

# 2015

ESP Working Paper Series

**Does Medium of Instruction Affect  
Learning Outcomes?—Evidence Using  
Young Lives Longitudinal Data of  
Andhra Pradesh, India**

P. Sree Kumar Nair

2015 No. 68



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This paper is one of a series of policy-oriented research papers on privatisation in education jointly commissioned by the Privatisation in Education Research Initiative (PERI) and Young Lives using school survey data from the Young Lives longitudinal study of childhood poverty in Ethiopia, India, Peru and Vietnam. The findings of these diverse studies reflect on the manner and extent to which the varied supply of schooling types and private tutoring influences the pivotal role education has to play in societal development and building sustainable futures for all.

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## About Young Lives

Young Lives is a longitudinal study of childhood poverty following the lives of 12,000 children in Ethiopia, India, Peru and Vietnam over 15 years. It is funded by UK aid from the Department for International Development (DFID) and co-funded by the Netherlands Ministry of Foreign Affairs from 2010 to 2014 and by Irish Aid from 2014 to 2015. The full text of Young Lives publications and more information about its work is available on the Young Lives website: [www.younglives.org.uk](http://www.younglives.org.uk)

## Abstract

This study analyzes the potential link between medium of instruction and student performance at primary school level. Value added models pertaining to the effect of medium of instruction on student achievement are estimated using Young Lives longitudinal data of primary school children in Indian state of Andhra Pradesh and Telangana. Using Math scores to proxy for student achievement we find that Telugu (mother tongue) medium students on an average perform significantly better as compared to English medium students after controlling for students ability, household characteristics and parental aspiration. This analysis suggests that introducing English medium of instruction at earlier grades during school life may negatively affect learning outcomes of students.

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## 1. Introduction

The economic benefits of English as a medium of education have been well recognized regardless of native language, regional background and socio-economic factors. The desire to provide early exposure to English education has therefore seen an increasing trend over the past years. This has led to mushrooming of English medium schools and growing demand for such schools in recent times, especially from the poor and lower middle class section of people. Having realized the economic benefits of learning English, it makes perfect sense to introduce English in schools at the earliest. In fact launching of SUCCESS (2008–09), a program converting 6500 government schools at the secondary level into English medium by the Government of Andhra Pradesh, was a step in this regard. Thus, this study is driven by some fundamental issues evolving in the Indian education system.

Owing to the popularity of English as a medium of instruction, there has been an exponential surge in the supply and demand for English medium schools in the past. In contrast to these growing trends, National Curriculum Framework<sup>1</sup> (NCF, 2005) has taken a completely different view of the growing demand for English language in the country. Instead of promoting English as the medium of education, the NCF categorically emphasizes on the importance of mother tongue in schools for improving students' learning levels, especially at primary levels. This conundrum reveals a gap between the common understandings of our policy documents and the growing aspirations among people. The question that essentially arises is whether medium of education at primary levels has any role in improving the learning levels that could translate into higher returns for students and their parents in future. Additionally, the question of which medium of instruction is beneficial and detrimental to student's achievement at primary level is of crucial significance. This paper uses a robust methodology to establish a crucial link between medium of instruction and learning outcomes and thereby it aims to encourage discussions and intellectual debate for policy purposes.

This paper focuses on Indian sample of the Young Lives international study that has been drawn from the states of Telangana and Andhra Pradesh. Recent developments on these fronts is indicative of the state governments willing to tolerate the costs of converting Telugu medium of instruction to English medium for the perceived future economic returns in the labor market. However, the point to note is that the long term potential economic gains in the individual labor market out of English medium of instruction for students are unclear. Another argument on contrary to this view can be that catering to the need for more English medium school at primary level may become an impediment to poor students with lower socio-economic background as these students would lack adequate support mechanism at home to learn English language. In general, students may better understand the concept in their mother tongue and studies from linguistic also suggest that once a language is mastered, picking up another language becomes easy. Owing to these conflicting views, it makes perfect sense to investigate the quality of learning outcomes at primary levels out of English vis-à-vis Telugu (mother tongue) medium of instruction.

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1. National Curriculum Framework (NCF) is a document by the National Council of Educational Research and Training (NCERT). It is a framework for syllabi, textbooks and teaching practices within the school education programs in India.

## 2. Literature and Its Limitations

Studies on the effects of medium of instruction on learning levels of a child are rather limited. Of the existing literature, most of the research related to medium of instruction has been conducted by scholars in Linguistics and development psychology. These studies primarily focus on what factors help in improving the language and language acquisition. For example, according to Heath (1983), Van Kleeck (1994) and Presco & Crago (2008) the ability to learn language is affected by social environment and medium of instruction. Contrary to such a view, this paper posits the role of medium of instruction on overall learning, understanding and cognitive development of a child. Other studies like McLaughlin (1984) focus on exposure to languages at home and its impact on a child's languages learning ability. Though McLaughlin tries to answer the question of impact of language at home on learning language ability, it doesn't further probe to see its impact on learning levels of other subjects like basic Math. This study, however, will try to further look into the learning outcomes of children with diverse backgrounds on Math achievement scores.

