Crime and Basic Skills

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Abstract
The crime-reducing impact of education has been widely documented. However, much less is known about the impact of basic cognitive and non-cognitive skills developed in primary school on youth crime. This paper studies the impact of basic literacy and numeracy skills on education achievement and criminality. It exploits two primary school programmes introduced into English schools, the literacy hour and the numeracy hour programmes, to study whether changing the structure and content of teaching can enhance literacy and numeracy skills in childhood, and if these in turn can act as tools to reduce youth crime. Our results show a significant impact of the literacy hour for males and the numeracy hour for females, as males exposed to the former initiative and females exposed to the latter appear more likely to achieve a high-stake certificate at the end of secondary school and less likely to commit youth crime. This suggests that public policy aimed at changing the content and structure of teaching and boosting relatively poor skills can raise pupil achievement and life chances in a lasting manner.

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1. Introduction

Education is an important means of crime prevention. Construction of human capital, improved labour market prospects and reduced day-to-day possibility to commit crime during adolescence are some of the channels behind the crime-reducing effect of education. Increased school attendance can reduce crime, particularly for males, both in the short run (Jacob and Lefgren, 2003; Luallen, 2006), and in the medium and long run (Lochner and Moretti 2004; Machin et al., 2011; Anderson, 2014; Gilpin and Pennig, 2015; Hjalmarsson et al., 2015; Bell et al., 2022).

Despite the large existing literature on the crime-reducing role of education, much less is known about the crime-reducing impact of the set of basic cognitive and non-cognitive skills developed in the early years and in primary school. Cognitive and non-cognitive skills developed in early years can determine student achievement and other outcomes in adolescence (see, e.g., Cunha et al., 2006, Almond and Currie, 2011; and Heckman et al., 2013). Even in OECD countries, where a growing fraction of population holds a university degree, basic skills in literacy and numeracy are essential for success in the labour market and the wage return for basic skills appears sufficiently large to indicate that basic skills are relatively scarce and in high demand (Cherry and Vignoles, 2020). In all OECD countries, individuals with lower literacy skills are much more likely than those with better skills to report poor health, to view themselves as objects and not actors in the political process, and to have less trust in others (OECD, 2016).

While basic skills have been shown to have a pervasive effect on many aspects of people's lives, very little is known about the importance of primary school. Moreover, relatively little is understood about the potential link between basic skills and crime. Relatively few studies exist on the impact of basic skills on crime and very few that assess the link between early years interventions and juvenile crime. This appears especially relevant in contexts where the lower

tail of the adult literacy and numeracy skills distribution is particularly pronounced, such as in the UK and the US, and where victims and perpetrators concentrate heavily in youth - as is the case for violent crime in the UK.

This paper evaluates the crime-reducing effects of the Literacy and Numeracy Hour programmes, which were highly structured literacy and numeracy hours, respectively, introduced to English primary schools in the 1990s. These policies aimed to raise the poor standards of English teaching and to improve the literacy and numeracy standards of primary school children. The Literacy Hour was first introduced in 268 inner-city primary schools (ending at age 11) in two waves, beginning in September 1996 and September 1997 in the context of the National Literacy Project (NLP). Most Local Education Authorities (LEAs), though not all, were selected to participate in the NLP where perceived pupil performance was generally low, and then schools were selected within them.[1]

Similarly, the Numeracy Hour was introduced in three waves from September 1996 to September 1999 into 468 inner-city primary schools, through an initiative known as the National Numeracy Project (NNP). Subsequently, the Literacy and Numeracy Hour programmes were rolled-out nationally to all English schools, through the National Literacy and Numeracy Strategies (NLS and NNS). Although the common background to these initiatives was concerns about poor standards of literacy and numeracy in English schools, there was very little geographic overlap regarding where these policies were implemented.

In our analysis, as children in some schools were exposed to the Literacy and Numeracy Hour programmes in years when children in similar schools were not, the spatial variation in

[1] There are 150 Local Education Authorities in England. They are responsible for the strategic management of local authority education services including planning the supply of school places, ensuring every child has access to a suitable school place, intervening where a school is failing its pupils and for allocating funding to schools.

the timing of exposure to these programmes is exploited empirically and a set of difference-in-differences specifications is defined to quantify the causal impact of the Literacy and Numeracy hour programmes on the educational and criminal trajectories of juveniles in England. These initiatives placed a much more rigid and structured form on the curriculum for English teaching than what was previously in place.[2] Since the policies occurred in the mid-1990s, they were very early policy interventions in the UK education system that has been characterized by a whole host of education reforms in later years (see Machin and Vignoles, 2005). Their early introduction is important since our estimates are not therefore contaminated by other policy interventions that may have occurred at the same time.

Looking at whether the content of teaching (i.e. what is taught) and the pedagogy of teaching (how it is taught) matter for student achievement and criminality is an important, policy relevant question. For a policymaker interested in devising interventions that genuinely improve basic skills, the parameters estimated here are of direct interest. To this end, this study uses individual-level administrative data matching education and criminal records from the UK Department for Education (DfE) and the UK Ministry of Justice (MoJ) from 2002-18 for the entire population of students sitting end-of-primary-school exams in England in the school years 1996/7 to 1998/9. Long-run consequences of the literacy and numeracy hour can be studied because the DfE-MoJ data follow children who were exposed to these initiatives until young adulthood and it tracks their entire educational and criminal trajectories until then.

In the empirical analysis, a set of difference-in-differences (DiD) specifications is defined to estimate the causal impact of the literacy and numeracy hour programmes, respectively, on reading and English achievement and math achievement of pupils in schools

[2] See West and Pennell (2003) for a discussion of these low levels of achievement.

affected by the policy relative to that in an unaffected, observationally similar control group of schools. Our DiD specifications exploit the fact that some children were first exposed to the literacy and numeracy hour for one or two school-years in 1997/8 and 1998/9 while other children were not. Our data enable us to conduct placebo tests in the pre-policy period to ensure that pupils in schools affected by the policy were not exhibiting different trends in student performance nor crime before the policy was implemented. [3]

Our results indicate that the literacy hour programme improved reading test scores at the end of primary school by 10.3% of a standard deviation for all pupils and by 13.3% of a standard deviation for males. In contrast, the numeracy hour programme improved math test scores at the end of primary school by 9% of a standard deviation. Separate analysis by gender reveals that achievement gains were concentrated among females in this case, since the numeracy hour programme improved math test scores at the end of primary school by 11.6% for treated females. Evidence of achievement gains in math exams from the numeracy hour appears also for males, but not as large as those arising from the literacy hour for reading test scores, where males notoriously lag behind females.

Analysis of student performance in the General Certificate of Secondary Education (GCSE) Exams, i.e., high-stakes end-of-secondary-school exams, reveals that the literacy hour programme reduced by 26.7% the likelihood of males leaving secondary school without a certificate and it increased their likelihood to achieve at least 5 A*-C grades in GCSE exams by nearly 6.5%. The numeracy hour, instead, did not affect the likelihood of females leaving

[3] An array of additional tests for differential pre-trends between treatment and control group schools have been conducted. For all Key Stage 2 test scores and crime outcomes of interest, treatment and control group students appear on to be on (short term) parallel trends prior to the introduction of these school reforms. However, these results cannot be yet made public and presented here because we have not yet received publication clearance from the UK's DfE and MoJ, i.e., the data owners.

secondary school without a certificate, but it increased their likelihood to achieve at least 5 A*-C grades in GCSE exams by nearly 5%. This is a key target for GCSE takers in England and it is widely regarded by employers and educators.[4]

Analysis of post-16 educational and criminal outcomes of individuals reveals that the literacy hour increased the likelihood of enrolment in Advanced level qualifications (known as A-levels), which are post-16 non-compulsory subject-based qualifications that generally lead to university. Therefore, A-levels enrolment in England is important as it has obvious implications for university enrolment. Overall, pupils exposed to the literacy hour programme were 7.13% more likely to enrol in A-levels. When looking at males only, effects appear larger as males exposed to the literacy hour were 17.4% more likely to enrol in A-levels. In contrast, exposure to the numeracy hour did not affect the likelihood to enrol in A-levels. This conclusion echoes the findings in Aucejo and James (2021) who show that literacy skills play a critical role in determining access to college. In this study, literacy skills seem to play a significantly greater role in explaining A-levels enrolment than math skills.

Results also show that pupils exposed to the literacy hour programme committed 62% fewer violent crimes at age 10-28, with the result being driven by males, while females exposed to the numeracy hour programme committed 37% fewer property crimes at age 10-28. Therefore, while the crime-reducing effect of the literacy hour programme is driven by a reduction in violence among males, the crime-reducing effect of the numeracy hour is driven by a reduction in property crime offences by females. Separate analysis by age reveals that the reduction in violence among males induced by the literacy hour started at age 18, whereas no crime reduction appears visible during adolescence. This result, combined with the greater

[4] Machin, McNally and Ruiz-Valenzuela (2020) show the effect of marginally missing a C grade in GCSE exams.

likelihood of pupils exposed to the Literacy Hour to enrol in A levels, suggests that a key mechanism through which the literacy hour reduced violent crime was by boosting skills that in turn allowed pupils to fare better in secondary school and to be eligible to pursue graduate studies or to get a job.

In contrast, analysis of the crime-reducing effect of the numeracy hour by age reveals that the reduction in property crime among females induced by the numeracy hour started at age 14-15. This result, combined with the lack of effects of the numeracy hour on A levels' enrolment, suggests that the mechanism through which the numeracy hour reduced property crime among females was not by boosting skills that in turn led pupils to enrol at university or to get a job. In this case, results suggest that the numeracy hour boosted a relatively weak set of skills for females (as they were doing slightly worse than males prior to the policy in England) at the end of primary school, which in turn led these pupils to reduce criminal activity during adolescence and to get better grades by the end of secondary school. While this then translated in a lasting reduction in the propensity to offend that appears visible until age 28, when our study terminates, it did not translate into higher rates of enrolment in A levels.

