JULY 2024

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# The Economic Case for *AI-Enabled Education*

A Companion to *The Economic Case for Reimagining the State*

TONY BLAIR INSTITUTE FOR GLOBAL CHANGE

# Contents

01

# Executive Summary

AI has the potential to significantly boost students' academic performance through three key channels.

- It could enhance the quality of teaching through AI co-pilots for teachers, which could help with lesson planning, student assessment and data analysis. For example, AI-powered platforms for schools, such as Century Tech, already analyse student data to help teachers address student weaknesses in a more targeted way.[1]

- It can free up teacher time to focus on more interactive learning by automating repetitive tasks such as grading assignments and tracking attendance. Teachers are beginning to use AI algorithms in edtech tools to grade students' work faster.[2]

- And it has the power to increase students' ability to absorb lesson content through AI tutor bots, which could tailor personalised content and provide real-time feedback. AI edtech startups have been at the forefront of building chatbot-style learning where an AI tutor imitates a human teacher. It prompts questions, provides on-demand support and gives instant formative assessments. Some edtech tools developed AI speech recognition for tutoring students.[3]

AI-enabled higher educational attainment could significantly improve the United Kingdom's economic outlook and the public finances by increasing the future productivity of the UK's workforce and boosting economic growth.

AI learning tools remain relatively new, so there is a dearth of in-depth academic studies and long-running, large-scale pilot programmes to robustly assess their impact on learners.

In this paper, a companion to *The Economic Case for Reimagining the State*, we attempt to quantify the costs and benefits of rolling out an AI-enabled education programme in the UK. This programme would set up the foundational infrastructure for AI to have the maximum effect on student attainment. It includes a digital learner ID to seamlessly integrate all educational information on one platform, AI-enabled edtech tools for students and an AI co-pilot for teachers – all enabled by widespread use of tablets and staff training in digital skills and AI competencies.

Overall, we find that:

- AI could boost educational attainment levels by around 6 per cent through a combination of improving average attainment of individual students and by enabling more students to progress to higher levels of education.

- Such effects will take time to feed through to the labour market but the potential gains are substantial. By boosting the productivity of the future workforce, AI-enabled education could raise GDP by around 6 per cent in the long run and add more than 0.1 per cent to growth per year for over 40 years.

- We estimate the cost of rolling out AI-enabled education to the UK's 26,500 schools would require investment in: a) new digital infrastructure including new edtech tools and a digital learner ID for each student; b) teacher training in the new technology; and c) ongoing investment in AI-enabled hardware for students and teachers. Overall, we estimate the programme would involve an initial setup cost of £0.4 billion and cost around £1.2 billion per year in today's prices to maintain (or 0.04 per cent of GDP per year).

- The speed with which an AI-enabled education programme could be rolled out will depend on the government's commitment. We take the experience of rolling out virtual-learning environments during the pandemic as instructive and assume an ambitious rollout plan: two years for technology development, a year for testing and a year for full-scale implementation.

- The fiscal benefits of an AI-enabled education programme should far outweigh the costs in the long term. We estimate the programme would lead a reduction in annual public-sector borrowing of 2 per cent of GDP after 50 years and a cumulative reduction in public-sector net debt of 30 per cent of GDP over the same timeframe. However, given the lags between improving the educational attainment of students and those students entering the labour force, the scheme does take time to break even. Over the first ten years, the scheme would add 0.3 per cent of GDP to the UK's debt position, but from that point on it would begin paying for itself – breaking even by 2042 and continually improving the public finances. By 2050, the cumulative benefits of the scheme would exceed its costs by a ratio of 2.7, and by 2070, this ratio would have risen to 7.7 and would still be rising.

- All of the above figures are based on an assessment of AI's capabilities as they are today, but the technology is not static. If instead we assume the technology continues to improve so that it raises educational attainment by 10 per cent (versus 6 per cent in the base case) then AI could boost GDP by a further 4 per cent in the long term and reduce the debt burden by a further 10 per cent of GDP after 50 years. This upside scenario is by no means implausible and highlights both the upside potential of investing in AI-enabled education now and the importance of designing the programme in a way that it can continually incorporate improvements in AI over time.

This paper draws on the best available evidence from a wide range of sources to provide an initial assessment, but we recommend that the UK government adopts an outcome-based funding approach to rolling out the programme nationwide.[4]

We begin this paper by reviewing the existing evidence on AI to gauge its potential impact on educational attainment, then explore how higher educational attainment could boost GDP growth. From there we examine the potential costs of rolling out an AI-enabled education programme nationwide, review the overall costs and benefits of such a programme, and conclude by looking to the future to see how advances in AI technology could change the cost-benefit analysis over time.

02

# What Impact Could AI Have on Educational Attainment?

Given the novelty of AI-enabled educational technology (edtech) and the uncertainty around its effects, we estimate the impact of AI on educational attainment by triangulating insights from two distinct methods: 1) we examine recent academic studies on the direct impact of recent (non-AI-enabled) edtech on educational attainment; and 2) we link recent studies on the potential impact of AI with academic literature that examines the role teacher quality, teacher time and personalised tuition play in educational attainment. Overall, these two methods produce similar-sized effects – suggesting AI could boost educational attainment by 6 to 8 per cent. We conservatively take the lower bound of this range forward in our analysis.

## Method 1: Recent Academic Studies on the Impact of Edtech on Educational Attainment

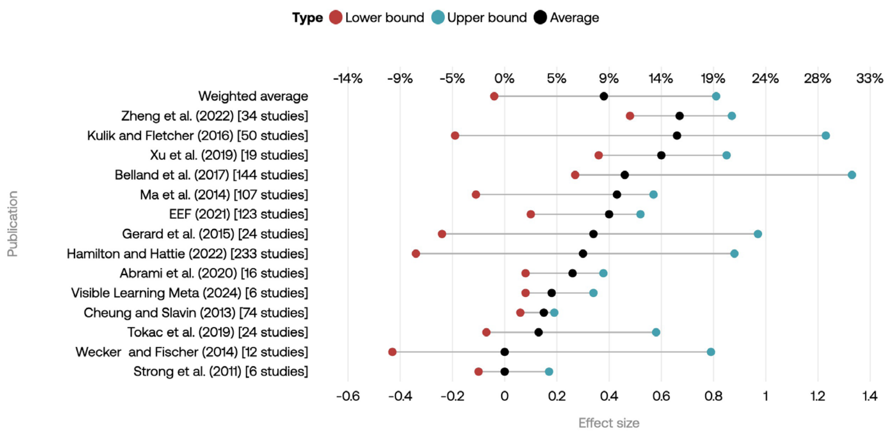
AI-enabled edtech refers to a new generation of educational tools that leverage artificial intelligence to help students and teachers through personalised advice and support. Evidence on the impact of AI-enabled edtech is limited and, where it does exist, typically does not quantify its effects.[5] To address this gap, we draw on meta-studies of how other digital technologies have affected students in the recent past (see Figure 1).[6] These studies typically report an "effect size" for each digital technology, which shows how attainment is affected, expressed in terms of the standard deviation around average grades.