Among studies that have used the Young Lives data sets; Cueto et al (2009, 2013) look into cognitive levels of the students across Young Lives countries (Ethiopia, Peru, India & Vietnam). The paper shows significant gaps in cognitive test scores with respect to different medium of instructions in all the Young Lives countries, except India. Similarly, Singh A (2013) estimates private school premium in scores using medium of instruction as a variable with no significant difference among rural English and Telugu medium students in Math scores. On the other hand, the present study strives to assess the causal contribution of medium of instruction on learning outcomes by keeping medium of instruction as the central variable for analysis. Given the growing importance of English medium education in general among people and governments all over the country, this issue needs an in-depth analysis and reflection. This paper considers all contemporary socio-economic factors to conclude whether medium of instruction plays an important role in improving the learning levels among children. The study also examines who are the beneficiaries and who lose out by opting for English as a medium of education.

Rosenthal et al (1983) also estimate differences in effect of language on achievement levels in elementary school between English and language minority students after adjusting for socio-economic status and race/ethnicity. The difference in the learning levels is quite understandable as the study dealt with two different ethnic communities. Unlike Rosenthal's study, the challenge in this study is to deal with the differences among linguist groups that are blurred and not as strikingly different as that observed among ethnic groups. Taking this factor into account, this study shall control for lesser distinct but important social status of children to understand the performance of Telugu medium of instruction on the learning levels. Another study by Ramchandran R. (2012) estimates the impact of mother tongue based medium of instruction on school dropouts in Ethiopia.

This study explores present trends of dissatisfaction among people from the policy documents that are recommending mother tongue medium of education at early levels of education. The idea is to understand the effect on learning outcomes of a child at primary levels if taught in a particular language, given the socio-economic conditions of the child. This would be done by using a unique longitudinal data set from the Young

Lives study in Andhra Pradesh. The data set would enable an analysis at primary level of the same cohort at different time points of life cycle to measure the short term and medium term effects of medium of instruction on learning levels. The major contribution of this study will be to integrate the socio-economic and community background effect with medium of instruction to estimate the learning levels of mother tongue medium students vis-à-vis English medium students. In this study, I use 'Value Added Method' by the medium of instruction to finally draw an understanding of the NCF (2005) view on mother tongue education versus the current trend in Indian education system at primary level.

The 'Value Added Model' has been largely used in the context of teacher's value addition on student's achievements. For instance Chetty, Friedman and Rockoff (2011); Kane and Staiger (2008) have used Value Added Method to estimates the teacher effectiveness. Similarly, Value Added Model has been used in the context estimating the teacher experience and certification that is accompanied by class size reduction by Jepsen & Rivkin (2009). The Value Added Model has been put to use for estimating the value addition in the context of schools as well. Andrabi et. al. (2011) have analyzed the effect of private schools in Pakistan. On similar lines, this study makes use of Value Added Methodology to estimate the achievement gains out of schools with different medium of instruction. In other words, this study will strive to prove the central hypothesis of this study that medium of instruction do have significant effect on the learning outcomes of students at primary level.

### 3. Data

To answer the central question of this study, I use data collected from an on-going project by the ‘Young Lives’ longitudinal study in Indian states of Andhra Pradesh (AP) and Telangana through 2002 and 2011. These two states are divided into districts and these districts are further divided into sub-districts or *Mandals*. The Young Lives survey covers 20 sub-districts from the two states. This study collected data on two cohorts of children through household visits: (1) Older cohort of 1008 children born between January 1994 and June 1995; and (2) Younger cohort of 2011 children born between January 2001 and June 2001.

For the analysis in this paper, I use data only from younger cohort as a non-native language can potentially be a major hindrance in learning at younger age when the child is required to learn English and gain basic knowledge of other subjects in English. Focusing only on the younger cohort is aimed at helping us better identify the potential loss of learning, if any, due to use of English as a medium of instruction. The data was collected through questionnaire responses using three rounds of household visits and addressing questions to children, respective adult family members and other informants in the community. These rounds were conducted in 2002, 2006–2007 and 2009–2010. This study also collected extensive information on a randomly selected subsample of schools of children in 2011.

The survey data includes children information by child, household, school and community characteristics. Special care has been given to capture the variations in learning outcomes of the children considering the school curriculum, age and stage of education. Year-wise details of data collected from the younger cohort have been mentioned in Table 1 along with their achievement tests that have been considered in this study. The raw scores reported in the survey have been normalized to ‘Z’ scores with mean of 0 and standard deviation of 1 for ease of comparability and analysis.

**Table 1—Quantitative Tests in Young Lives**

	Round 1 (2002)	Round 2 (2006–07)	Round 3 (2009–10)	School Survey (2011)
Younger Cohort	6–18 months old	Age 5	Age 8	Age 9
		CDA Quantitative	Mathematics	Mathematics

I further elaborate the data from various rounds and explain how they will be used for analysis:

*Test Scores.* I have used Math test scores from round 2 (2006–07), round 3 (2009–10) and school survey (2011). While the overall data covers 1930 younger cohort children by 2010. My sample comprises 915 children drawn from 233 schools collected from 20 sentinel sites (Mandals) across chosen districts that were covered in all three rounds. These districts form a part of three distinct regions—Telangana, Coastal Andhra and Rayalaseema.