To our knowledge, this is among the first studies of whether a policy of this type actually works in tackling youth violence. In previous work, Machin and McNally (2008) documented the short run impact of the literacy hour initiative on student test scores in Key-Stage 2 exams at the end of primary school. This study confirms their findings for Key-Stage 2 exams and it expands the analysis to the numeracy hour programme and the long-run effects of both the literacy hour and the numeracy hour programmes.

Finally, both policies seem to be successful in that they were not expensive to implement and thus highly cost effective. Hence, when one considers this kind of policies against other,

much more expensive, alternatives – like class size reductions and raising teacher salaries – one sees that the literacy and numeracy hour fare really well. Of course, one should realise that their success rests on improving skills at the lower end of the achievement distribution and getting children to basic levels. On this basis, they seem to be highly successful and desirable policies.

The rest of the paper is structured as follows. Section 2 reviews the existing literature of relevance, seeking to highlight that the link between basic skills and criminality is remarkably understudied. Section 3 discusses the introduction of the literacy hour and the numeracy hour, as well as the way in which schools were selected. Section 4 describes the nature of testing in English schools, our data, some statistics at baseline and our research design. Section 5 provides causal estimates of the effects of the literacy and numeracy hour programmes on our outcomes of interest and it also tests some hypothesized mechanisms behind our results. Section 6 tests the cost effectiveness of the policy. Section 7 concludes.

2. Related Literature

Although many early childhood development programmes have been studied rigorously, there are very few in which the crime dimension has been considered, and are mainly small scaled and/or preschool programmes. Furthermore, behavioural outcomes are usually self-reported. The Perry Preschool Programme, for example, is considered a successful early childhood intervention targeting disadvantaged, low IQ African-American children aged three to four in the US. Thanks to its long-term follow-up, this programme has been shown to improve wages, education, marriage and health in adulthood. It is also one of the few early childhood initiatives in which crime outcomes were studied. The programme reduced crime and social isolation for

both adult men and women (Belfield et al., 2006; Heckman et al., 2010; and Conti et al., 2013). Rather than long run gains in IQ, the gains in non-cognitive skills induced by participation in the programme lies behind this boost to later life outcomes (Heckman et al., 2013).

The Carolina Abecedarian Project (ABC programme) is another well-studied early childhood education programme with long term follow-up. The ABC programme is a social experiment conducted in North Carolina on four cohorts of disadvantaged children born in 1972-77. The ABC programme studied the effect of stimulating early childhood environment for the prevention of the development of mild mental retardation in disadvantaged children. This intervention has improved adult health and other youth outcomes by boosting both cognitive and non-cognitive capacities of participants (Griffin et al., 2013; Campbell et al., 2014; and Conti et al., 2013). However, there are no conclusive estimates of the effect of this programme on crime. Walker et al. (2011) study a psychosocial stimulation programme in Jamaica for growth retarded children aged 9 to 24 months in a 2-year trial (weekly play sessions to improve mother-child interaction). They found reductions in self-reported violence, crime participation and carry of weapons at age 22. All these small-scale studies tracked individuals over time.

This study also contributes to the literature that studies how best to raise pupil achievement. Perhaps starting with Card and Krueger (1992), Angrist and Lavy (1999) and Hanushek (1997, 2003), many papers have studied in recent years the impact of changing school resources such as class size, teacher quality and measures of expenditure. Educationalists address many of the same issues, but also investigate the efficacy of what is taught in particular subjects and how this is put across in the classroom in terms of such issues as time on task, frequency of

monitoring pupils' work and grouping arrangements.[5] In contrast, very few papers in economics look at how subjects are taught. Exceptions are Angrist and Lavy (2002) that study the role of Computer Aided Instruction, Glewwe et al. (2000) that study the impact of flip charts in Kenyan classrooms, Angrist and Lavy (2001) that study the effect of in-service teacher training on achievement in Jerusalem elementary schools, and Rouse and Krueger (2004) that show the effect of an instructional computer program designed to improve literacy.

This gap appears especially noticeable given the policy relevance of this question and how research on reading appears to have influenced public policy (see, e.g., how research findings have been used in the US as a rationale for the reading component of the No Child Left Behind Act of 2001). As discussed by Beard (2000), this research, as well as the experience of 'Success for All' in the US (Slavin and Madden, 2000, 2003), has been influential in the development of a national policy on literacy in England (the National Literacy Strategy).

This study also contributes to the large existing literature that shows the importance of early childhood conditions in shaping skills, determining human capital development, and in turn defining later life outcomes of individuals. High-quality early childhood circumstances matter for an array of long-term outcomes (Knudsen et al., 2006; Heckman, 2008; and Heckman et al., 2013), and attributes developed in early years determine a large fraction of the variability in lifetime earnings across individuals (e.g., Cunha et al., 2006). Evidence also exists of discrepancy in cognitive and non-cognitive skills as early as prior to the beginning of school (Carneiro and Heckman, 2003; Cunha et al., 2006; and Cunha and Heckman, 2007). Family

[5] See the reviews by Sammons (1999) or Teddlie and Reynolds (2000) on educational research on school effectiveness, or Stainthorp (1996) for a review of evidence on what children need to learn to become skilled readers, and Scheerens (2000) and Creemers (1994) on classroom instruction.

investment appears crucial for this early divergence, as marked differences in the development of skills appear since early childhood across different socio-economic backgrounds (see, e.g., Hart and Risley, 1995; Lareau, 2011; Fernald et al., 2013; Kalil, 2013; and Moon, 2014).

Finally, this study contributes to the literature that evaluates the effectiveness of several early childhood interventions designed to bridge these gaps and the resulting discrepancies in early skills development. These include programmes focused on children in their early years and aimed to reduce violent and anti-social behaviours, as well as early family and parenting programmes seeking to provide families and parents with training and skills that help them better attend to the physical, mental, and social skills of their children. These types of programmes often focus on methods of instruction to strengthen the parent's competencies in monitoring and disciplining their child's behaviour and promoting the child's social and emotional competence. Programmes also include parental trainings to use positive and nonviolent techniques to handle children's behaviour (Piquero et al., 2016). The lessons from these studies are that early childhood programmes can boost cognitive development in lasting ways, they are more effective than interventions during adolescence, and they are most effective when mentoring and scaffolding are involved (Heckman and Mosso, 2014).

3. English Primary Schools, the Literacy Hour and the Numeracy Hour

3.1. The Literacy Hour

Following much discussion about poor standards of English teaching, the literacy hour was introduced into all English primary schools during the school year 1998/99 in the context of the National Literacy Strategy. The national policy was based on the perceived success of the National Literacy Project (NLP), which was introduced to a sub-set of schools in certain Local

Education Authorities (LEAs) in September 1996. The NLP policy was not envisaged as a pilot at the time, and indeed was introduced by a different political administration to that which launched the national strategy.

The policy was introduced in a context in which there was considerable pressure on all schools to improve due to monitoring and accountability measures introduced in the early 1990s. For example, from 1995/96 onwards, primary school examination results were published in School Performance Tables. From 1993/94 a system of school inspections was implemented, whereby the regulatory body (OfSTED, the Office for Standards in Education) would inspect each school at four-year intervals and make reports publicly available. If OfSTED gave a very poor evaluation of school performance, the school could be put on 'special measures' and ultimately shut down.[6]

The literacy hour is firmly based upon criteria aimed at improving standards of literacy highlighted in the National Curriculum that was introduced to schools in 1988. This sets out details of what must be taught, the standards that should be achieved at different stages of the education sequence and recommends a minimum teaching time for core subjects. The National Literacy Strategy, and the National Literacy Project before it, was aimed at raising standards of literacy in primary schools by improving the quality of teaching through more focused literacy instruction and effective classroom management. It can also be seen as an attempt to improve school management of literacy through target-setting linked to systematic planning and monitoring and evaluation.

[6] Parents could also act on a poor OfSTED inspection or a low ranking in the School Performance Tables by applying to admit their child to another school (and there are no restrictions on state schools to which they can apply, although criteria such as proximity to school are applied if there is over-subscription). Such 'voting with feet' materially affects schools since funding is tied closely to pupil numbers.

Key components of the policy are a framework for teaching, which sets out termly teaching objectives for the 5–11 age range and provides a practical structure of time and class management for a daily literacy hour.[7] With regard to the former, a range of texts are specified and teaching objectives are set out at three levels (text, sentence and word) to match the text types studied. The daily literacy hour is divided between 10–15 minutes of whole-class reading or writing; 10–15 minutes whole-class session on word work (phonics, spelling and vocabulary) and sentence work (grammar and punctuation); 25–30 minutes of directed group activities (on aspects of writing or reading); and a plenary session at the end for pupils to revisit the objectives of the lesson, reflect on what they have learnt and on what they need to do next.

Beard (2000) discusses how the literacy hour relates to findings from educational research. Of particular relevance are 'structured teaching' (e.g. making clear what has to be learnt; dividing material into manageable units; teaching in a well-considered sequence) and 'effective learning time' (e.g. as reported by Scheerens (1992) in his meta-analysis). Beard (2000) also notes that the literacy hour has been influenced by literacy schemes in the US and in Australia. Stannard and Huxford (2007) discuss the background to the 'literacy hour' and its content at length.

3.2. Did the Literacy Hour Change Teaching Practices?

Whilst the literacy hour introduction constituted a discrete, well-defined and systematic change in the teaching of literacy in primary schools, one might ask to what extent the quality of English teaching was sub-standard prior to its introduction. The general standard of reading and writing was clearly a serious concern, particularly in some LEAs.[8] For example, an

[7] In this paper, we refer to this set of measures as 'the literacy hour'.

[8] Indeed, John Stannard, the Director of the National Literacy Project, told us that 'in some LEAs teaching of literacy had fallen apart'. The person in charge of introducing NLP in Tower Hamlets LEA in East London was

OfSTED report about the teaching of reading in Inner London primary schools included criticism of the following practices: free reading with little or no intervention by the teacher; too much time spent hearing individual pupils read; insufficient attention to the systematic teaching of an effective programme of phonic knowledge and skills (OfSTED, 1996).