We have created a simple mapping of effect size onto educational attainment using the UK's GCSE distribution. A UK Department for Education study[7] found that one standard deviation improvement in GCSE grades resulted in just under a 20 per cent improvement in average lifetime earnings. We use this figure as a proxy for the returns to extra educational attainment. This implies a mapping of roughly five to one between the "effect size" reported in edtech studies and the educational attainment figures we are interested in: for example, an effect size of one corresponds to an increase in educational attainment of around 20 per cent.

Across the literature, digital edtech exhibits a wide-ranging impact on student attainment – with effect sizes ranging from -0.40 to 1.33 of a standard deviation, albeit with significant clustering in the zero to 0.8 range (see Figure 1). This variability in outcomes reflects a range of factors, including the type of technology, student demographics such as age and initial attainment level, and how the technology is implemented. Several studies also highlight that the benefits do not accrue linearly, with the effects more pronounced among students with lower initial performance levels (see for example, Gerard et al (2015); Abrami et al (2020); Ma et al (2014)). Overall, if we take a weighted average across 14 meta-studies (which themselves cover 872 individual studies), we find an average effect size of 0.38, or an 8 per cent improvement in educational attainment.

FIGURE 1

## Impact of pre-AI-era edtech on educational attainment based on a range of academic meta-studies




Note: top axis indicates a percentage change in educational attainment

Source: TBI analysis

# Method 2: AI Impact on Teacher Time and Educational Attainment

Here, we link frontier research on the benefits of AI with existing academic research on how improvements in teacher quality, teacher time and personalised tuition could boost educational attainment:

### EFFECT 1: AI COULD IMPROVE THE QUALITY OF TEACHERS

A wide range of research (including Muijs and Reynolds 2017, and Hanushek and Woessmann 2017) finds a strong link between teacher expertise and student achievement. Martin et al's (2023) meta-analysis suggests that teacher quality accounts for 9.2 per cent of the difference in educational performance across students. AI has the potential to close some of this attainment gap by improving teacher quality – particularly for lower performers. For instance, colleges in England using Century Tech, an AI edtech tool, reported that teachers could factor individual students' needs into their long-term planning and could track progress much more simply.[8]

Noy and Zhang (2023) find that ChatGPT can substantially improve worker productivity in writing tasks, but the effect is particularly marked for lower performers. From their findings, we can derive that ChatGPT can reduce around half of the disparity in worker quality by raising underperformers. If AI were able to replicate this effect in the teaching profession – by halving the disparity in teacher quality – then based on Martin et al's (2023) analysis mentioned above, this could improve educational attainment by up to 4.6 per cent. Clearly, there will be challenges to achieving this. Noy and Zhang's (2023) evidence is based on a single task – writing – while teachers perform a variety of other complex tasks. We therefore conservatively assume that just under half of the full potential effect is possible based on AI's current capabilities, meaning that **AI could improve teacher quality and raise educational attainment by around 2 per cent**.

## EFFECT 2: AI COULD SAVE TEACHERS TIME AND INCREASE TIME FOR INTERACTIVE LEARNING

The amount of time that students get to interact directly with their teachers has a key bearing on educational outcomes. Wedel (2021) finds that on average an extra hour of instruction leads to a 0.03 standard deviation improvement in test scores.

Our own analysis suggests that up to 8 per cent of teachers' working hours could be saved with the help of AI, by assisting with grading assignments or lesson planning, for example. Other studies, such as McKinsey (2020), suggest even larger effects (a 20 to 30 per cent time saving). In a Department for Education study (2024), UK educators report that using generative-AI tools leads to time savings – of multiple hours in some instances – on tasks like creating lesson content. For example, Noodle Factory, a personalised tutoring tool using large-language-model (LLM) technology, states that teachers using it report 50 per cent time savings.[9] Moreover, an independent assessment (2023) of the UK Oak National Academy,[10] which provides digital teaching resources, finds that 40 per cent of educators using it save on average four hours per week.[11]

Teachers typically work 50 hours per week, according to the Department for Education,[12] so an 8 per cent time saving equates to four hours per week. If all those hours were dedicated to extra interactive teaching, then – based on Wedel's (2021) findings that every extra hour of instruction leads to a 0.03 standard deviation increase in test scores – four extra hours would lead to 0.12 standard deviations of higher test scores. This is equivalent to around 2 per cent improvement in educational attainment (based on the mapping outlined in Method 1). However, given that teachers on average spend just under half their working hours teaching in the classroom (24 out of 50 hours), it is perhaps more likely that only half of the hours saved due to AI would be reallocated to teaching – implying **AI could improve educational attainment by around 1 per cent by saving teachers' time**.

## EFFECT 3: AI COULD INCREASE THE ABILITY OF STUDENTS TO ABSORB LESSON CONTENT

Various AI edtech providers report significant improvements in educational attainment by improving the ability of students to absorb lesson content via personalised learner bots – mimicking the effects of students having a private tutor:

**Khan Academy:** The use of Khan Academy tools in Brazil (2018) between fifth and ninth grade improved student performance in the national standardised exam for maths and Portuguese by four points – equivalent to 30 per cent of the learning expected in a school year in elementary school.[13]

**MindSpark:** A 2016 study showed that MindSpark after-school programmes using adaptive learning helped students score 0.37 standard deviations higher than their peers receiving small-group tuition in maths and 0.23 standard deviations in Hindi – equivalent to an 8 per cent and 5 per cent improvement for maths and Hindi respectively.[14]

**Sparx Maths:** A 2019 UK study from Sparx Maths found that using this adaptive learning tool for one hour per week increased predicted GCSE maths grades by 18 per cent.[15]

The academic evidence on the impact of private tuition on educational attainment is decidedly mixed, partly because of the variability in personal tutor quality and partly because of selection bias in respect of which students have private tutors:

- Some studies such as Ömeroğulları et al (2020) and Guill & Bos (2014) find that students with personal tutors scored 15 to 20 per cent *lower* on maths and English tests.

- Some studies show no consistent benefit (Guill & Bonsen, 2010; Luplow & Schneider, 2014).

- Other studies find a targeted improvement in select settings: for example, Zhang (2013) and Ha et al (2017) found tutoring helped some low achievers in specific subjects.

Other studies find significant positive effects. For example, Choi & Park (2016) found private tutoring improved 9th-grade maths scores by 0.237 standard deviations in South Korea, while Guo et al (2020) reported 0.10-0.14 and 0.07-0.09 standard deviation increases in Chinese and maths scores respectively. Perhaps most significantly, a comprehensive meta-analysis by Zhang & Liu (2022) of 3,735 studies found private tutoring boosted educational attainment by 0.34-0.51 standard deviations. The latter study equates to an improvement in educational attainment of 6 to 10 per cent.