*Main Independent Variable: Medium of Instruction.* I have used school survey (2011) to collect data pertaining to schools classified by different medium of instruction. My sample contains 49 English medium schools located in urban areas and 29 schools in rural areas. On the other hand, 35 Telugu medium schools in urban and 109 in rural areas have been included in the sample. Thus, our sample contains 182 primary school students across 78 English medium schools and 694 students in 144 Telugu medium schools.

*Controls.* The data collected by Young Lives contain information on caste, gender, educational variables and medium of instruction. Teacher related variables are also included such as age, gender, experience, qualification etc. The school level survey of 2011 includes a set of 250 schools randomly selected from rural, urban and type of school stratification such that it indicates adequate representation of children. I make use of the school survey data to control for the school characteristics of students. The school survey covered aspects such as teacher and class characteristics, children experiences, teaching processes, funding, infrastructure etc. Among various subject-wise tests such as English, Telugu and Maths conducted in the school survey; I use math test scores as a measure of achievement for assessing the learning outcomes. Math scores have been used for a simple reason that unlike math, the English medium students will have an edge over Telugu medium students in English tests and vice versa. Another point to note is that not only the medium of instruction were followed in class but also the assessments were conducted in both the languages respectively. Thus, there may be both instructional and test effects.

It is important to look into how the English and Telugu (Mother tongue) medium school going students differed in their school characteristics since other school characteristics, apart from medium of instruction, also play a role in the performance of students. Pupils in English medium and Telugu medium schools are similar along many dimensions such as the school infrastructure in rural areas and children household characteristics in urban areas. Some of the school characteristics that can play an important role in the learning outcomes have been listed by the school type (medium of instruction) in Table A1.1. Table A1.1 uses a mix of infrastructural and demographical indicators and assesses how the English and Telugu medium students differed on these parameters. As expected there is a significant gap between both infrastructural and demographical indicators between the urban English and Telugu medium schools. Urban English medium schools are better endowed with facilities and higher student-teacher ratios. On the other hand, the rural English and Telugu Medium schools do not significantly differ in the infrastructural facilities while there exist significant differences in the demographical variables.

In order to control for children and household characteristics, I use data from round 3 that was conducted in 2010 just before the school survey of 2011. Table A2 highlights the characteristics of sample children by the medium of instruction at schools. English medium students are wealthier and better placed in anthropometric measures than Telugu medium students in both rural and urban areas. The nutritional differences between English and Telugu medium students are wider in the rural areas than the urban areas. In fact, these stark and observable differences between Telugu and English medium students suggests that it may be important to control for these background characteristics while estimating the effects of medium of instruction on Math achievement scores.

## 4. Methodological Framework

Most of the studies conducted in the past that have analyzed differences in achievement of students among schools have ignored the role of medium of instruction on the achievement levels of students. For example, most of the studies that have investigated the effect of private versus government schools have controlled for medium of instruction. The role of medium of instruction at primary level is certainly important. Moreover, lack of understanding of the language of medium of instruction at school can increasingly affect the student's interest in the subject and therefore their achievement levels.

The approach in this paper is to directly estimate the value added to the achievement scores by the medium of instruction at school. The achievement formulation has been done by following the initial specification of (Hanushek 1979, 2006) employing the education production function estimation as:

$$A_{it} = f(X_i, F_A) + \gamma_A A_{it-1} + \delta_s + \varepsilon_{it} \quad (1)$$

The above estimation follows a simple value-added model of achievement. Current achievement ( $A_{it}$ ) is a function of lagged achievement ( $A_{it-1}$ ), expected to capture the contribution of all the unmeasured past inputs, endowments and ability differences. The other inputs at period  $t$  includes Family or home based inputs ( $F_A$ ), vector of peer and child specific inputs ( $X_i$ ), and from schools ( $\delta_s$ ). This formulation is however subject to get effected by possible bias from measurement error in the lagged score and any unobserved heterogeneity of learning ability. These biases is of lesser concern as the as many of the recent studies such as Andrabet al. (2011), Chetty, Friedman and Rockoff (2011), Angrist, Pathak and Walters (2011) etc, have suggested very limited bias associated with such a value added estimates.

## 5. Empirical Implementation

In order to estimate the value added by the English and Telugu medium of instruction to the achievement levels of the students, I estimate the following core specification separately for rural and urban areas (Singh, 2013):

$$A_{it} = \alpha + \beta_1 MOI_i + \beta_2 A_{it-1} + \varepsilon_{it} \quad (1)$$

$$A_{it} = \alpha + \beta_1 MOI_i + \beta_2 A_{it-1} + \beta_3 X_i + \varepsilon_{it} \quad (2)$$

$$A_{it} = \alpha + \beta_1 MOI_i + \beta_2 A_{it-1} + \beta_3 X_i + \beta_4 \text{Parental Aspiration} + \varepsilon_{it} \quad (3)$$

$$A_{it} = \alpha + \beta_1 MOI_i + \beta_2 A_{it-1} + \beta_3 X_i + \beta_4 \text{Parental Aspiration} + \beta_5 \text{Timeuse}_i + \varepsilon_{it} \quad (4)$$

is my outcome variable, Maths test score for 2011 has been regressed on Medium of Instruction (categorical variable: it takes 1 if the first official language in school is Telugu and 0 if the first official language in the school is English). The key parameter in the aforementioned equation is—the effect of medium of instruction on math achievement scores. I use sub-district (Mandal) fixed effects in the above specification. is the lagged test Math scores of 2009 and 2006; includes household background characteristics with parent's educational background, wealth index and caste dummies. I also use some information pertaining to investment into children's studies such as the home based support and teacher's active participation in enhancing the learning experience of students. This has been built in as an index using number of questions that were answered by the children.