It was thought that standards in the teaching of reading varied widely from school to school, with many primary teachers not having had the opportunity to update their skills to take account of evidence about effective methods of teaching reading and how to apply them (Literacy Task Force, 1997a).[9] Stannard and Huxford (2007) provide similar insights into the nature of teaching before the 'literacy hour', and particularly stress the lack of whole-class teaching. They also note evidence from the School Curriculum and Assessment Authority and the Schools Inspectorate (OfSTED) estimating that schools allocated between 22 and 25% of their time to the teaching of English; but in a class of 30, this might only amount to direct teaching time (per pupil) of 3–5 minutes per week.

A daily hour of continuous teaching time devoted to literacy with carefully planned content and a clear structure was a radical departure from what went before. It represents a change in how literacy skills are taught rather than an increase in the time devoted to English.[10] Stannard and Huxford (2007) argue that a revolutionary feature of the NLP was its focus on intervening at the level of classroom instruction because prior to that, English policy makers had stressed that teachers should always take the lead on this.

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equally downbeat saying, prior to NLP, teachers used to 'hear' reading rather than 'teach' it and noted that there was a lot of 'quiet reading time'.

[9] These concerns about reading in particular prompt us to consider the impact of the NLP on reading in specifically, as well as on overall performance in English.

[10] Also, according to Stannard and Huxford (2007), the decision to recommend 1 hour per day was based on the working assumptions underpinning the balance of time for English in the National Curriculum.

In schools that were selected for the NLP, the programme was introduced to school staff through attendance at an induction day on Management of Literacy by the Headmaster and Chair of Governors, and a training week for designated key teachers, including English coordinators. There was also one school inset day devoted to NLP issues. There were conferences in each LEA for head teachers and a representative of the governing body. Thus, the NLP was a fairly low-cost policy to implement.

The Schools Inspectorate (OfSTED, 1998) evaluated the NLP by visiting 20% of the schools involved. Three visiting were made: two in 1997 during the spring and the autumn terms and the final one in the summer term of 1998. Over 300 literacy hours were observed and discussions were held with head teachers and staff, including the key teachers. The report says that the impact of the literacy hour on the quality of teaching, and on pupils' attitudes and interest in reading and writing was very positive. It says that the NLP brought about significant improvements in the quality of teaching and has been the important catalyst in raising standards of literacy in the large majority of schools.

3.3. The National Literacy Project

The National Literacy Project (NLP) was introduced in about 400 schools during the school years 1996/97 and 1997/98.[11] The Office for Standards in Education (which published the above cited report about the teaching of literacy in inner city London) approached the then Secretary of State for Education to adopt the policy within Local Education Authorities (LEAs) where educational standards were low. However, not all such LEAs were selected into the NLP. From a research design perspective, the NLP gives a setting where some children were exposed

[11] The NLP was also launched in an additional 112 ‘first’ or infant schools, which we do not consider here because the treatment group in this case does not correspond to the same birth cohort. These schools cater for children up to between the age of 7 and 10 (depending on the school). The majority of children in England (over 80%) attend primary schools that cater for children up to and including the Key Stage 2 assessment at age 11.

to the literacy hour for one school-year when children in similar schools were not, allowing us to define a set of difference-in-differences (DiD) specifications and retrieve the causal impact of its introduction on the school and crime trajectories of children exposed to it.

The selection of NLP schools occurred via a two-stage process. First, some LEAs were selected to participate, and second some schools within LEAs were chosen. At the first stage, the LEAs chosen were, in the main part, those perceived to have lowest pupil performance. In reality, this turns out to be somewhat mixed, with a range of LEAs being chosen. Most, but clearly not all, are from the lower end of the national achievement distribution, and some LEAs with below average levels were not included. According to the Director of the National Literacy Project, the LEAs chosen for the NLP were selected (fairly arbitrarily) from a longer list.

It turns out that about 80% of NLP schools were located in LEAs in inner city, urban areas.[12] This is where the most disadvantaged and poorly performing schools in England are concentrated (West and Pennell, 2003). Collectively, about 40% of primary schools within these LEAs were involved in the NLP. The remaining NLP schools were in eight LEAs in three counties.[13] Only about 7% of primary schools in these counties were involved in the NLP. Since the policy was more actively promoted in the former areas (and partly for methodological reasons)[14], we focus our analysis on the effect of the NLP in urban schools. In the context of debate about poorly performing inner city schools in the UK, it is entirely appropriate to focus on schools in these areas.[15]

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[12] Specifically, these inner city schools are located within several LEAs in London and also Sandwell, Liverpool, Manchester, Sheffield, Newcastle and Bristol

[13] The three counties are Hampshire, Essex and Norfolk. The precise LEAs are as follows: Hampshire, Portsmouth, Southampton, Essex, Southend-on-Sea, Thurrock, Isle of Wight, Norfolk.

[14] It is easier to define a suitable control group for schools in urban areas (as discussed below).

[15] However, we note that the intervention seems to have been ineffective for the small number of treatment schools located in these rural areas. This could be as a result of genuine heterogeneity in the effect of the policy or (in our view more plausibly) because the implementation might have been weaker in these areas.

In terms of which schools were selected within LEAs, advice was given to choose schools most in need of the programme, but to achieve some balance between schools that were perceived to be low achieving and those with ongoing problems (e.g. poor leadership) and low achieving schools showing some signs of improvement.[16] However, since the NLP was planned to last 5 years, a rolling programme was envisaged wherein schools would enter the programme in different waves. The planned cost of the NLP was £12.5 million over five years.

3.4 The Numeracy Hour

After nearly ten years of discussion about what mathematics should be taught, in the late 1990s a public belief spread in England that the math skills too of English children were unsatisfactory and so was, therefore, the way mathematics was being taught in primary schools. Teaching methods started to be progressively questioned and the content of mathematics teaching started to receive public attention. In particular, OFSTED started to raise concerns over the excessive reliance on individualization and the insufficient dosage of whole-class teaching (Jones, 2002). The relatively poor achievement of English pupils in international studies of mathematical attainment (Keys, Harris and Fernandes, 1996; Reynolds and Farrell, 1996) also spurred the common belief that the mathematics of English children was not good enough and that some teaching approaches were not appropriate.

In 1996, the then Secretary of State for Education, Gillian Shephard, announced parallel national literacy and numeracy projects which would involve poorly performing LEAs in England. The National Numeracy Project (NNP) started in the autumn of 1996. By the end of 1998 ‘there were approximately 750 schools, 7000 teachers and 180,000 children taking part’ (Straker, 1999: 39). The heart of this programme was a daily ‘numeracy hour’ to be taught in

[16] John Stannard, Director of the National Literacy Project 1996-98, personal communication.

primary schools. As part of this initiative, head-teachers, mathematics co-ordinators and classroom teachers received a highly structured training that provided familiarization with the Framework for Teaching Mathematics from Reception to Year 6 (DfEE,1999), a detailed planning document that set out what mathematics should be taught on a termly basis from Reception to Year 6 (and that then became the key planning document for mathematics in most English primary schools). The planned cost per pupil of this initiative was approximately £18 (in 1997 GBP prices).[17]

Like the literacy hour, the numeracy hour programme was intended to improve the quality of teaching through greater focus in instruction and greater effectiveness in classroom management. It was supported by a framework for teaching, which defines termly objectives for the 5-11 age range and sets out a practical structure of time and class management. The framework document for the 'numeracy hour' included a booklet of exemplar lessons and training on strategies to teach mental calculation. Mental calculation was in fact a key ingredient of the numeracy programme and was deemed to lie at the heart of the programme, while the use of calculators in school was significantly restricted. To this end, the numeracy hour itself included a three-part template for daily mathematics lessons, starting with 10-15 minutes of oral/mental arithmetic practice, then direct interactive teaching of entire classes and groups, and in the end 10 minutes of plenary review. Thus, the numeracy hour did not constitute an increase in the overall time devoted to teaching numeracy subjects, but rather a significant change in how these subjects were taught.

The goal of the numeracy hour was to increase the share of pupils who met the standard expected at age 11 in mathematics from 55% to 75% from 1996 to 2002. These targets were

[17] See Section 4 of the Preliminary Report by the Numeracy Task Force: https://www.stem.org.uk/resources/elibrary/resource/27877/numeracy-matters-1998.

stressed in the government's Green Paper, Excellent in Schools (DfEE, 1997) which also indicated that all schools needed to introduce a numeracy hour from September 1999. Teacher training began in 1998–9, with the numeracy hour starting officially in all primary schools in September 1999. By September 1999, most English primary teachers had received at least some training targeted at implementing the numeracy hour programme. Key features of this initiative included a systematic and standardized national training programme; detailed planning using a week-by-week schedule (DfEE,1999); an emphasis on calculation, especially mental calculation; and a three-part template for a daily maths lesson (Brown et al., 2000).

4. The English School System, Data and Econometric Approach

4.1. Testing in English primary schools and Outcomes of Interest

Following the introduction of the National Curriculum in 1988, testing throughout the school years has been an important feature of the English school system. Children are administered tests at ages 7, 11, 14 and 16, in what is known as Key Stages 1, 2, 3 and 4. Key Stages 1 and 2 take place in primary school and Key Stages 3 and 4 in secondary school. These national tests are externally set and marked.[18] Key Stages 2 and 4 are particularly 'high stake' tests for schools as results are published in national school Performance Tables.

Since the literacy and numeracy hour programmes were introduced in primary schools, the empirical analysis assesses their impact on the Key Stage 2 tests that children take at the end of primary school; on the Key Stage 4 tests (i.e., GCSE tests) that youth take at the end of secondary schooling when they are aged 16; on enrolment into A-levels, which is a non-compulsory qualification-based phase of education where youth enrol to prepare for university;

[18] Key Stage 4 exams are also known as the General Certificate of Secondary Education (GCSE) exams.

and on crime at age 10-28, i.e., from the age of criminal responsibility in England to the last year in which our data allow us to follow individuals. This is a relevant age to study, as the risk of offending is highest on average during young adulthood (Quetelet, 1831).