AI-enabled personal learner bots have the potential to overcome some of the existing challenges with private tuition – for example, by providing tuition of consistent quality, on a continuous basis (as opposed to a few hours a week) and tailored to the unique learning style of the student: a co-pilot, if you like. This might suggest that a well-designed AI-enabled personal learner bot could improve educational attainment by up to 10 per cent based on the most optimistic studies highlighted above. However, given the uncertainty highlighted in the literature, we assume a much smaller effect equal to less than one-third of these studies – estimating that **AI-enabled personalised learner bots could improve educational attainment by around 3 per cent**.

Taking all three effects into account, AI could improve educational attainment by almost 17 per cent if we take the upper bound of the three effect sizes (4.6 per cent from higher teacher quality, 2 per cent from additional teacher time and up to 10 per cent from an AI-learner bot). However, given the strength of academic evidence supporting each channel, we take a more conservative view and assume they could collectively boost educational attainment by around 6 per cent (2 per cent from higher teacher quality, 1 per cent from additional teacher time and around 3 per cent from an AI learner bot). This is a similar ballpark to the estimate generated from Method 1 (which showed an 8 per cent improvement in educational attainment), and we conservatively adopt the estimate from Method 2 for our central scenario.

# 03 How Could AI-Enabled Education Affect GDP?

## Conceptual Framework

We use a growth accounting model, inspired by Vollrath (2020), to translate our estimates of AI's potential impact on educational attainment onto GDP.[16]

We measure output growth ($g_y$) based on a standard Cobb-Douglas production function:

**Equation 1:**

$$g_y = e_H g_H + e_K g_k + g_{tfp}$$

Where $g_H$ is growth in human capital, $g_k$ is growth in physical capital and $g_{tfp}$ is growth in Total Factor Productivity and $e_H$ and $e_k$ are the labour and capital shares of income respectively. For the purposes of this analysis, we are only interested in changes in the human capital component of GDP.

Human capital is then determined by a human capital index (HCI), which comprises an education index $(\overline{h^{educ}})$, experience index $(\overline{h^{educ}})$ and the size of the labour force, which depends on the total numbers of workers *(Workforce)* and the average hours worked *(Hours)*:

**Equation 2:**

$$HCI = \overline{h^{educ}} \times \overline{h^{exp}} \times Workforce \times Hours$$

The education index $(\overline{h^{educ}})$ is the key component we are interested in and is based on two components: the returns to schooling *(r)* and the number of years of schooling *(s)*. AI can therefore improve educational outcomes through two key channels: by increasing educational attainment for a given number of years of schooling (so increasing returns to schooling through *r)* or by extending the number of years of schooling (through *s)*.

**Equation 3:**

$$\ln h_j^{educ} = r_j \times s_j$$

## Building a Baseline Scenario

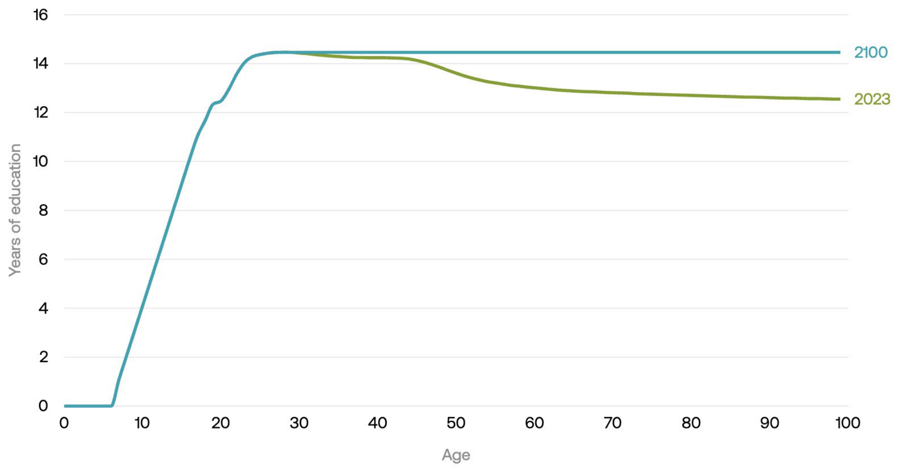
To assess the impact of AI-enabled education on GDP we first need to construct a baseline forecast for how GDP would evolve in the absence of AI-enabled education. We do this using the following steps:

1. **Workforce trends:** We combine the latest national population projections by age from the Office for National Statistics (ONS) with data on employment rates and average hours worked by age from the UK Labour Force Survey (LFS) to produce a baseline forecast for how the size of the workforce and total hours worked are likely to evolve from 2025 to 2100.[17]

2. **Years of education:** We then assume that all future cohorts of workers will be educated to the current standard of the most recently educated cohort – for instance, each future cohort will, on average, receive 14.5 years of education by the age of 28 (see Figure 2). This has the effect of normalising the number of years of education across the workforce as the labour force gradually turns over (as new cohorts enter and older cohorts exit), so that by 2100 all cohorts reach a maximum 14.5 years of education on average.

FIGURE 2

### Average years of education by age: 2023 versus 2100 baseline scenario




Source: UK Labour Force Survey on population education levels and TBI calculations

3. **Returns to education:** We follow Vollrath (2020) and assume that there is a 10 per cent return per year of schooling (*r in equation 3 above).* This figure is uncertain and there is a range of estimates in the academic literature, but as Vollrath argues, 10 per cent is a reasonable median estimate. Due to the specification of equation 3 above (note the use of the natural logarithm) the returns to years of schooling compound exponentially over time.

4. **Human capital index:** We then combine data on workforce, years of education and returns to education from steps 1 to 3 above to construct the human capital index. We then multiply changes in the human capital index by the labour share (which is 0.6 based on the latest LFS data), to calculate a baseline GDP forecast from 2025 to 2100.

## Modelling the Impact of AI-Enabled Education on Future GDP

### SCALE OF IMPACT

We assume that AI-enabled education will raise GDP through two main channels:

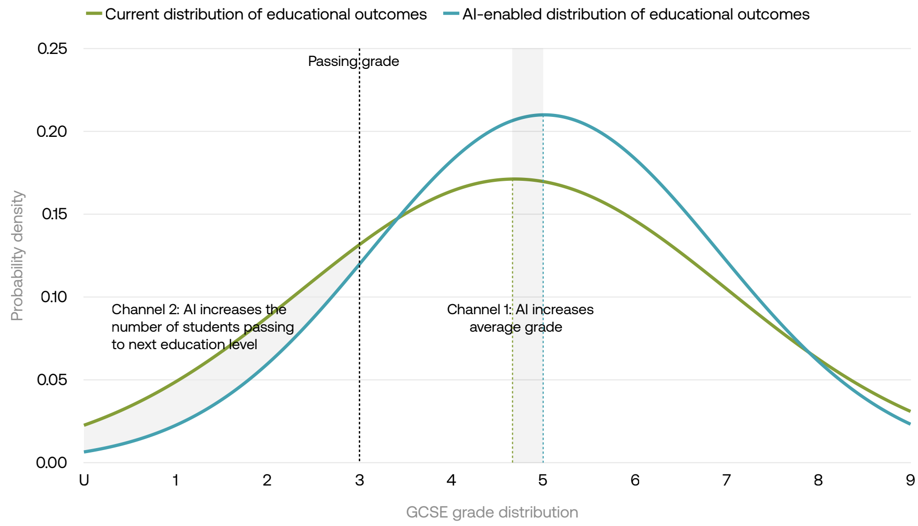
1. **Increasing the returns to education:** The size of this channel is directly related to the academic evidence discussed in the chapter on the impact AI could have on educational attainment. We assume that the average return per year of education rises by 6 per cent (for instance, *r* from equation 3 above rises from 10 per cent to 10.6 per cent). This effect compounds across each year of AI-enabled education and ultimately boosts GDP by just over 5 per cent in the long run.