## 6. Results

I estimate equation (1) using 2009–10 data for 8 year old students and 2011 data for 9 year old students together. The medium of instruction dummy takes value 1 if the school's first official language is Telugu (Mother Tongue) and 0 if the school's first official language is English. Establishing causality between medium of instruction and achievement levels have serious issues of endogenous selection. Differences between Telugu and English medium math achievement scores are not only due to systematic but can also be due to unobservable characteristics. In order to clearly assess the value addition of Telugu medium schools on Math achievement scores of students, I estimate equations 1 to 4 by gradually introducing more controls. These controls pertain to range of characteristics of children, household and school.

In specification 1, in all the tables in the Appendix, I only control for child ability using lagged score that embodies several things that can potentially form a part of child abilities. Since household characteristics and child characteristics may also affect the level of learning, I also include household characteristics and gender of child in specification 2. Similarly, parental aspiration regarding their child's future and the amount of effort that the child puts in various households and other activities is also likely to affect child performance. To account for these effects, specifications 3 and 4 control for differences in parental aspirations and time spent by children on various activities in a typical day, respectively.

In addition to controlling for background and observable school characteristics, sub-district (Mandal) fixed effects are included in all specifications and standard errors are also clustered at the Mandal level. This controls the unobservable within districts by capturing invariant characteristics of Mandals. For instance Mandals with English medium schools might be potentially different from Mandals without English medium schools. This indicates that merely controlling for background and other characteristics cannot deal with all forms of biases; I used Mandal fixed effect to deal with Mandal level confounders. It improved the robustness of the approach as well as the coefficient of determination of the model in comparison to models where Mandal fixed effects were not used.

Table A2 presents the results obtained from estimating equation 1 using specifications 1–4 for both 8 and 9 year olds combined for both rural and urban areas combined. In our first specification value added estimate of Telugu medium is positive but not significant. This is probably due to various other factors such as household characteristics and parental aspiration confounding the effect of medium of instruction on learning. As we can see in specifications 2–4 the coefficient on medium of instruction turns positive and significant once we control for these other factors. Additionally, the size of the coefficient also changes considerably when more controls are added. In particular, adding more household characteristics and gender of child along with the amount of effort that the child puts in various households and other activities increases the magnitude of the impact. Result in specification 4 suggests that after controlling for various child and household characteristics Telugu medium of instruction is associated with a 0.22 standard deviation increase in Math score as compared to English medium of instruction. This effect is both statistically significant and economically large. The results in Table A2 are consistent with my hypothesis that medium of instruction significantly affects student learning.

The value added methodology of calculating the achievement gain of Telugu medium of instruction vis-à-vis English at primary level allows me to account for distinct location differences through fixed effects. It is evident from the section on data description that there exists a significant difference in all the important variables of concern in the rural and urban areas. These complex and wide disparities between rural and urban areas and resultant achievement scores dilute the conclusion that could be drawn from the achievement gains as a result of Telugu medium of instruction. Hence, adding more information and controlling these varying background characteristics of students, schools, teacher and household becomes immensely important to isolate the effect of medium of instruction in rural and urban areas. Therefore, I proceed to estimate the value added separately for rural and urban areas, for both 8 year olds and 9 year olds separately.

Table A3.1 (Panel A) and Table A3.2 (Panel B) of the 9 year old cohort presents the main findings of urban and rural areas in 2011, respectively. Rural–urban classification shows that the estimation of value added by medium of instruction is not very different in terms of achievement, measured by their impact on student’s Math achievement scores. Specification 4 of Table A3 for each Panel A and B indicates that the value addition of Telugu medium of instruction after controlling for background characteristics is about 0.14 standard deviation. On the other hand, regression results using specification 4 in Table A4.2 (Panel B) of the 8 year olds achievement scores in the rural areas shows a conspicuous increase of 0.21 standard deviation by Telugu medium of instruction over English medium of instruction. All the value added estimates are consistent with my hypothesis except Table A4.1 (Panel A), that analyses 8 year olds in 2010 in urban settings, indicating that the effect of medium of instruction is insignificant. This can be due to possible reasons of lack of power as the urban sample has only 140 observations, significantly lesser than all our earlier scenarios.

## 7. Interpreting the Results for Math Achievement scores

This paper brings out the importance of mother tongue based instruction at school at primary level as there exist considerable evidence to show that medium of instruction does impact learning outcome at primary level. Summary statistics indicate that Telugu medium students are still substantial in number and are a disadvantaged lot as they not only have fewer infrastructural facilities but also their nutritional levels are significantly lower than their counterparts. Such a situation leads to lower cognitive development of students. Moreover Human Development Report of Telangana (2014) also reveals that there is lesser accountability on the part of government school permanent teachers that offer Telugu medium education. Against all such odds, there exists a strong potential for Telugu medium students to perform better. Thus, this evidence supports the claim that this paper strives to make about the need to give importance to mother tongue based education at primary levels of education.