4.2. Data

The empirical analysis is based on individual-level administrative data matching education and criminal records from the UK Department for Education (DfE) and the UK Ministry of Justice (MoJ) from 2002-18 for the entire population of students sitting end-of-primary-school exams in England in the school years 1996/7 to 1998/9. The DfE data extract contains administrative records of pupil-level achievement and pupil characteristics. The former consists of detailed test score records of students at the end of Key Stage 2 and Key Stage 4. The first available year of national Key Stage 2 data at pupil level is in 1995/96, which corresponds to the school year before the National Literacy Project and the National Numeracy Project were introduced, while the first available year of national Key Stage 4 data at pupil level is in 2001/02. Since pupils sit Key Stage 4 exams five years after sitting Key Stage 2 exams, this implies that Key Stage 4 data are not actually available for the 1995/96 cohort of Key Stage 2 takers (i.e., who took Key Stage 4 exams in 2000/01).

The literacy hour was first introduced in 268 inner-city primary schools (ending at age 11) in two waves, beginning in September 1996 and September 1997. Similarly, the numeracy hour was introduced in three waves from September 1996 to September 1999 into 468 inner-city primary schools. Although the common background to these initiatives was concerns about poor standards of literacy and numeracy in English schools, there was very little geographic overlap regarding where these policies were implemented. Consequently, both programmes were rolled-out nationally to all English schools.

The main analysis therefore focuses on schools that implemented the literacy and numeracy hour programmes for the first time in the school year of 1997/8. In the case of the literacy hour, the outcomes of pupils enrolled in these primary schools are compared with those of pupils in schools that did not implement the literacy hour until the school year of 1998/9, when the National Literacy Strategy was introduced nationwide. In the case of the numeracy hour, the outcomes of pupils enrolled in primary schools that adopted the numeracy hour for the first time in the school years of 1997/8 and 1998/9 are compared with those of pupils enrolled in schools that did not implement the numeracy hour until the school year of 1999/2000, when the National Numeracy Strategy was introduced nationwide.

The main analysis uses, for the same pupils, the Key Stage 2 data in the school years of 1995/6 to 1998/9, the Key Stage 4 data in the school years of 2001/2 to 2003/4 and the A-level data in the school years of 2002/3 and 2004/5. Several pupil characteristics are included in the DfE data extract and our analysis uses information on gender of the student, socio-economic deprivation, proxied by Free School Meal eligibility, ethnicity and native language. Information on the precise school of enrolment at all stages of education is also included in the dataset and is used in our analysis.

With regard to outcome measures, the analysis of the short run impact of the literacy and numeracy hour programmes concentrates on two measures at the end of primary school: the standardised reading and math score and the percentile ranking in Key Stage 2 exams. Since the marking scheme can change over time, we convert raw scores to percentile scores and standardisation is done within school-year. The analysis of the long run effects of the literacy and numeracy hour programmes concentrates on three measures at the end of

secondary school: whether a student leaves secondary school with a GCSE record at all or not, whether a student hits the target of at least 5 A*-C GCSE grades and enrolment in A levels.

Finally, information on the criminal records of juveniles in England is extracted from the Ministry of Justice's Police National Computer (PNC). The PNC stores and shares criminal records information across England and Wales. It contains precise information on all the criminal offences committed by an individual. It contains detailed information on the nature of the criminal offence committed, on the date of the offence, as well as on the age of the offender. This information is used in our analysis to define our outcome of interest, namely the count of offences committed by an individual at the age of 10-28. Information on the nature of the offence committed allows us to group crimes into violent crime, which includes violence against the person, sexual offences and public order offences; property crime, which includes robbery, theft, fraud and criminal damage and arson; and drug offences. In all cases, our analysis includes only indictable offences, i.e., serious offences for which the sentence is at least six months' imprisonment.

4.3. Descriptive statistics

Table 1 shows a set of descriptive statistics for pupils in literacy hour schools, numeracy hour schools and pupils in other schools in the school year 1996/7, i.e., one year before the 'literacy hour' and 'numeracy hour' schools implemented the policies. Table 1 shows that, except for the share of males that appears similar in both groups of schools, our outcomes of interest are imbalanced between the treatment and comparison groups. In particular, Table 1 indicates that in 1996/7 pupils in treatment group schools performed significantly worse than the national average in their Key Stage 2 exams, and this appears true for both reading and math. In 2001/2, the same individuals performed significantly worse than the national average

also in their Key Stage 4 exams and committed a significantly higher number of criminal offences at age 10-28.

4.4. Econometric Approach

The econometric analysis defines a set of difference-in-differences (DiD) specifications to retrieve the causal estimates of interest on all individuals observed in a set of matched primary schools that are observed in all cohorts of study. Propensity Score Matching was conducted at baseline on a set of observable characteristics of schools, and only schools on the common support were included in the DiD analysis. Given the non-random nature of the treatment schools, the set of covariates included in the analysis are likely to play an important role here and therefore all our econometric analysis controls for a set of time-invariant binary (0/1) variables that measure the gender of the individual, free school meal eligibility status, white British ethnicity and native speaker status. For pupil *i* enrolled in primary school *s* in school-year *t*, the difference-in-differences specification can be expressed as follows:

$$Y_i = \alpha_s + \alpha_t + \beta_1 * \mathrm{NLP/NNP}_{is} + \beta_2 * Post_{it} + \beta_3 * (\mathrm{NLP/NNP}_{is} * Post_{it}) + \beta_4 \boldsymbol{X_i} + \epsilon_i, \quad (1)$$

where Y_i is the educational or criminal outcome of pupil *i* enrolled in primary school *s* in school-year *t*, α_s is a set of primary school fixed effects and α_t is a set of school-year fixed effects. NLP_{is} is a binary variable that takes value 1 if school *s* implemented the literacy hour in 1997/8 and value 0 if school *s* implemented it in 1998/9, while NNP_{is} is a binary variable that takes value 1 if school *s* implemented the numeracy hour in 1997/8 or 1998/9 and value 0 if school *s* implemented it in 1999/2000. Schools that implemented the literacy or numeracy hour programmes in 1996/7 are excluded from the analysis because long run student achievement outcomes cannot be measured for pupils who sat Key-Stage 2 exams in 1995/6 (and, thus, a pre-period is not available for these schools). $Post_{it}$ is a binary variable that takes

value 1 for individuals who sat their Key-Stage 2 exams starting from 1997/8 and value 0 for individuals who sat their Key-Stage 2 exams in 1996/97. β_3 is therefore the coefficient of interest as it captures exposure to the literacy and numeracy hour and it measures the impact of exposure during primary school to the literacy or numeracy hour on our outcomes of interest. $\boldsymbol{X_i}$ is a vector of time-invariant binary (0/1) variables that measure the gender of the individual, free school meal eligibility status, white British ethnicity and native speaker status, and ϵ_i is the error term. Standard errors are clustered in the entire analysis at the primary school level.[19]

5. The impact of NLP and NNP on Pupil Achievement and Youth Crime

5.1. Impact of the Literacy Hour on Pupil Achievement and Crime

Results are first presented for the literacy hour, and Table 2 shows our first set of results. Here data from the 1995/6, 1996/7 and 1997/8 cohorts of Key Stage 2 (KS2) takers are included in the analysis, with the 1997/8 cohort of KS2 takers being the first and only cohort to be exposed to the literacy hour and the 1995/6 and 1996/7 KS2 cohorts being two cohorts of KS2 takers who sat KS2 exams prior to the introduction of the literacy hour. Panel A of the Table focuses on reading KS2 test scores, Panel B focuses on math KS2 test scores and Panel C focuses on the overall KS2 test scores, computed as the sum of reading and math KS2 test scores.

The "Post x ITT" estimates in Columns (1)-(5) of the Table indicate that the literacy hour programme improved reading test scores at the end of primary school for treated pupils in

[19] In a set of robustness exercises, since treatment was evidently selective on observables, we also compared pupil performance in literacy hour schools with a matched sample of non-literacy hour schools using the Callaway and Sant'Anna (2021) estimator in a difference-in-differences (DiD) framework (see, also, Abadie, 2005), with estimates being derived from the improved doubly-robust DiD estimator based on inverse probability of tilting and weighted least squares suggested in Sant'Anna and Zhao (2020). However, these estimates turned out to be a strong replication of what is reported here.

the 1997/8 cohort of KS2 takers by 10.3% of a standard deviation on average and by 13.3% of a standard deviation for males, while smaller gains appear for females. Columns (3)-(5) also show that no significant difference in KS2 trends appears prior to the introduction of the literacy hour between treatment and control pupils. The "Pre x ITT" coefficient, which captures the evolution in performance in KS2 exams from the 1995/6 to 1996/7 cohort of KS2 takers in treatment schools relative to control schools, is always statistically insignificant and numerically smaller than the "Post x ITT" estimate. Panel B shows that the literacy hour did not affect performance in math KS2 exams, whereas Panel C shows that the overall student performance in KS2 exams improved by 7.5% of a standard deviation on average and by 8.3% of a standard deviation for males as a result of the literacy hour programme.

Columns (6)-(10) are organized in the same way as Columns (1)-(5), but the standardised test scores are replaced by the percentile test scores. The substantive conclusions of our analysis are unchanged. In particular, Panel A indicates that the literacy hour programme improved reading percentile test scores at the end of primary school by nearly 5% for all pupils and by 6.8% for males, with no significant effect for females. Therefore, here the magnitudes of the point estimates appear generally smaller, but the conclusion remains unchanged: while there was no differential pre-trend between treatment and control schools in student performance in KS2 exams, the introduction of the literacy hour boosted student performance in reading KS2 exams, especially those of males, while it left student performance in math exams seemingly unaffected.