2. **Increasing years of education:** One secondary impact of AI increasing average attainment rates is that it should enable some students who previously would have failed to achieve sufficient grades to progress to higher levels of education to do so. We estimate the scale of this effect by modelling the distribution of educational outcomes at Key Stage 4 (GCSE-equivalent) and Key Stage 6 (A-level equivalent). We assume

these distributions shift to the right to reflect higher rates of AI-enabled education and we assume the distribution of outcomes compresses slightly – to reflect the academic evidence (for example, from Gerard et al 2015), which suggests edtech tends to benefit those at the lower end of the distribution more (Figure 3). Overall, these changes imply that the proportion of students staying in education past the age of 16 should rise from 86.5 per cent to 92.2 per cent (an increase of around 36,700 students in England), while the proportion staying on beyond the age of 18 should rise from 51.2 per cent to 60.2 per cent – another 53,500 students in England (Figure 4).[18] These changes are big enough to increase average years of education in the workforce by around 0.1 years and boost GDP by a little over 1 per cent in the long-run.

FIGURE 3

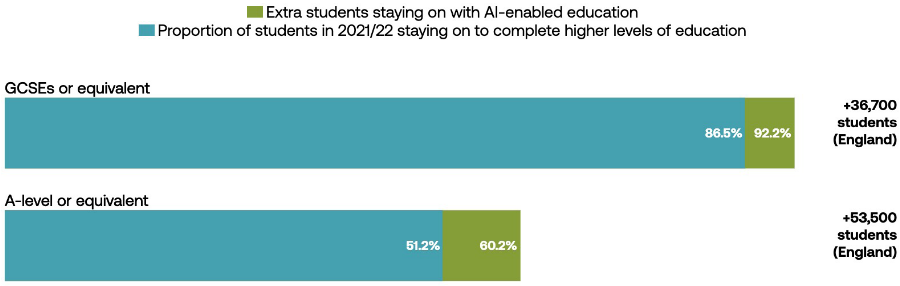
## Illustrative diagram showing how AI could improve educational outcomes




Source: TBI calculations

FIGURE 4

## Proportion of students moving to next education level with AI-enabled education




Source: Official government statistics on Key Stage 4 destination measures and A-level or equivalent results, Ofqual data on GCSE results and TBI calculations

# Timing of Impact – How Quickly Will the Effects Materialise?

The full impact of AI-enabled education on the economy will take time to materialise based on the speed the technology is rolled out nationwide, the number of years of AI-enabled education students need to gain the maximum benefit and the time taken for the whole labour force to turn over so that every worker has benefitted from an AI-enabled education. We consider each of these potential lags:

### PACE OF ROLLOUT OF AI ACROSS UK SCHOOLS

This will be determined by the extent to which the next government prioritises the programme. In the past, edtech rollout has been patchy and often slow (see Edtech advisory forum, 2020[19]) but during the Covid-19 pandemic remote-learning technology was deployed to the majority of schools in one to two years, even though government resources were overstretched (CooperGibson Research, 2022) – showing what is possible. In this case, we assume a three-year setup phase to:

- Create the central digital infrastructure required for the programme, including a digital-learner record for each student
- Verify and link existing AI-enabled edtech tools into the central digital interface so that teachers and students can easily access a range of certified AI-enabled training tools
- Negotiate a hardware contract to obtain tablets for students and teachers so they can use AI-enabled tools in lessons
- Redesign Continuous Professional Development (CPD) to incorporate AI into ongoing teacher training
- Test and refine the rollout model in a small number of schools
- Intensively train two members of the senior leadership from each school to champion AI

By year four we anticipate the programme will be fully operational, but both faster and slower timeframes are possible.

### TIME STUDENTS NEED TO USE AI-ENABLED EDTECH TO GAIN THE FULL BENEFIT

Our central assumption is that the benefits of an AI-enabled education cumulate linearly each year from age 6 to 18 (Years 2 to 13). So, if AI were rolled out nationwide, the current cohort of A-level (or equivalent qualification) students in Year 13 would gain only one-twelfth of the benefit of an AI-enabled education compared with the current cohort of Year 2 students by the time they reach age 18.

We have based our assumption on Gerard et al (2015), who find that edtech has a similar-sized effect across all years of education. However, there is a range of other estimates in the literature that suggest different effects. For example, Hamilton and Hattie (2022), who run a meta-analysis of meta-analyses, find that edtech tends to benefit primary-school students more than those in secondary school, while other studies suggest the biggest impact of edtech occurs relatively quickly – within the first few months of rollout. Our assumption is relatively conservative, in that it takes 12 years from the point the AI programme is fully rolled out for the first cohort of fully AI-educated students to leave school.

We also assume different kinds of exposure to AI for students of different ages. We assume that teachers of all grades use AI intensively as a co-pilot to help save time and improve the quality of their teaching, but we assume the intensity with which AI is used directly by students in the form of an AI-personalised learner bot in the classroom (via tablets) varies by age given concerns over screen time. We assume no use of tablets in Reception and Year 1, which then gradually scales up each year, so that by Year 7 all secondary-school students have their own tablet on which they complete most of their lessons.

### TIME TAKEN FOR THE WHOLE LABOUR FORCE TO BENEFIT FROM AN AI-ENABLED EDUCATION

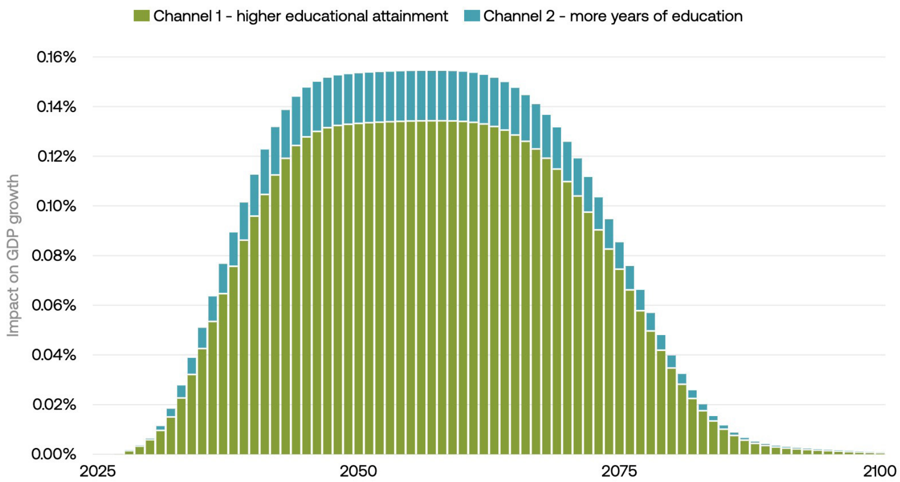
The final lag in realising the benefits from an AI-enabled education relates to the speed with which the labour force turns over. Newly AI-educated students entering the workforce will experience higher rates of productivity, but it takes time for these better-educated individuals to gradually replace older workers who were trained using different means. We use a cohort model to analyse these effects – based on the ONS's latest population projections by age and data from the Labour Force Survey on worker transitions in and out of employment. Given the majority of workers spend around 50 years in the labour force, it takes around half a century for the whole labour force to turn over and the full effect to be realised.