The present study reveals that Telugu medium students at primary levels have performed better, as observed after controlling for children's nutritional and time use characteristics. These results are particularly important for the state as there are presently a number of programmes that aim towards ensuring higher nutritional level and helping students spend time at schools. The mid-day meal scheme at schools is one such programme by the government. Thus, the present schemes and programmes, if implemented and executed properly can create higher potential of Telugu medium students to perform better without incurring any additional costs. Such complementarities should particularly benefit the disadvantaged students by ensuring higher learning outcomes. In other words, a step towards a transition of schools at primary level from Telugu to English medium might create larger inequalities by widening the gap in the achievement levels. Thus, this study is pertinent not only because of its immediate policy relevance in the Indian state but also for its long term interest in the economic value of the well-defined human capital embodied in language skills.

## 8. Conclusion

The state governments appear to be willing to bear the monetary as well as imputed costs of language transition. Such costs include cost that pertains to errors and mistakes on part of teachers during the transition process and concomitantly the students who are taught by same teachers. This step towards transition of the language of instruction and its consequence in terms of perceived economic gains in the labor market is still unclear. Moreover, insistence on instruction in English is certainly a barrier for the poor, rural and lower caste students as revealed by this study. The other explanation towards having primary schools with mother tongue medium of instruction is that in general at lower classes, students may be able to learn more effectively when schools instruct their students in their native language. In fact in the local labor market; having strong native language skill might prove to be of more enduring value than English language. As local trade and businesses generally happens in local language and not in English. Considering all these factors, it becomes imperative for the policy makers to discuss and lament the effects of medium of instruction on learning outcomes.

Amidst increasing demand for English as the medium education at the earliest level of schooling, I have addressed two major questions concerning the issue. First, whether achievement scores are responsive to medium of instruction at school and second, whether mother tongue medium of instruction can increase the learning outcomes at primary level. Although the Value Added Model (VAM) has limited bias, the results should be treated with adequate caution. The findings of this paper indicate that there are only perceived future economic benefits of studying in English medium of instruction while learning levels of students can suffer at lower levels of schooling. As it is ambiguous as to which effect would dominate the total outcome in the long run, the impact on future economic benefits is unclear. This paper suggests that growth in achievement can be significantly different depending on the medium of instruction of the school at primary levels of student education.

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## Appendix

**Table A1.1—School Characteristics in English and Telugu Medium Schools (Younger Cohort)**

School Characteristics	Rural areas			Urban areas		
Variables	English Medium School	Telugu Medium School	Difference	English Medium School	Telugu Medium School	Difference
Number of Students (I–V)	363.49	106.56	256.93***	369.12	285.55	83.57**
	(17.43)	(3.47)	(11.26)	(24.07)	(36.25)	(41.77)
Number of Teachers (I–V)	10.09	4.44	5.65***	12.67	8.48	4.19***
	(0.38)	(0.10)	(0.31)	(0.89)	(0.78)	(1.26)
Proportion of Permanent Teachers	0.42	0.58	–0.16***	0.31	0.28	0.03
	(0.04)	(0.02)	(0.05)	(0.05)	(0.06)	(0.08)
Proportion of Male Teachers	0.52	0.69	–0.17***	0.13	0.33	–0.19***
	(0.04)	(0.01)	(0.04)	(0.04)	(0.06)	(0.06)
Proportion of Teachers with Teaching Qualification	1.74	1.54	0.20***	1.36	1.53	–0.18**
	(0.05)	(0.02)	(0.06)	(0.05)	(0.06)	(0.08)
Student–Teacher Ratio	30.38	30.94	–0.56	37.26	22.83	14.43***
	(1.36)	(1.78)	(2.2)	(1.59)	(0.34)	(1.08)
Has Electricity Connection	0.99	0.95	0.04	1.00	0.80	0.20***
	(0.01)	(0.03)	(0.0)	—	(0.02)	(0.04)
Has a Library	0.44	0.32	0.12	0.27	0.08	0.20***
	(0.05)	(0.06)	(0.1)	(0.05)	(0.01)	(0.03)
Has a Playground	0.49	0.47	0.03	0.97	0.78	0.19***
	(0.05)	(0.06)	(0.1)	(0.02)	(0.02)	(0.04)

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School Characteristics	Rural areas			Urban areas		
Variables	English Medium School	Telugu Medium School	Difference	English Medium School	Telugu Medium School	Difference
Has drinking water availability	0.96	0.87	0.09	1.00	0.71	0.29***
	(0.02)	(0.04)	(0.0)	—	(0.02)	(0.05)
Number of Separate Class Rooms	14.24	11.31	2.94*	10.70	4.35	6.35***
	(1.01)	(1.37)	(1.67)	(0.34)	(0.15)	(0.43)
Has Toilets	1.00	0.94	0.06**	0.77	0.63	0.14***
	—	(0.03)	(0.03)	(0.04)	(0.02)	(0.05)
<b>Class Characteristics</b>						
Proportion of Boys	0.53	0.49	0.04	0.66	0.46	0.20***
	(0.01)	(0.02)	(-0.02)	(0.01)	(0.02)	(0.04)
Text book in Use	1.47	1.45	0.02	1.25	1.48	-0.23***
	(0.06)	(0.07)	(0.1)	(0.06)	(0.02)	(0.07)
Multigrade Teaching	0.26	0.50	-0.24***	0.18	0.79	-0.61***
	(-0.24)	(0.07)	(0.08)	(0.04)	(0.02)	(0.05)
<b>Teacher Characteristics</b>						
Teacher: Age	30.06	29.92	0.14	29.18	32.37	-3.19***
	(0.86)	(1.32)	(1.5)	(0.59)	(0.38)	(1.01)
Teacher: Salary	3,871.20	7,456.72	-3585.52***	3,793.63	10,282.74	-6489.12***
	(308.62)	(1,240.61)	(1093.88)	(136.16)	(374.41)	(970.58)
Teachers with her Qualification	0.71	1.07	-0.35**	1.47	1.08	0.39***
	(0.10)	(0.13)	(0.16)	(0.09)	(0.04)	(0.11)