Table 3 uses the same sample of pupils to show estimates of the impact of the literacy hour on crime at age 10-28. Columns (1)-(3) show that the literacy hour did not reduce the overall count of crimes committed by pupils exposed to the literacy hour programme. However,

the subsequent columns show that this actually masks substantial heterogeneity in the crime-reducing effect of the literacy hour, as a significant and substantial reduction in the count of violent offences at age 10-28 was in fact caused by the literacy hour. In particular, pupils exposed to the literacy hour committed 62% fewer violent crime offences at age 10-28, with the effect being entirely driven by males. Columns (7)-(12) show no evidence of a crime-reducing effect of the literacy hour for property crime and drug crime. The lack of significance in the estimated "Pre x ITT" coefficients in all columns of the Table provides support to our causal interpretation of the violence-reducing effect of the literacy hour programme.

The longitudinal nature of our data allows us to follow individuals over time and to observe how their criminal behaviour evolved from age 10 to 28. Therefore, Figure 1 attempts to understand when and why the literacy hour reduced violence among pupils exposed to the programme. The Figure displays estimates of the impact of the literacy hour on violent crime *by* age. Therefore, results at each age in Figure 1 indicate the impact of the literacy hour on criminality *by* that age, not *at* that age. If a crime reduction already appeared, e.g., by age 14, then university enrolment would be an unlikely mechanism behind this crime reduction. If, in contrast, a crime reduction only appeared in the late teens/early twenties, then university enrolment would be a potential plausible mechanism behind our results.

The left-hand side diagrams show results for the full sample, while the right-hand side diagrams focus on males. The upper diagrams display results for the count of crimes, while the lower diagrams display results for the risk (0/1) of committing any violent crime by a given age. All diagrams in Figure 1 indicate that the violent crime reduction generated by the literacy hour started at around age 18, whereas no crime reduction appears visible during adolescence. Results are particularly pronounced for males. At age 18, pupils in England are no longer

subject to compulsory school attendance, and therefore the protective factor exerted by school attendance during adolescence disappears. One interpretation of the results in Figure 1 is that the literacy hour boosted literacy skills in males who were then able to stay on at school for longer or to get a job and who, in one case or another, therefore had a higher opportunity cost of committing crime at the end of secondary school.

5.2. Pupil Achievement at the End of Secondary School

In order to dig more into this, Table 4 shows our estimates of the impact of the literacy hour programme on student performance in the high-stakes end-of-secondary-school General Certificate of Secondary Education (GCSE) exams. This analysis includes only pupils from the 1996/7 and 1997/8 cohorts of KS2 takers, because long run student achievement outcomes are not available in our data for the 1995/6 cohort of KS2 takers. Therefore, Panel A replicates our main results for crime by crime category, showing that the reduction in violence generated by the exposure to the literacy hour programme still appears in this subsample of the full dataset. Panel B shows the results of our analysis of student performance in GCSE exams.

Columns (1)-(3) show that the literacy hour reduced by 26.7% the likelihood of males leaving secondary school without a certificate (reported in column (2)), while it left females unaffected. Columns (4)-(6) also show that the literacy hour increased the likelihood to leave secondary school with at least 5 A*-C grades in GCSE exams by 4.16% on average and by 6.5% for males. This is a key target for GCSE takers in England and it is widely regarded by employers and educators. Analysis of post-16 educational outcomes of individuals is reported in columns (7)-(9). Results reveal that the literacy hour increased the likelihood of enrolment in Advanced level qualifications (known as A-levels), thus increasing the chances of treated pupils to enrol at university. Overall, pupils exposed to the literacy hour programme were

7.13% more likely to enrol in A-levels. When focusing on males only, who seem to drive this effect, pupils exposed to the literacy hour were 17.4% more likely to enrol in A-levels compared with control pupils. As written above, this echoes the findings in Aucejo and James (2021) that shows literacy skills to play a key role in determining access to college in the US.

5.3. Pupil Selection in Better Secondary School

Did pupils who were exposed to the literacy hour enrol in better secondary schools, and does this contribute to explain their performance gains at the end of secondary school? Panel C of Table 4 attempts to address this question by modelling as dependent variables some characteristics of the secondary schools of enrolment. In particular, columns (1)-(3) show results when the prior average GCSE test score in the secondary school of enrolment is modelled as dependent variable. If, e.g., pupils exposed to the literacy hour enrolled in *better* secondary schools after being exposed to the literacy hour, a positive link should appear here between the outcome variable and the exposure to the literacy hour programme. This is in fact what is found here. The coefficients displayed in columns (1)-(3) appear statistically significant and numerically large for males, indicating that males exposed to the literacy hour enrolled in secondary schools whose aggregate test scores were 35.3% higher in the year prior to the enrolment of pupil *i*.

Columns (4)-(6) model the prior average permanent exclusion rate in the secondary school of enrolment as dependent variable, while Columns (7)-(9) model the prior average permanent exclusion rate before the January Census in the secondary school of enrolment as dependent variable. This is a period in which potentially strategic exclusions can take place in England in year 11, because pupils excluded from school prior to the January census do not contribute to the aggregate school results. If, e.g., pupils exposed to the literacy hour enrolled

in *stricter* secondary schools after being exposed to the literacy hour, a positive link should appear here between the outcome variable and the exposure to the literacy hour programme. However, this is not what is found here, as none of the estimated coefficients in columns (4)-(9) appear significant nor numerically large.

In sum, these results indicate that the literacy hour programme improved student performance in GCSE exams and likelihood to enrol in A-levels. These results are important as they indicate that boosting skills in primary school can have lasting consequences for the lives of individuals as it can increase their chances to attend university.

5.4. Impact of the Numeracy Hour on Pupil Achievement

What was the impact of the numeracy hour programme? The rest of the empirical analysis focuses on this. Table 5 is organized in the same way as Table 2, but it shows results for the numeracy hour. In this case, since the numeracy hour was not extended to all schools in England until 1999/2000, the cohort of 1998/9 KS2 takers was also added to the analysis. Table 5 columns (1)-(5) show that, unlike the literacy hour, the numeracy hour programme left reading skills unaffected and it improved math test scores at the end of primary school by 9% of a standard deviation on average, by 6.6% of a standard deviation for males and by 11.6% of a standard deviation for females. Columns (6)-(10), where the standardised test scores are replaced by the percentile test scores, lead to the same substantive conclusions. In particular, they indicate that the numeracy hour programme improved math percentile test scores at the end of primary school by 5% on average, by 3.6% for males and by 6.6% for females.

As the average percentile test scores in 1996/7 reported in Tables 2 and 5 suggest, before the literacy and numeracy hour programmes males tended to lag behind in reading and literacy subjects while females tended to lag behind, albeit to a lesser extent, in numeracy subjects.

Thus, taking stock of the short-run analyses in Tables 2 and 5, it appears that the literacy and numeracy hour programmes were able to boost basic skills where they were most needed in childhood, i.e., where the skills of children were relatively poorer. In the case of males, this was the case for literacy subjects while for females this was the case for numeracy subjects. In contrast, the evidence in Tables 2 and 5 provides little support to the hypothesis that there may have been spillover effects between the two initiatives, as no benefit appears of the numeracy hour on reading test scores and no benefit appeared in Table 2 of the literacy hour on math test scores.

5.5. Impact of the Numeracy Hour on Crime, Pupil Achievement at the End of Secondary School and Selection Into Secondary Schools

Table 6 investigates whether also the numeracy hour had a crime-reducing effect and whether the numeracy hour too affected pupil achievement at the end of secondary schooling. Table 6 is organised in the same way as Table 4. Panel A shows that the numeracy hour programme reduced both violence and property crime at age 10-28 for females, but not for males. In particular, the count of violent crimes at age 10-28 decreased by 32.8% for females, and their count of property crime offences reduced by 37%. Panel B shows that, unlike the literacy hour for males, the numeracy hour did not affect the likelihood of school completion for females. However, as a result of the numeracy hour, females became nearly 5% more likely to achieve at least 5 A*-C grades in GCSE exams at the end of secondary school. Columns (7)-(9) fail to detect any impact of the numeracy hour on the count of A levels in which a student enrolled. Finally, Panel C shows little to no evidence of differential enrolment by quality or strictness of secondary school for pupils exposed to the numeracy hour.

Figure 2 displays a similar exercise to Figure 1, as it investigates by which age the property crime-reducing effect of the numeracy hour became visible for the full sample and for females in particular. Figure 2 is organised in the same way as Figure 1. However, in this case a property crime reduction appears already by age 14-15, when pupils are still in secondary school. Therefore, in this case secondary school completion seems an unlikely mechanism behind the crime-reducing impact of the numeracy hour for females. In contrast, these results seem to indicate that females exposed to the numeracy hour received a boost to their relatively weak set of skills, which in turn allowed them to do better at during secondary school and avoid contact with the police, although this did not translate in differential rates of A levels enrolment.

In sum, our results reveal that the literacy hour programme benefited disproportionately males, as it boosted their literacy skills where males tended to lag behind prior to the reform, while the numeracy hour programme benefited disproportionately females, as it boosted their numeracy skills where females tended to lag behind prior to the reform. This conclusion also appears in terms of crime reduction, since the literacy hour programme reduced "male crime" and the numeracy hour programme reduced "female crime". Therefore, a policy takeaway of these results is that boosting skills that are relatively weak in childhood does not just have the potential to bridge the gap between males and females in achievement across subjects, but it has also the potential to reduce their propensities to commit crime during youth.

6. Cost-Benefit Analysis of the Literacy Hour and the Numeracy Hour

The empirical analysis has shown a significant impact of the literacy hour on reading achievement at the end of primary school, on overall student performance in high-stakes exams

taken at the end of secondary school, on the likelihood to enrol in A-levels and on the count of crimes, especially violent, committed at age 10-28. Similarly, the numeracy hour has been shown to affect the student achievement at various stages of education and the criminality in adolescence of females. The question remains as to whether the policies were cost effective. Hence the per pupil costs of the policy are compared with the economic benefits, as reflected in predicted crime reduction. This analysis complements the empirical exercise in Machin and McNally (2008), where a cost-benefit analysis of the literacy hour policy is conducted using predicted labour market earnings.