## Results

We combine our estimates of the scale and timing of the potential impact of AI-enabled education on UK GDP and compare that with our baseline forecast. Figures 5 and 6 show the overall impact of AI-enabled education on GDP growth and the level of GDP respectively for our central scenario.

FIGURE 5

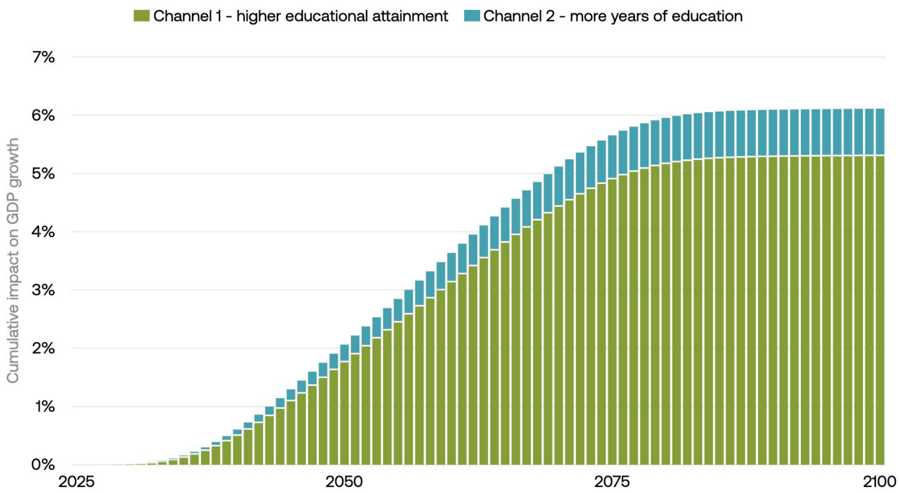
## Annual impact of AI-enabled education on GDP growth




Source: Office of National Statistics population projects, UK Labour Force Survey average hours and employment rates, and TBI own calculations

FIGURE 6

## Cumulative impact of AI-enabled education on the level of GDP




Source: Office of National Statistics population projects, UK Labour Force Survey average hours and employment rates, and TBI own calculations

Given the lags involved in rolling out the technology to the whole workforce, the programme takes time to boost GDP. Over the course of the next two Parliaments, GDP is 0.16 per cent higher by 2035. However, the programme has a long-lived effect on GDP lasting around 60 years, with a peak impact on GDP growth of just over 0.15 per cent per year and a cumulative long-run impact of just over 6 per cent on the level of GDP by 2085. As is clear from Figures 5 and 6 the majority of this effect is linked to the impact of AI improving average educational attainment (Channel 1), with only around a sixth of the impact linked to extra students staying on to higher levels of education (Channel 2).

### SENSITIVITY ANALYSIS

Given the uncertainties associated with the assumptions above, we consider two alternative scenarios to explore the different impacts AI-enabled education could have on GDP growth:

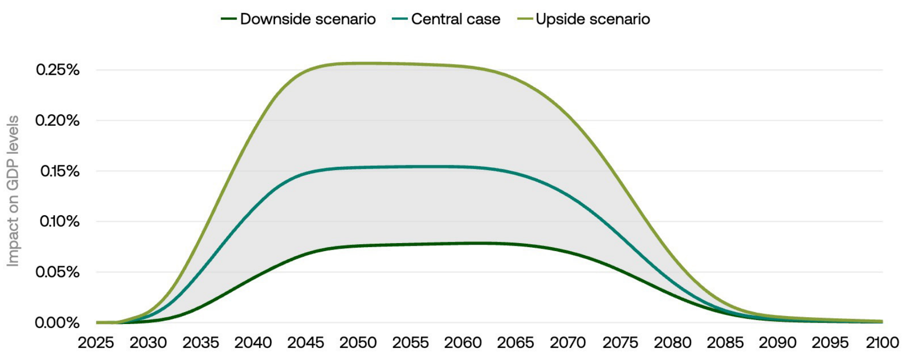
**Upside scenario:** In this scenario, we assume that AI lifts educational attainment by 10 per cent (as opposed to the 6 per cent assumed in our central case). This is consistent with some of the more optimistic studies of the impact of edtech highlighted earlier (see Figure 1). We assume the speed of the impact is the same as the central case – taking three years to setup and test the programme (in line with the experience seen during the pandemic) and for the programme to be fully operational from year four.

**Downside scenario:** In this scenario, we assume that AI boosts educational attainment by only 3 per cent (on the assumption that AI-enabled tools are only rolled out to teachers not students), and that it takes eight years to set up the programme and roll it out nationwide (consistent with some of the slower rollout speeds seen outside of the pandemic).

Figures 7 and 8 show the impact of these scenarios on GDP growth and the level of GDP over time. In the upside scenario, we see a larger effect (with a peak effect on GDP growth of 0.26 percentage points and a cumulative long-term boost to GDP of 10 per cent), with growth 0.3 per cent higher by 2035 after two parliamentary terms. By contrast, in the downside scenario the impact on GDP is not only more subdued (peaking at an annual effect of 0.08 per cent on GDP growth and reaching 3 per cent cumulatively) but it materialises much more slowly – with no discernible impact on GDP for at least the next two Parliaments.