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**Table A1.2—Differences between English and Telugu (mother tongue) medium schools (Younger Cohort)**

Children Characteristics Variables	Rural			Urban		
	English Medium	Telugu Medium	Difference	English Medium	Telugu Medium	Difference
Maths Scores (2006–07)	0.41	–0.16	0.57***	0.27	0.29	–0.03
	(0.10)	(0.04)	(0.11)	(0.10)	(0.12)	(0.16)
Maths Scores (2009–10)	0.12	–0.06	0.15	–0.10	0.13	–0.23
	(0.09)	(0.04)	(0.1)	(0.10)	(0.10)	(0.15)
Maths Scores (2011)	0.10	–0.07	0.17	–0.03	0.33	–0.35**
	(0.09)	(0.04)	(0.1)	(0.11)	(0.12)	(0.16)
Weight z–score	–1.81	–2.15	0.33***	–1.33	–1.67	0.34*
	(0.09)	(0.04)	(0.10)	(0.12)	(0.15)	(0.19)
Height z–score	–1.42	–1.69	0.27***	–0.89	–1.24	0.34*
	(0.09)	(0.04)	(0.10)	(0.12)	(0.13)	(0.18)
Home Support Index	0.48	0.50	–0.02	0.58	0.57	0.01
	(0.03)	(0.01)	(0.0)	(0.03)	(0.03)	(0.05)
Wealth Index	0.52	0.44	0.08***	0.70	0.65	0.05***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Mother’s Educational Level	1.00	0.50	0.50***	1.64	1.40	0.23
	(0.11)	(0.03)	(0.09)	(0.13)	(0.15)	(0.20)
Father’s Educational Level	1.89	1.01	0.88***	2.16	1.92	0.25
	(0.15)	(0.05)	(0.13)	(0.15)	(0.19)	(0.24)
Remidial Classes for Maths	0.01	0.30	–0.28***	0.10	0.08	0.02
	(0.01)	(0.02)	(0.05)	(0.03)	(0.04)	(0.05)
Teacher’s participation	0.66	0.41	0.25***	0.91	0.76	0.14***
	(0.05)	(0.02)	(0.05)	(0.02)	(0.04)	(0.05)

**Table A2**—Telugu medium of instruction effect: (8 and 9 year olds combined)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	−0.019 (0.081)	0.187** (0.078)	0.203** (0.078)	0.223** (0.079)
MScoreL1	0.423*** (0.029)	0.372*** (0.022)	0.356*** (0.025)	0.347*** (0.026)
Male		0.003 (0.045)	−0.020 (0.044)	−0.003 (0.047)
Scheduled Caste		−0.271*** (0.063)	−0.274*** (0.067)	−0.269*** (0.063)
Scheduled Tribe		−0.099 (0.113)	−0.079 (0.117)	−0.097 (0.117)
Backward Caste		−0.150** (0.062)	−0.148** (0.063)	−0.157** (0.063)
Mother's education		0.010* (0.006)	0.010 (0.006)	0.010 (0.006)
Father's education		−0.000 (0.004)	−0.001 (0.004)	−0.001 (0.004)
Index of home support		0.051 (0.098)	0.048 (0.098)	0.056 (0.100)
Teacher's participation		1.025*** (0.294)	1.048*** (0.309)	1.025*** (0.320)
Wealth index		1.054*** (0.181)	1.012*** (0.183)	0.967*** (0.180)
Caring for others				0.002 (0.056)
Hours per day domestic task				0.030 (0.034)
Task on family farm/business				−0.128 (0.256)
Paid work outside household				0.010 (0.047)
Hours in School				0.044 (0.036)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Studied outside school hours				0.079*** (0.026)
Parents aspire			0.019*** (0.005)	0.014*** (0.005)
Constant	0.011 (0.064)	-1.292*** (0.231)	-1.519*** (0.247)	-1.948*** (0.363)
Observations	1,709	1,648	1,626	1,626
R-squared	0.319	0.365	0.369	0.375