The planned cost of the NLP was £12.5 million over 5 years. The main costs were 14 local centres (each costing about £25,000 per year) and literacy consultants in each participating Local Education Authority (about £27,000 per year for each consultant). Schools also received some funding for teacher training and resources, which was broadly the same for each school (though some account was taken of the pupil–teacher ratio). However, since the national rollout took place two years after the NLP was introduced, only the first two years are relevant. The total cost per annum was thus £2.5 million (or about £2.8 million in 2001 prices) and, given how many students were affected in 1997 and 1998 (i.e., 222,261 pupils in aggregate), the cost per pupil is £25.52 per annum (Machin and McNally, 2008). Similarly, based on the Preliminary Report by the Numeracy Task Force, the cost of the NNP, inclusive of running costs and salaries of National Centre Staff, is £19 in 2001 prices.

To estimate the economic value of the crime-reducing benefits of the literacy hour, we focused on the 29% reduction in the count of violent crimes at age 10-28 reported for the full sample in column (1) of Table 4. Thus, we first calculated the incidence of violent crime at age 10-28 for the pre-cohort, i.e., the cohort that sat Key-Stage 2 exams in 1996/97 in the schools in

our analysis and thus that was unaffected by the literacy hour. Then, using the estimated 29% reduction in the count of violent crimes, as well as the 78.7% conviction rate of the UK Crown Court in 2018-19,[20] we calculated the count of individuals in our analysis that did not commit a violent crime because of the literacy hour. Subsequently, we multiplied this number by the total unit cost of an assault without injury in England as per the UK Home Office's (2018) estimates.[21] Among violent crimes, an assault without injury, which is used here to measure the unit cost of violent crime, is deemed to cause the lowest economic and societal cost. Thus, in our calculation, we are obtaining a conservative estimate of the economic benefit of the literacy hour, because the higher is the cost of the (avoided) crime the higher would be the benefit of the reform. This empirical exercise retrieved an economic benefit of more than £32 million in 2015/16 prices.

The economic benefit stemming from the prevention of violence generated by the literacy hour was then compared with its economic cost of about £4.3 million in 2015/16 prices. Clearly, the benefits of the literacy hour outweighed its costs. The benefit/cost ratio of 7.44 clearly indicates that, for every pound invested in the literacy hour, more than 7 pounds were gained in terms of reduced youth violence. This is particularly noticeable given the recent spate in juvenile violence and knife crime in England and Wales.

To estimate the economic value of the crime-reducing benefits of the numeracy hour, we adopted the same approach and we focused on the 37% estimated reduction in the count of property crimes at age 10-28 for females generated by the numeracy hour. Proxying the cost of

[20] The conviction rate of the UK Crown Court in 2018-19 is publicly available at the following link: https://www.cps.gov.uk/publication/key-measures.

[21] Anticipation cost, consequence cost, response cost and total unit cost of assault without injury, as well as of other crimes recorded in the UK are taken from Table E1 of Home Office (2018) publicly available at the link below: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732110/the-economic-and-social-costs-of-crime-horr99.pdf

a property crime with the cost of a theft from a person of £1,380, this exercise finds that nearly 10,000 women failed to commit a property crime offence from age 10 to 28 as a result of the numeracy hour, thus retrieving an economic benefit of more than £13 million in 2015/16 prices. This is clearly much higher than the planned budget for the National Numeracy Project of approximately £4 million in 2015/16 prices.

7. Conclusion

The construction of human capital since early childhood is a crucial determinant of life trajectories. In many countries, even relatively low levels of basic skills in numeracy and literacy attract a wage premium, and the distribution of skills and long-term economic growth across countries clearly display a positive correlation (Schwerdt et al., 2020). Policymakers therefore need robust evidence in order to devise interventions that genuinely improve basic skills. Despite the potential for cognitive and non-cognitive skills developed in early years to affect student achievement and other outcomes in adolescence, relatively little is understood around the crime-reducing impact of the set of cognitive and non-cognitive skills that can be developed in early years.

In this paper, we have considered the potential for a change in the content and structure of teaching to impact on pupil performance and youth criminality. Our analysis is facilitated by the introduction of a literacy hour to English primary schools, through the National Literacy Project (NLP), which introduced the literacy hour to around 400 English primary schools in 1997 and 1998, and a numeracy hour to English primary schools, through the National Numeracy Project (NNP), which introduced the numeracy hour to around 468 inner-city

primary schools from 1997 to 1999. Although both initiatives originate from concerns about poor standards of literacy and numeracy in English schools, there was very little geographic overlap between these policies.

A set of difference-in-differences specifications is defined to investigate what happened to pupil achievement and future criminality in schools exposed to the literacy and numeracy hour. Individual-level administrative data matching education and criminal records from the UK Department for Education (DfE) and the UK Ministry of Justice (MoJ) were used for the entire population of students in primary state schools in England in 1995/6-98/9. Our estimates show that students exposed to the literacy and numeracy hour in primary school ranked higher in Key-Stage 2 exams, and exposure to the literacy and numeracy hour in primary school also led to sizeable increases in their Key-Stage 2 test scores. While the test scores in reading and by male students drive the improvement generated by the literacy hour programme, the test scores in math and by female students drive the improvement generated by the numeracy hour.

Estimates also show that individuals exposed to the literacy hour in primary school were less likely to leave school without any General Certificate of Secondary Education (GCSE) record and more likely to enrol in Advanced level qualifications (known as A-levels), while both programmes made exposed pupils more likely to obtain at least five A*-C Grades in high-stakes GCSE exams at the end of secondary school. Finally, males exposed to the literacy hour committed fewer violent offences from the age of 10 to 28 while females exposed to the numeracy hour committed fewer property offences at the same age. Additional estimates show that the reduction in male violence generated by the literacy hour became visible by age 18 and remained visible until age 28, when our study terminates, thus suggesting that secondary school completion and better subsequent opportunities were key ingredients behind this crime

reduction. In contrast, the reduction in female property crime generated by the numeracy hour became visible by age 14 and remained visible until age 28, when our study terminates, thus suggesting that females exposed to the numeracy hour were less likely to offend during adolescence and more likely to invest in their education during secondary school.

The evidence reported here therefore suggests that public policy aimed at changing the content and structure of teaching can raise pupil achievement and life chances in a lasting manner. These findings are of considerable significance when placed into the wider education debate about what works best in schools for improving pupil performance. They are also of considerable significance for education policies in countries which have problems with their levels of literacy and numeracy skills. As suggested in the paper, the research remit of economists has tended to be rather narrow in comparison with educationalists in this area.

Our approach shows that one of the areas receiving much less attention from economists in the past, namely looking at the content and organisation of what is taught, matters for English and reading as well as for mathematics. This is particularly important given that it will almost certainly be the case that the same teachers were teaching literacy and numeracy before and after the introduction of the literacy and numeracy hour. Indeed, as the effects we identify come from a government policy aimed at improving literacy and numeracy, the evidence we report suggests that public policy aimed at changing instruction methods can significantly raise pupil achievement and can do so in a highly cost-effective manner. Moreover, the evidence reported here suggests that boosting skills that are relatively weaker in childhood does not just have the potential to bridge the gap between males and females in achievement across subjects, but it has also the potential to reduce the respective propensities to commit crime during youth.