FIGURE 7

## Alternative scenarios showing the impact of AI-enabled education on GDP growth

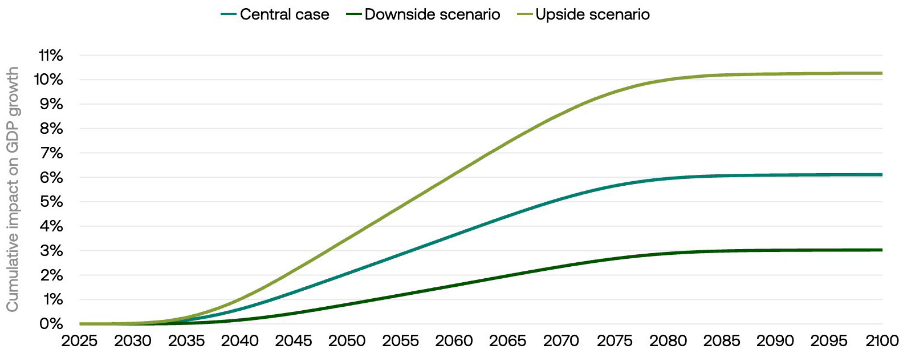



Upside scenario: 10% higher attainment and 4 years rollout
Central case: 6% higher education attainment, 4 years to set up the programme, 12 years for students to gain full benefit
Downside scenario: 3% higher attainment and 8 years rollout

Source: Office of National Statistics population projects, UK Labour Force Survey average hours and employment rates, and TBI own calculations

FIGURE 8

## Alternative scenarios showing the cumulative impact of AI-enabled education on the level of GDP




Upside scenario: 10% higher attainment and 4 years rollout
Central case: 6% higher education attainment, 4 years to set up the programme, 12 years for students to gain full benefit
Downside scenario: 3% higher attainment and 8 years rollout

Source: Office of National Statistics population projects, UK Labour Force Survey average hours and employment rates, and TBI own calculations

03

# The Costs of AI Rollout

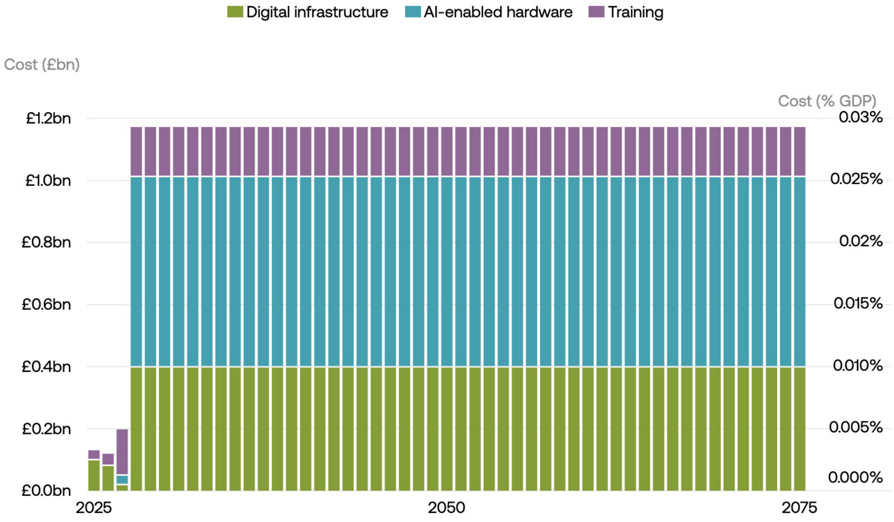
There are three main costs associated with deploying an AI-enhanced educational programme in the UK: 1) digital infrastructure and software; 2) hardware; and 3) teacher training. In this chapter we analyse the initial setup and ongoing costs associated with each of these elements.

We assume the programme will be rolled out to all UK schools, excluding non-maintained schools and nurseries, equivalent to 26,529.[20] This means there would be 560,400 full-time equivalent teachers in the programme each year and almost 10 million primary- and secondary-school students.[21] The devolved nature of the UK school system presents a challenge in determining how much an AI-enabled education programme would cost in reality. For example, many schools already have access to some tablets, which are a key hardware cost associated with the programme. We conservatively assume that the central government covers the whole cost of the programme and that any indirect savings accrue back to individual schools (for example, from schools with existing tablets no longer needing to fund them, or from efficiency savings from tablets reducing printing costs).

Overall, we estimate that it will cost £0.4 billion in today's prices in total over three years to set up the programme (0.01 per cent of GDP) and just under £1.2 billion each year (0.04 per cent of GDP) to run. We conservatively assume that over time these costs grow in line with GDP even though advances in technology could reduce the costs of the hardware and software in real terms (Figure 9).

FIGURE 9

## Cost breakdown by cost type




Source: TBI analysis and calculations

# Digital Infrastructure and Software

### DIGITAL LEARNER ID

**Delivery model:** Investing in a digital learner ID is an essential part of the core digital infrastructure needed to capitalise on the benefits of AI-enabled education. This comprehensive data ecosystem should seamlessly integrate all educational information for a given student and make it available in real time to the student, their parents and teachers.[22] To achieve this ambition a range of disparate data systems, including the National Pupil Database,[23] school and local-authority data, will need to be brought together in a unified platform. This platform would include a user-friendly digital portal – to enable students, teachers and parents to access the data, and utilise them to improve learning outcomes – and investment in data security and interoperability to ensure the system interacts seamlessly with privately provided edtech tools to achieve the maximum benefits of those tools.

**Setup costs (£0.05 billion):** Several US states have already successfully built digital learner IDs. In 2018, Nevada spent $2.5 million on a similar scheme while Virginia spent $6.5 million (Leventoff, 2018). We adjust these figures to account for inflation over the past six years and the size of the UK population, and then convert them into British pounds. This implies that the cost of setting up a digital learner ID in the UK with a user-friendly interface would be around £52 million (based on the more expensive Virginia case study).

**Ongoing annual costs (£0.01 billion per year):** We estimate it will cost £10 million (in today's prices) per year to maintain this system, based on US states' maintenance costs for their longitudinal federated data system (Leventoff, 2018).

### AI-ENABLED EDTECH TOOLS

**Delivery model:** To deliver the benefits of AI-enabled education for both students and teachers, we envision two approaches – government-finetuned AI foundational models for teachers and students, and collaborations with privately provided AI edtech tools for students. Both approaches require upfront investment from government – to set up the foundational models and to improve access and help create a vibrant market for privately provided edtech tools for students. The latter includes the cost of certifying new edtech tools and creating a central platform with clear information on each tool to help schools choose the best tools for their needs.

**Setup costs (£0.04 billion):** We assume that building an in-house AI foundational model would cost the government around £40 million, about half the amount OpenAI spent on training GPT-4.[24] We also assume that all schools will have access to high-speed internet to enable use of AI-enabled tools, based on the government's existing plan to roll out lightning-fast broadband across the country.[25]

**Ongoing costs (£0.4 billion per year):** Private edtech providers charge approximately £40 per user per year to access their tools, which typically only cover a subset of the curriculum (for example, Khan Academy[26]).

However, based on a confidential survey of edtech experts, we think costs could fall to around £30 per user per year to cover the whole curriculum, given the potential for bulk-buying discounts for the 10 million students covered by this programme. This implies the total ongoing costs of accessing AI-enabled edtech tools would be around £0.3 billion per year in today's prices. In addition, we assume a further £100 million in ongoing costs to cover data security, cloud data storage and management, and setting up an easy-access portal for schools to select appropriate tools based on a survey of private data-service providers.