Notes: Robust standard errors in parentheses. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01  
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A3—Telugu medium of instruction effect: (9 year olds)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	0.009 (0.061)	0.147** (0.063)	0.145** (0.062)	0.154** (0.056)
MScoreL1	0.633*** (0.035)	0.593*** (0.033)	0.594*** (0.037)	0.597*** (0.038)
Male		-0.075 (0.063)	-0.046 (0.064)	-0.044 (0.064)
Scheduled Caste		-0.322*** (0.081)	-0.330*** (0.082)	-0.328*** (0.085)
Scheduled Tribe		-0.256* (0.131)	-0.271* (0.131)	-0.277** (0.131)
Backward Caste		-0.160** (0.068)	-0.166** (0.070)	-0.168** (0.073)
Mother's education		0.007* (0.004)	0.007* (0.004)	0.007* (0.004)
Father's education		0.001 (0.004)	0.002 (0.004)	0.001 (0.004)
Index of home support		0.102 (0.102)	0.094 (0.098)	0.103 (0.096)
Teacher's participation		0.664*** (0.220)	0.734*** (0.226)	0.710*** (0.242)
Wealth index		0.393 (0.261)	0.450* (0.258)	0.435* (0.244)
Caring for others				-0.098 (0.061)
Hours per day domestic task				-0.003 (0.041)
Task on family farm/business				-0.175 (0.328)
Paid work outside household				0.049 (0.167)
Hours in School				-0.047 (0.034)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Studied outside school hours				0.059*
				(0.032)
Parents aspire			-0.018**	-0.020***
			(0.007)	(0.007)
Constant	-0.018	-0.660***	-0.513**	-0.202
	(0.048)	(0.230)	(0.237)	(0.385)
Observations	856	825	814	814
R-squared	0.499	0.524	0.528	0.536

Notes: Robust standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$   
 Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A3.1 (Panel A)—Telugu medium of instruction effect: (9 year olds, urban)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	0.217** (0.067)	0.184** (0.074)	0.170* (0.077)	0.140* (0.074)
MScoreL1	0.728*** (0.070)	0.740*** (0.078)	0.751*** (0.083)	0.761*** (0.081)
Male		-0.323 (0.184)	-0.309 (0.182)	-0.278 (0.171)
Scheduled Caste		-0.342* (0.153)	-0.328* (0.149)	-0.300* (0.147)
Scheduled Tribe		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Backward Caste		-0.309** (0.102)	-0.313** (0.107)	-0.290* (0.135)
Mother's education		0.021 (0.013)	0.023 (0.013)	0.025* (0.012)
Father's education		0.014 (0.016)	0.013 (0.017)	0.017 (0.017)
Index of home support		0.218 (0.175)	0.217 (0.169)	0.198 (0.141)
Teacher's participation		-0.362 (0.819)	-0.385 (0.850)	-0.400 (0.841)
Wealth index		-2.616*** (0.319)	-2.541*** (0.331)	-2.445*** (0.406)
Caring for others				-0.035 (0.115)
Hours per day domestic task				0.089* (0.041)
Task on family farm/business				0.000 (0.000)
Paid work outside household				-0.373*** (0.109)
Hours in School				-0.109 (0.076)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Studied outside school hours				-0.057
				(0.100)
Parents aspire			-0.014	-0.015
			(0.012)	(0.013)
Constant	-0.067**	1.884***	2.018***	2.884***
	(0.027)	(0.494)	(0.455)	(0.531)
Observations	144	140	137	137
R-squared	0.431	0.511	0.514	0.525

Notes: Robust standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$   
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A3.2 (Panel B)—Telugu medium of instruction effect: (9 year olds, rural)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	-0.081 (0.074)	0.122 (0.085)	0.115 (0.086)	0.144* (0.077)
MScoreL1	0.614*** (0.038)	0.565*** (0.034)	0.565*** (0.040)	0.564*** (0.040)
Male		-0.033 (0.063)	-0.003 (0.063)	-0.007 (0.066)
Scheduled Caste		-0.344*** (0.095)	-0.356*** (0.097)	-0.354*** (0.097)
Scheduled Tribe		-0.230 (0.137)	-0.248* (0.136)	-0.264* (0.139)
Backward Caste		-0.144* (0.075)	-0.150* (0.078)	-0.159* (0.081)
Mother's education		0.005 (0.004)	0.005 (0.004)	0.005 (0.004)
Father's education		0.001 (0.004)	0.002 (0.004)	0.001 (0.004)
Index of home support		0.075 (0.120)	0.073 (0.113)	0.080 (0.113)
Teacher's participation		0.821*** (0.181)	0.891*** (0.188)	0.876*** (0.206)
Wealth index		0.640** (0.260)	0.687** (0.254)	0.665** (0.234)
Caring for others				-0.103 (0.065)
Hours per day domestic task				-0.013 (0.047)
Task on family farm/business				-0.192 (0.341)
Paid work outside household				0.078 (0.199)
Hours in School				-0.033 (0.042)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	Mscore	Mscore	Mscore	Mscore
Studied outside school hours				0.081***
				(0.024)
Parents aspire			-0.019**	-0.023***
			(0.008)	(0.008)
Constant	0.051	-0.848***	-0.684**	-0.510
	(0.065)	(0.224)	(0.245)	(0.420)
Observations	712	685	677	677
R-squared	0.518	0.551	0.557	0.567

