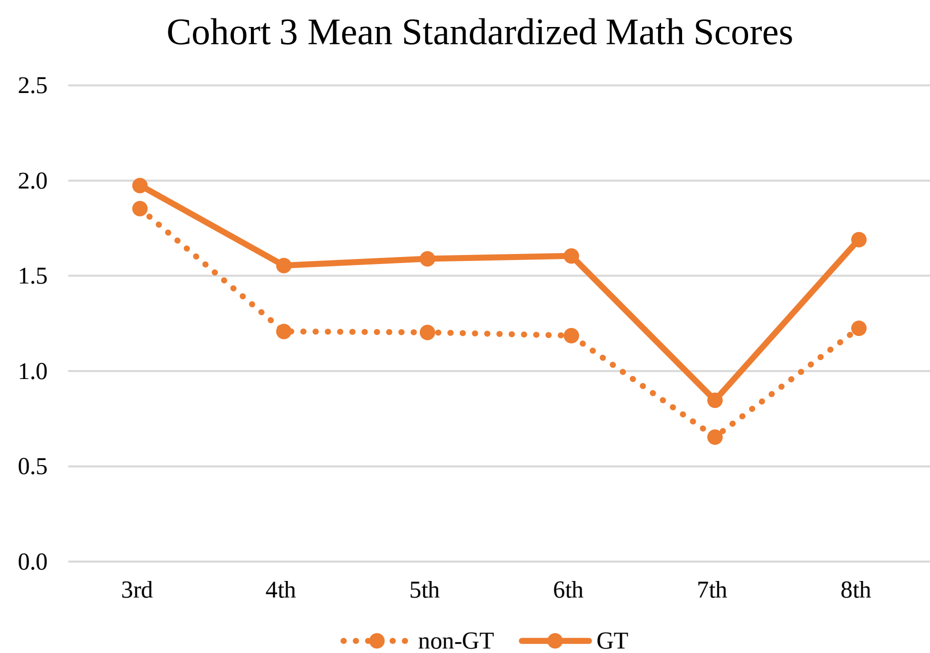

Figure A6. Mean standardized Literacy scores for Cohort 3

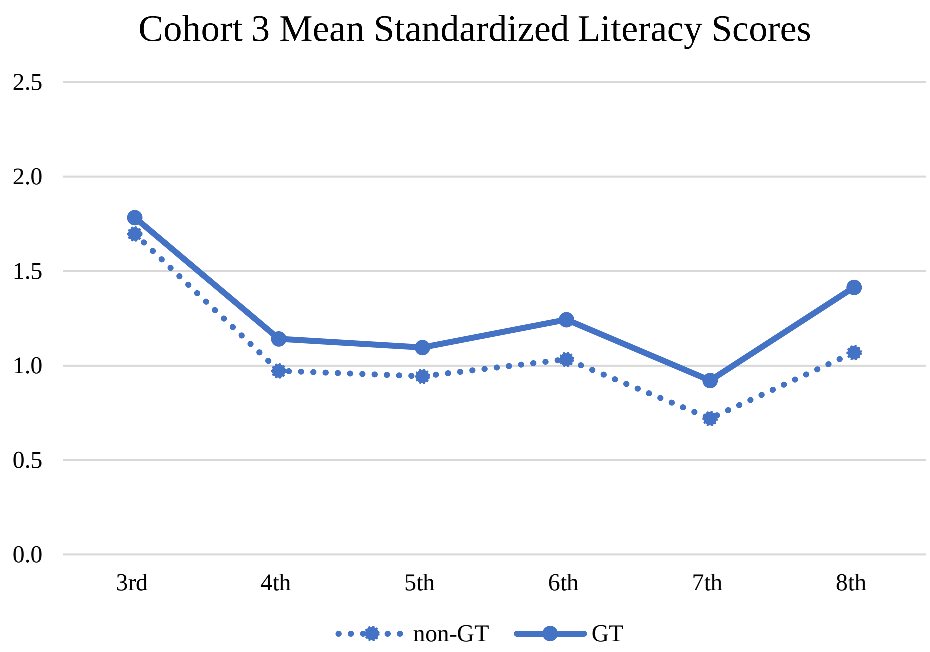

Figure A7. Mean standardized mathematics scores for Cohort 4

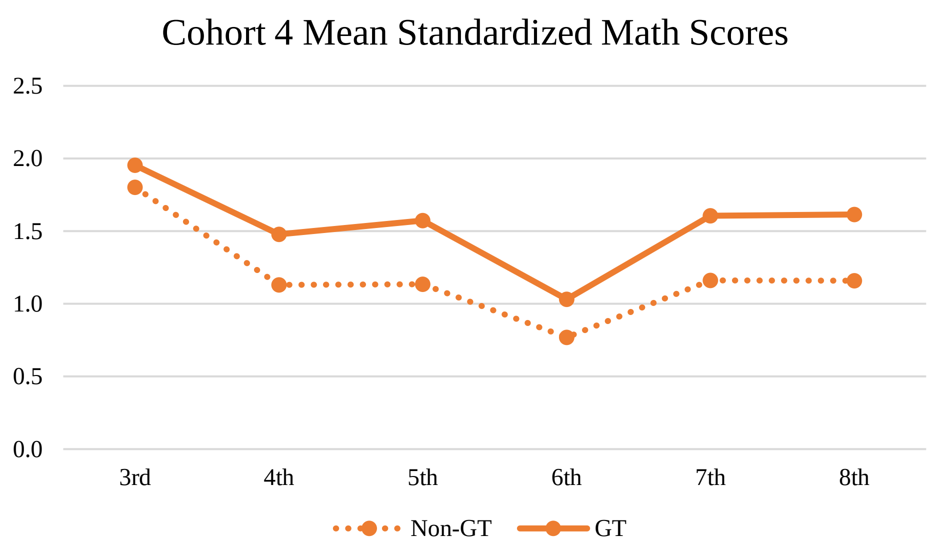

Figure A8. Mean standardized literacy scores for Cohort 4