### HARDWARE COSTS

**Delivery model:** A number of governments have already recognised the importance of having up-to-date ICT hardware in the classroom to ensure students and teachers can utilise the benefits of edtech tools to complement traditional methods of teaching. Several governments have already been convinced of the merits of a nationwide rollout of tablets – for example, Japan's GIGA project successfully rolled out connected tablets to every student in the country between 2019 and 2021.[27][28]

The same logic applies to AI-enabled edtech tools – students and teachers need reliable hardware to access the tools. We therefore assume as part of this programme that every teacher, every secondary-school student and one in five primary-school students get issued with a tablet. The latter are rotated through the school; the ratio is designed to assuage concerns of excessive screen time among primary-school students and was adopted by Glasgow City Council[29] in its successful tablet-rollout programme. The Glasgow City Council digital learning strategy reports that, based on its survey results, 80 per cent of young people responded that their iPad helped them overcome barriers to their learning and 90 per cent reported working with increased independence.[30]

To procure high-quality tablets, we assume the government would negotiate a large-volume purchase agreement for the provision of devices with relevant apps, licensing and warranties, whereby tablets are replaced every three years (to ensure access to the latest capabilities).

**Ongoing cost (£0.6 billion per year):** We estimate the cost of buying a high-quality tablet equates to about £100 per year (so £300 across three years for the whole device including all the relevant licensing, warranties and components)[31] based on current market rates and a discount for bulk purchases.[32] Given that just over 6 million devices would be required, this equates to an ongoing hardware cost of just above £0.6 billion each year.

### HUMAN TRAINING COSTS

**Delivery model:** To ensure that AI-enabled educational tools are fully utilised across all schools, we assume that the UK's existing CPD teacher training – which Ofsted has suggested has problems[33] – is revamped. We assume:

- All deputy head and assistant head teachers (around 52,000 individuals) receive a one-off 35-hour bootcamp of extra training on AI-enabled education tools. This is consistent with the Education Policy Institute's report[34] that one week (35 hours) of CPD would give time to train teachers on digital and pedagogical leadership. This is also consistent with evidence suggesting that the effectiveness of the senior leadership of schools affects student attainment.[35] These new "AI champions" would be responsible for disseminating best practice across teachers within their schools.

- The extension of CPD training by three hours per teacher per year and a significant revamp of the existing CPD programme to include digital skills, digital pedagogy and other competences to implement AI technology in the classroom. This would include increased funding for the three hours of additional training per teacher per year and retendering the training contract for CPD modules to specify the inclusion of AI competence and digital skills-related elements.

In the long run, additional AI and digital training should be provided during the process of qualifying as an educator, to ensure that all incoming teachers receive training on digital skills and AI competence, and know how to use them in the classroom.

**Setup costs (£0.2 billion):** We assume that it costs £80 per hour to train a teacher, based on data from the Employer Skills Survey (2022)[36] and Education Policy Institute (2021).[37] This implies an initial setup cost of £0.15 billion to train each of the 52,000 AI champions for 35 hours. We also assume a retendering cost of £60 million to upgrade the CPD programme to include a stronger emphasis on AI and technology (based on the cost of recent retendering processes).[38]

**Ongoing costs (£0.16 billion per year):** This includes £15 million in today's prices to train all newly appointed assistant and deputy head teachers (based on an annual attrition rate for deputy head teachers of 10 per cent[39]); £10 million per year to continually update the CPD programme to ensure it reflects the latest AI tools (based on the cost of similar Department for Education contracts[40]); and £135 million to pay for the additional three hours of CPD per teacher each year.

# 04 Net Benefits of an AI-Enabled Education Programme

Drawing on the above chapters, we find that the overall net impact of AI-enabled education on the public finances is substantial in the long term – leading to a reduction in annual public-sector borrowing of 2 per cent of GDP after 50 years and a cumulative reduction in public-sector net debt of 30 per cent of GDP over the same timeframe (see Figures 10 and 11). This could create more than £30 billion per year in extra fiscal space after the programme is fully rolled out. However, given the lags between implementing the scheme and its benefits materialising, the scheme does involve some upfront costs. During the first ten years of the programme, the scheme adds 0.3 per cent of GDP to the UK's debt position, but from 2035 on, the scheme begins paying for itself – breaking even by 2042 and continually improving the public finances from that point on. By 2050, the cumulative benefits of the scheme exceed costs by a ratio of 2.7; by 2060 this ratio rises to 5.2 and by 2070 it rises to 7.7 and is still rising at that point.

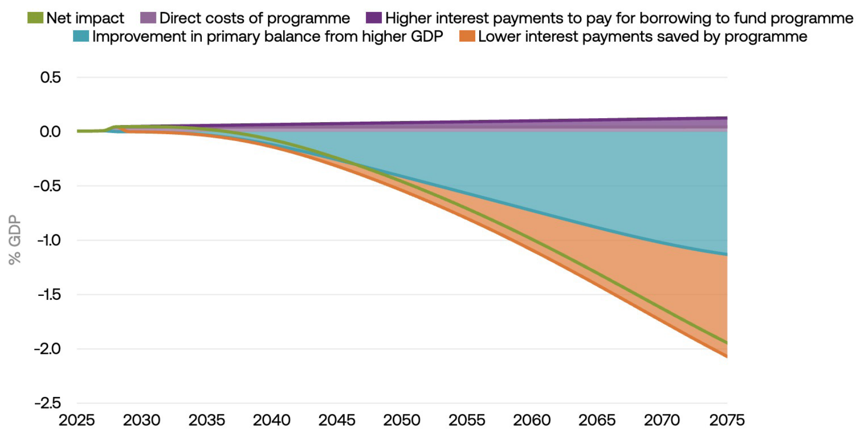
To generate the above figures, we have mapped the direct costs of the programme and its GDP impact through a fiscal model that has been designed to be consistent with how the Office for Budget Responsibility models the economy. Specifically:

**Costs:** The direct costs of the programme feed into the model via higher public spending on education, which is funded through higher borrowing in the short term. Higher borrowing indirectly adds to the cost of the programme through higher debt-interest payments (we assume an interest rate of 4 per cent based on the UK's long-term yield curve).

**Benefits:** The improvement in GDP also has a range of effects on the public finances. It boosts tax revenue on a 1:1 basis so that a 1 per cent increase in GDP also raises tax revenue by 1 per cent. In practice, given the size of the tax burden (40 per cent of GDP), this means that a 1 per cent improvement in GDP raises revenue by 0.4 per cent of GDP. The improvement in GDP is also assumed to encourage public spending based on Baumol's cost disease, whereby some public-sector costs rise in line with productivity improvements elsewhere in the economy. In practice, this means that a 1 per cent improvement in GDP raises public spending by 0.2 per cent of GDP (on the assumption that government spending accounts for around 40 per cent of GDP and around half of that spending relates to income-linked payments through the public-sector wage bill or through benefits). Since the revenue boost is around double the increase in public spending, this leads to an improvement in the primary fiscal balance over time, which has a secondary impact of reducing debt interest payments by allowing the government to pay down debt. This latter effect grows in importance over time as the gains from the scheme pay down more debt each year.