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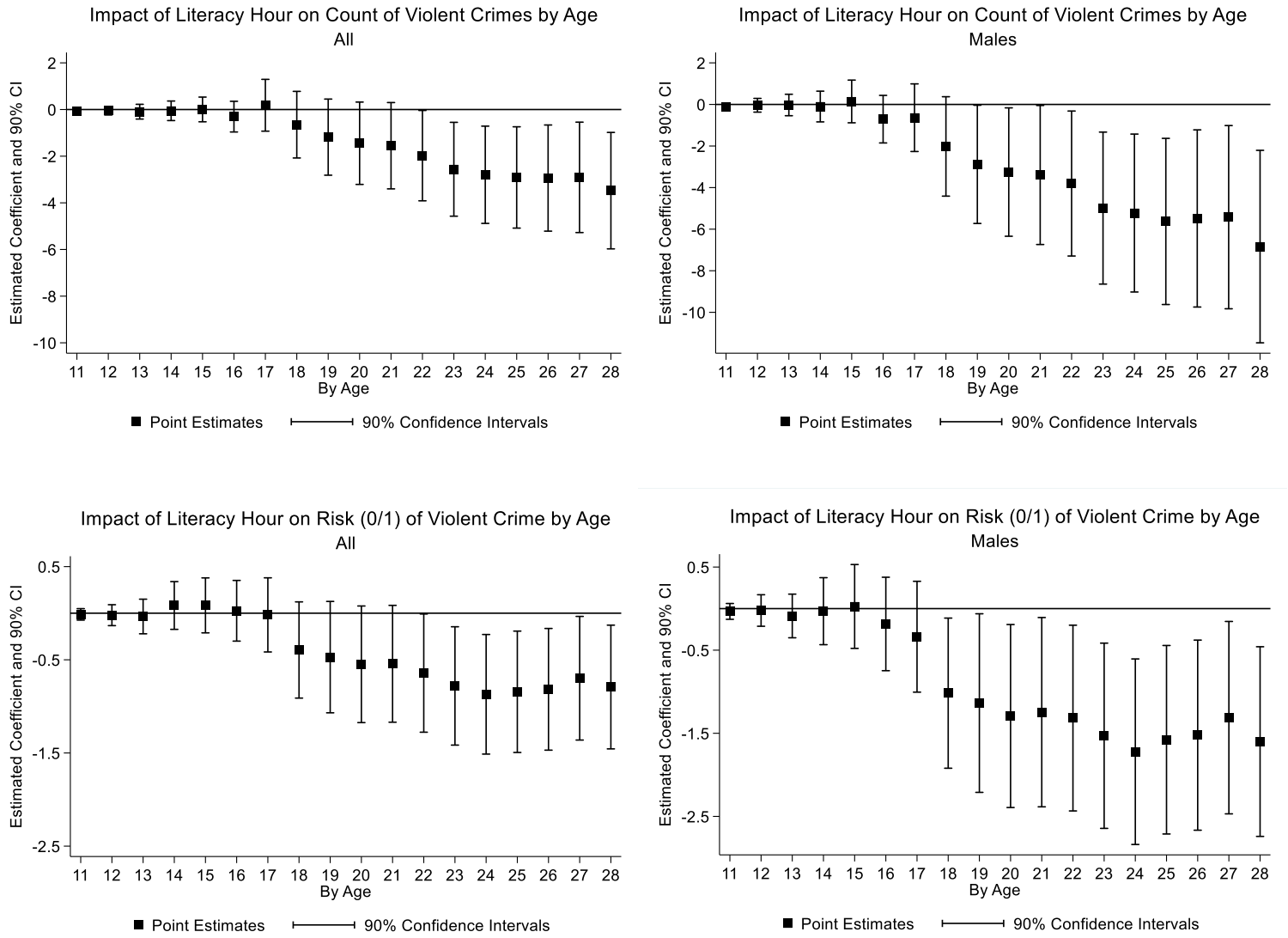
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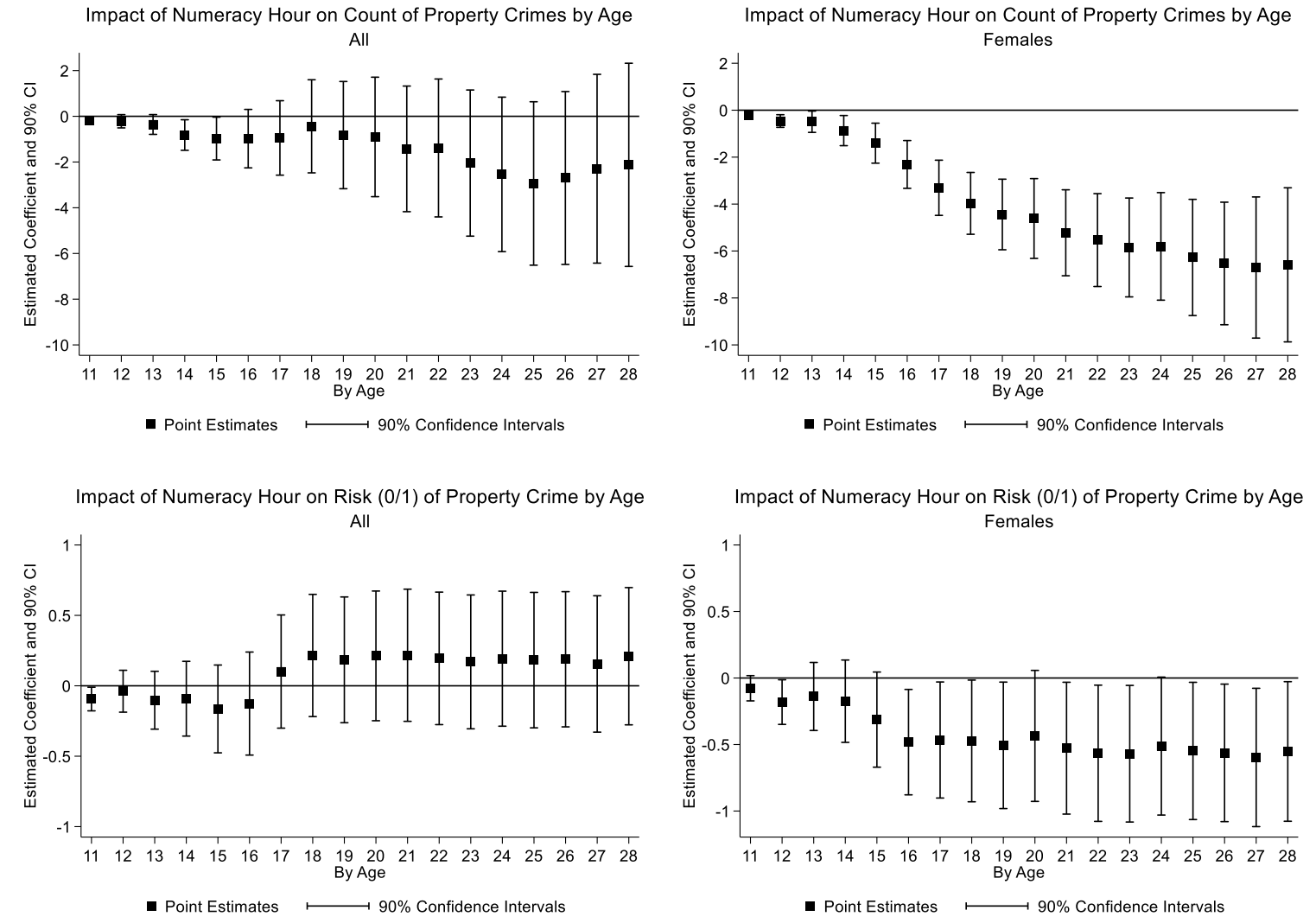
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Figure 1. Estimates of the Impact of the Literacy Hour on Violent Crime by Age



Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Literacy Hour Programmes starting from 1997. Comparison group includes students enrolled in 1997 in matched schools. School Fixed Effects, Cohort Fixed Effects and individual characteristics were controlled for in all OLS estimates reported here. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all estimates.

Figure 2. Estimates of the Impact of the Numeracy Hour on Property Crime by Age



Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Numeracy Hour Programmes starting from 1997/8. Comparison group includes students enrolled in 1997 in matched schools. School Fixed Effects, Cohort Fixed Effects and individual characteristics were controlled for in all OLS estimates reported here. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all estimates.

Table 1. Balancing Tests between Treatment Schools and Other Schools in 1997

	Literacy Hour Programme			Numeracy Hour Programme		
	(1)	(2)	(3)	(4)	(5)	(6)
	Treated Schools	Other Schools	Difference	Treated Schools	Other Schools	Difference
Male	0.490	0.500	-0.010*	0.499	0.503	-0.004
			(0.006)			(0.004)
Percentile Reading	39.101	49.008	-9.907***	42.156	49.699	-7.543***
			(0.981)			(0.574)
Percentile Math	40.330	49.707	-9.377***	43.209	50.484	-7.275***
			(1.092)			(0.614)
Standardised Reading	-0.356	-0.002	-0.354***	-0.240	0.023	-0.263***
			(0.037)			(0.021)
Standardised Math	-0.323	0.007	-0.330***	-0.220	0.032	-0.252***
			(0.040)			(0.022)
KS4 5 A*-C Grades	0.360	0.495	-0.135***	0.396	0.503	-0.107***
			(0.013)			(0.008)
Ever Crime	0.172	0.137	0.035***	0.170	0.137	0.033***
			(0.007)			(0.007)
Ever Property Crime	0.121	0.093	0.028***	0.120	0.093	0.027***
			(0.006)			(0.006)
Ever Violent Crime	0.058	0.046	0.012***	0.056	0.046	0.010***
			(0.003)			(0.003)
Ever Drugs	0.073	0.052	0.021***	0.070	0.052	0.018***
			(0.004)			(0.004)
Observations			439148			439148

Notes: Columns (1), (2) and (3) in the Figure show balancing tests in 1997 between students enrolled in 1997 in schools that implemented the Literacy Hour Programme starting from 1997 (Treatment Schools) and students enrolled in 1997 in other schools. Columns (4), (5) and (6) in the Figure show balancing tests in 1997 between students enrolled in 1997 in schools that implemented the Numeracy Hour Programme starting from 1997 (Treatment Schools) and students enrolled in 1997 in other schools. Estimates in all Columns were calculated on a sample of 439,148 juveniles enrolled in primary school in England.

Table 2. Estimates of the Impact of the Literacy Hour on Key Stage 2 Test Score

	All	All	All	Males	Females	All	All	All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A	Reading Standardized KS2 Test Score					Reading Percentile KS2 Test Score				
Post x ITT	0.071**	0.074**	0.103***	0.133***	0.069*	1.733**	1.821**	2.470***	3.132***	1.723
	(0.030)	(0.030)	(0.036)	(0.044)	(0.040)	(0.807)	(0.801)	(0.953)	(1.103)	(1.111)
Pre x ITT			0.056	0.055	0.062			1.248	1.108	1.554
			(0.040)	(0.045)	(0.046)			(1.041)	(1.140)	(1.234)
% Effect						3.48%	3.65%	4.95%	6.78%	3.22%
Mean Dep Var in 96-7						49.859	49.859	49.859	46.175	53.567
Panel B	Math Standardized KS2 Test Score					Math Percentile KS2 Test Score				
Post x ITT	0.044	0.043	0.046	0.041	0.05	1.202	1.176	1.255	1.094	1.337
	(0.029)	(0.029)	(0.035)	(0.042)	(0.039)	(0.832)	(0.834)	(0.994)	(1.181)	(1.124)
Pre x ITT			0.007	-0.014	0.03			0.153	-0.288	0.666
			(0.033)	(0.039)	(0.041)			(0.921)	(1.101)	(1.131)
% Effect						2.37%	2.32%	2.48%	2.11%	2.71%
Mean Dep Var in 96-7						50.626	50.626	50.626	51.948	49.294
Panel C	Overall Standardized KS2 Test Score					Overall Percentile KS2 Test Score				
Post x ITT	0.059**	0.059**	0.075**	0.083**	0.064*	1.525*	1.54*	1.901**	2.068*	1.645
	(0.029)	(0.029)	(0.035)	(0.042)	(0.039)	(0.798)	(0.797)	(0.954)	(1.131)	(1.079)
Pre x ITT			0.030	0.016	0.047			0.695	0.396	1.111
			(0.036)	(0.040)	(0.043)			(0.953)	(1.107)	(1.155)
% Effect						3.03%	3.06%	3.78%	4.17%	3.23%
Mean Dep Var in 96-7						50.258	50.258	50.258	49.554	50.967
Individual Characteristics	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
School FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Cohort FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Observations	1315074	1315074	1315074	658869	656205	1315074	1315074	1315074	658869	656205
Schools	11558	11558	11558	11558	11558	11558	11558	11558	11558	11558

Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Literacy Hour Programmes starting from 1997. Comparison group includes students enrolled in 1997 in matched schools. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all OLS estimates reported here.