Notes: Robust standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$   
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A4—Telugu medium of instruction effect: (8 year olds)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	-0.059	0.170	0.197*	0.220**
	(0.106)	(0.105)	(0.106)	(0.105)
MScoreL1	0.287***	0.240***	0.221***	0.207***
	(0.039)	(0.038)	(0.041)	(0.043)
Male		0.066	0.003	0.031
		(0.049)	(0.048)	(0.055)
Scheduled Caste		-0.183	-0.181	-0.172
		(0.116)	(0.120)	(0.117)
Scheduled Tribe		0.040	0.085	0.059
		(0.187)	(0.189)	(0.185)
Backward Caste		-0.109	-0.100	-0.113
		(0.101)	(0.102)	(0.102)
Mother's education		0.012	0.012	0.012
		(0.008)	(0.008)	(0.008)
Father's education		-0.000	-0.002	-0.002
		(0.005)	(0.005)	(0.005)
Index of home support		0.015	0.019	0.024
		(0.119)	(0.115)	(0.118)
Teacher's participation		1.159**	1.125**	1.100**
		(0.447)	(0.462)	(0.481)
Wealth index		1.446***	1.309***	1.238***
		(0.221)	(0.230)	(0.236)
Caring for others				0.090
				(0.072)
Hours per day domestic task				0.054
				(0.057)
Task on family farm/business				-0.087
				(0.210)
Paid work outside household				-0.018
				(0.094)
Hours in School				0.112**
				(0.050)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	Mscore	Mscore	Mscore	Mscore
Studied outside school hours				0.083**
				(0.031)
Parents aspire			0.047***	0.041***
			(0.009)	(0.008)
Constant	0.049	-1.622***	-2.104***	-3.066***
	(0.084)	(0.330)	(0.334)	(0.520)
Observations	853	823	812	812
R-squared	0.258	0.323	0.342	0.355

Notes: Robust standard errors in parentheses. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01  
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A4.1 (Panel A)—Telugu medium of instruction effect: (8 year olds, urban)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	−0.032 (0.288)	0.158 (0.213)	0.167 (0.227)	0.180 (0.242)
MScoreL1	0.181** (0.069)	0.116 (0.066)	0.107 (0.068)	0.103 (0.072)
Male		−0.100 (0.077)	−0.138* (0.072)	−0.147* (0.075)
Scheduled Caste		−0.141 (0.208)	−0.168 (0.194)	−0.195 (0.194)
Scheduled Tribe		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Backward Caste		−0.372*** (0.097)	−0.370*** (0.084)	−0.370*** (0.094)
Mother's education		0.017 (0.010)	0.013 (0.010)	0.011 (0.010)
Father's education		0.040** (0.016)	0.038** (0.015)	0.037* (0.018)
Index of home support		−0.224 (0.201)	−0.211 (0.221)	−0.189 (0.249)
Teacher's participation		0.831 (0.775)	0.682 (0.790)	0.695 (0.934)
Wealth index		1.609 (0.938)	1.453 (0.886)	1.266 (1.023)
Caring for others				−0.044 (0.119)
Hours per day domestic task				−0.054 (0.178)
Task on family farm/business				0.000 (0.000)
Paid work outside household				−0.295 (0.162)
Hours in School				0.058 (0.084)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Studied outside school hours				0.045
				(0.101)
Parents aspire			0.036**	0.037**
			(0.013)	(0.013)
Constant	0.093	-1.737*	-1.979*	-2.384*
	(0.110)	(0.925)	(0.984)	(1.259)
Observations	144	140	137	137
R-squared	0.109	0.290	0.303	0.310

Notes: Robust standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$   
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.

Table A4.2 (Panel B)—Telugu medium of instruction effect: (8 year olds, rural)

Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Medium of Instruction	-0.072 (0.101)	0.176* (0.101)	0.206* (0.106)	0.214* (0.106)
MScoreL1	0.305*** (0.042)	0.265*** (0.039)	0.243*** (0.043)	0.227*** (0.047)
Male		0.067 (0.057)	-0.005 (0.056)	0.026 (0.065)
Scheduled Caste		-0.153 (0.142)	-0.151 (0.148)	-0.140 (0.144)
Scheduled Tribe		0.067 (0.207)	0.112 (0.210)	0.086 (0.205)
Backward Caste		-0.059 (0.127)	-0.055 (0.130)	-0.067 (0.129)
Mother's education		0.011 (0.009)	0.010 (0.009)	0.011 (0.009)
Father's education		-0.004 (0.005)	-0.005 (0.005)	-0.005 (0.005)
Index of home support		0.006 (0.152)	0.014 (0.145)	0.021 (0.150)
Teacher's participation		1.257** (0.515)	1.244** (0.525)	1.193** (0.547)
Wealth index		1.444*** (0.232)	1.310*** (0.250)	1.243*** (0.257)
Caring for others				0.097 (0.079)
Hours per day domestic task				0.066 (0.063)
Task on family farm/business				-0.094 (0.211)
Paid work outside household				0.027 (0.117)
Hours in School				0.106* (0.058)

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Variables	(1)	(2)	(3)	(4)
	a4	a3	a2	a1
	MScore	MScore	MScore	MScore
Studied outside school hours				0.088** (0.031)
Parents aspire			0.048*** (0.011)	0.041*** (0.009)
Constant	0.057 (0.088)	-1.641*** (0.366)	-2.156*** (0.373)	-3.057*** (0.607)
Observations	709	683	675	675
R-squared	0.281	0.343	0.363	0.376

Notes: Robust standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$   
Standard errors clustered at Sub-district (Mandal) level. Mandal fixed effects included in all regressions.







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