Table 3. Estimates of the Impact of the Literacy Hour on Crime at Age 10-28

	All	Males	Females	All	Males	Females	All	Males	Females	All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All Crimes			Violent Crimes			Property Crimes			Drugs Crimes		
Post x ITT	-5.115	-3.33	-6.578	-3.766**	-6.423**	-1.043	-1.42	1.704	-3.64	0.071	1.389	-1.895**
	(8.307)	(14.836)	(5.022)	(1.516)	(2.771)	(1.018)	(6.304)	(11.29)	(4.282)	(3.316)	(6.47)	(0.801)
Pre x ITT	3.493	14.725	-5.011	-0.556	0.796	-1.594	3.507	11.685	-3.284	0.542	2.244	-0.133
	(8.037)	(15.042)	(4.985)	(1.411)	(2.722)	(1.158)	(6.159)	(11.717)	(4.34)	(3.373)	(6.737)	(1.218)
% Effect	-14%	-5.65%	-47.05%	-61.98%	-62.41%	-56.93%	-6.87%	5.5%	-35.29%	0.73%	7.86%	-94.7%
Mean Dep Var in 96-7	36.524	58.924	13.98	6.076	10.292	1.832	20.669	30.958	10.313	9.78	17.674	2.001
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1315074	658869	656205	1315074	658869	656205	1315074	658869	656205	1315074	658869	656205
Schools	11558	11558	11558	11558	11558	11558	11558	11558	11558	11558	11558	11558

Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Literacy Hour Programmes starting from 1997. Comparison group includes students enrolled in 1997 in matched schools. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all OLS estimates reported here.

Table 4. Estimates of the Impact of the Literacy Hour on Crime at Age 10-28, Long Run Student Achievement and Secondary School Characteristics, Cohorts 1997-98

	All	Males	Females	All	Males	Females	All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A	Violent Crimes			Property Crimes			Drugs Crimes		
Post x ITT	-3.496*	-7.836**	0.788	-6.383	-11.159	-1.390	-1.151	-2.296	-2.058
	(1.788)	(3.410)	(1.777)	(6.743)	(13.285)	(6.361)	(4.042)	(7.839)	(1.355)
% Effect	-29.47%	-38.997%	22.03%	-15.85%	-18.50%	-6.92%	-6.02%	-6.64%	-52.61%
Mean Dep Var in 96-7	11.863	20.094	3.577	40.273	60.321	20.095	19.121	34.555	3.912
Panel B	Secondary School Dropout			5+ A*-C Grades in GCSE Exams			Count of A Levels Enrolled		
Post x ITT	-0.011	-0.023**	0.002	0.021**	0.029**	0.010	0.118***	0.266***	-0.045
	(0.008)	(0.010)	(0.010)	(0.010)	(0.014)	(0.014)	(0.042)	(0.063)	(0.065)
% Effect	-14.1%	-26.74%	2.86%	4.16%	6.46%	1.78%	7.13%	17.40%	-2.52%
Mean Dep Var in 96-7	0.078	0.086	0.070	0.505	0.449	0.563	1.655	1.529	1.784
Panel C	Prior Average GCSE Test Score in Secondary School of Enrolment			Prior Average Exclusion Rate in Secondary School of Enrolment			Prior Average Strategic Exclusion Rate in Secondary School of Enrolment		
Post x ITT	0.020***	0.018*	0.020**	-0.004	-0.005	-0.004	-0.003	-0.000	-0.006
	(0.007)	(0.011)	(0.009)	(0.007)	(0.009)	(0.009)	(0.006)	(0.007)	(0.007)
% Effect	38.46%	35.29%	37.73%	-7.14%	-8.77%	-7.27%	-10.34%	-0%	-21.43%
Mean Dep Var in 96-7	0.052	0.051	0.053	0.056	0.057	0.055	0.029	0.030	0.028
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	891507	447066	444441	891507	447066	444441	891507	447066	444441
Schools	11558	11555	11552	11558	11555	11552	11558	11555	11552

Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Literacy Hour Programmes starting from 1997. Comparison group includes students enrolled in 1997 in matched schools. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all OLS estimates reported here.

Table 5. Estimates of the Impact of the Numeracy Hour on Key Stage 2 Test Score

	All	All	All	Males	Females	All	All	All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A	Reading Standardized KS2 Test Score					Reading Percentile KS2 Test Score				
Post x ITT	0.005	0.004	0.013	-0.004	0.034	0.088	0.064	0.234	-0.241	0.843
	(0.018)	(0.017)	(0.020)	(0.024)	(0.021)	(0.489)	(0.488)	(0.553)	(0.650)	(0.609)
Pre x ITT			0.019	0.016	0.027			0.376	0.240	0.609
			(0.019)	(0.023)	(0.022)			(0.540)	(0.637)	(0.632)
% Effect						0.18%	0.13%	0.47%	-0.48%	1.69%
Mean Dep Var in 96-7						49.859	49.859	49.859	46.175	53.567
Panel B	Math Standardized KS2 Test Score					Math Percentile KS2 Test Score				
Post x ITT	0.076***	0.076***	0.090***	0.066***	0.116***	2.194***	2.201***	2.556***	1.889***	3.256***
	(0.017)	(0.017)	(0.020)	(0.023)	(0.022)	(0.481)	(0.481)	(0.558)	(0.653)	(0.632)
Pre x ITT			0.032*	0.024	0.041*			0.784	0.679	0.924
			(0.018)	(0.021)	(0.022)			(0.511)	(0.586)	(0.638)
% Effect						4.33%	4.35%	5.05%	3.64%	6.605%
Mean Dep Var in 96-7						50.626	50.626	50.626	51.948	49.294
Panel C	Overall Standardized KS2 Test Score					Overall Percentile KS2 Test Score				
Post x ITT	0.058***	0.057***	0.071***	0.048**	0.096***	1.633***	1.629***	1.929***	1.318**	2.613***
	(0.017)	(0.017)	(0.019)	(0.024)	(0.021)	(0.467)	(0.467)	(0.540)	(0.652)	(0.596)
Pre x ITT			0.030*	0.024	0.038*			0.664	0.571	0.826
			(0.018)	(0.021)	(0.021)			(0.497)	(0.590)	(0.611)
% Effect						3.25%	3.24%	3.84%	2.66%	5.13%
Mean Dep Var in 96-7						50.258	50.258	50.258	49.554	50.967
Individual Characteristics	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
School FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Cohort FE	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Observations	1927475	1927475	1927475	967642	959833	1927475	1927475	1927475	967642	959833
Schools	11558	11558	11558	11558	11558	11558	11558	11558	11558	11558

Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Numeracy Hour Programmes starting from 1997/8. Comparison group includes students enrolled in 1997 in matched schools. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all OLS estimates reported here.

Table 6. Estimates of the Impact of the Numeracy Hour on Crime at Age 10-28, Long Run Student Achievement and Secondary School Characteristics, Cohorts 1997-99

	All	Males	Females	All	Males	Females	All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A	Violent Crimes			Property Crimes			Drugs Crimes		
Post x ITT	0.857	2.653	-1.174*	-3.421	0.322	-7.495***	0.778	1.851	0.490
	(1.132)	(2.170)	(0.658)	(3.212)	(6.071)	(2.673)	(2.185)	(4.356)	(0.817)
% Effect	7.224%	13.20%	-32.82%	-8.49%	0.53%	-37.30%	4.07%	5.36%	12.52%
Mean Dep Var in 96-7	11.863	20.094	3.577	40.273	60.321	20.095	19.121	34.555	3.912
Panel B	Secondary School Dropout			5+ A*-C Grades in GCSE Exams			Count of A Levels Enrolled		
Post x ITT	-0.002	0.001	-0.004	0.012**	-0.005	0.028***	-0.024	-0.036	-0.022
	(0.003)	(0.004)	(0.004)	(0.006)	(0.008)	(0.008)	(0.028)	(0.037)	(0.039)
% Effect	-2.56%	1.16%	-5.71%	2.38%	-1.11%	4.97%	-1.45%	-2.35%	-1.23%
Mean Dep Var in 96-7	0.078	0.086	0.070	0.505	0.449	0.563	1.655	1.529	1.784
Panel C	Prior Average GCSE Test Score in Secondary School of Enrolment			Prior Average Exclusion Rate in Secondary School of Enrolment			Prior Average Strategic Exclusion Rate in Secondary School of Enrolment		
Post x ITT	-0.005	-0.007	-0.003	0.006	0.002	0.010*	0.001	-0.001	0.002
	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
% Effect	-9.61%	-13.72%	-5.66%	10.71%	3.51%	18.18%	3.45%	-3.33%	7.14%
Mean Dep Var in 96-7	0.052	0.051	0.053	0.056	0.057	0.055	0.029	0.030	0.028
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1470390	738993	731397	1470390	738993	731397	1470390	738993	731397
Schools	11558	11555	11552	11558	11555	11552	11558	11555	11552

Notes: ITT status defined as students enrolled in 1997 in schools that implemented the Numeracy Hour Programmes starting from 1997/8. Comparison group includes students enrolled in 1997 in matched schools. Individual characteristics include a binary indicator for the gender of the individual, an indicator for Free-School-Meal eligibility status, an indicator for White British ethnicity and an indicator for whether the individual is an English native speaker. Standard errors are clustered at the school level in all OLS estimates reported here.