FIGURE 10

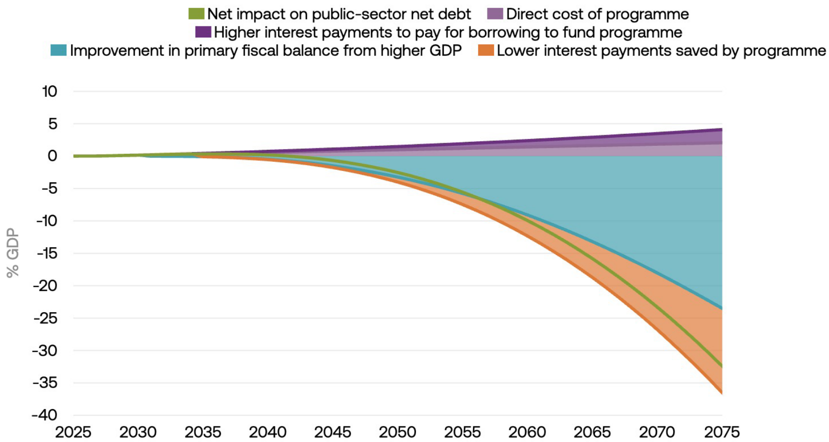
## Impact of AI-enabled education on annual public-sector net borrowing




Source: TBI calculations

FIGURE 11

# Impact of AI-enabled education on public-sector net debt




Source: TBI calculations

# 05 Looking to the Future: Further Potential Gains From AI

All of the above calculations are based on an assessment of AI's current capabilities, creating a snapshot of what could be achieved based on the technology as it is today. But AI is not static; its capabilities are advancing rapidly. In this chapter, we explore an upside scenario where the technology continues to improve over time so that it eventually raises educational attainment by 10 per cent instead of the 6 per cent base case.

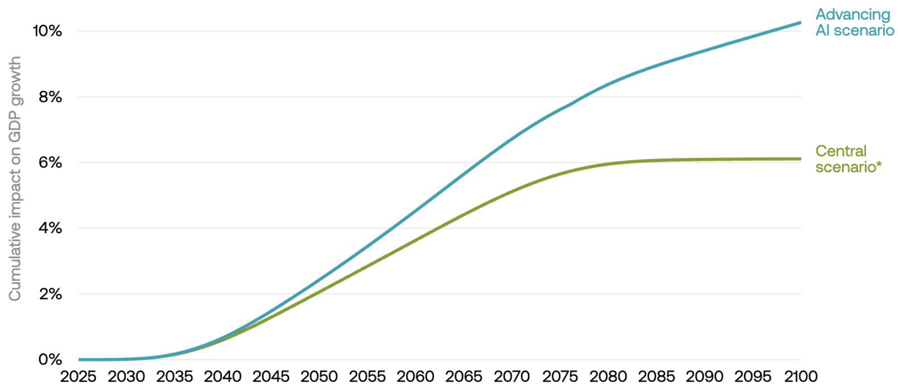
We select a 10 per cent figure based on the analysis in the first chapter on the impact AI could have on educational attainment, where some of the evidence on the potential for AI to improve attainment (particularly through higher teacher quality and the ability of students to absorb lesson content) points to bigger effects than the more conservative assumptions of our base case. For simplicity, we assume these technological advances occur gradually, so it takes time to lift GDP.

We also assume that advances in AI technology do not add any additional fiscal costs to the programme. The rationale for this is that in the base case we have conservatively assumed that the cost of existing edtech software will remain static in real terms. That is, there will be no improvement in quality and no fall in software costs, even though in practice competition tends to drive both effects. For the upside scenario, we assume competition does spur an improvement in edtech quality that drives higher educational attainment, but the price of the tools remains static in real terms.

Unsurprisingly, this "advancing AI" scenario improves the cost-benefit calculus even more. GDP rises by around 10 per cent in the long run versus 6 per cent in the base case (Figure 12) and the public finances improve materially. Annual public-sector borrowing is 2.5 per cent of GDP lower after 50 years (versus 2 per cent in the base case) and the cumulative reduction in public-sector net debt is more than 40 per cent of GDP over the same timeframe (versus 30 per cent in the base case) – as shown in Figures 13 and 14. This shows both the potential upside from investing in an AI-enabled education programme and the importance of designing the programme in a way that it can continually incorporate improvements in AI-edtech over time at minimal cost.

FIGURE 12

## Cumulative impact of advancing AI technology on the level of GDP

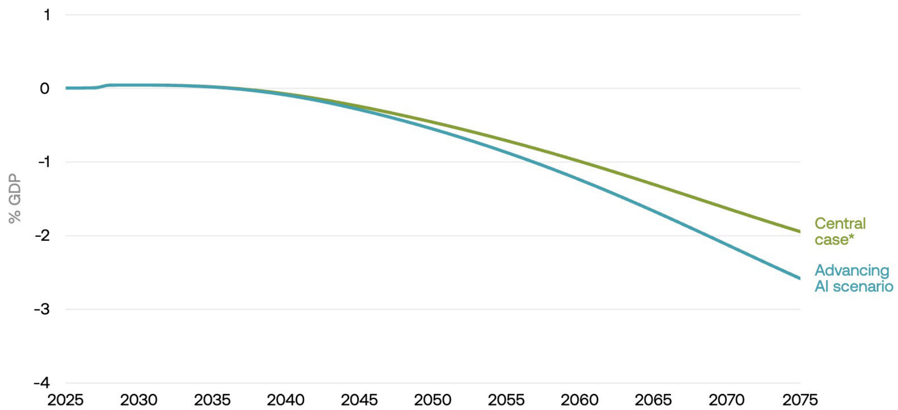



*Central scenario: 6% improvement in educational attainment

Source: Office of National Statistics' population projects, UK Labour Force Survey average hours and employment rates, and TBI own calculations

FIGURE 13

## Impact of further advances in AI-enabled education on public-sector net borrowing

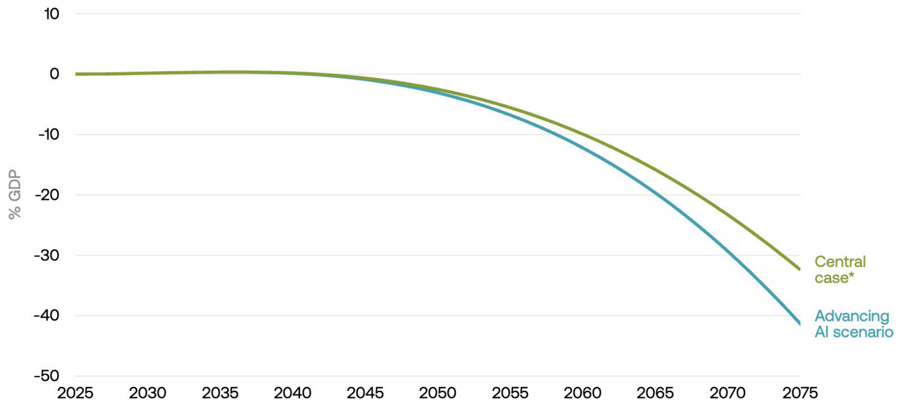



*Central case: 6% improvement in educational attainment

Source: TBI calculations

FIGURE 14

# Impact of further advances in AI-enabled education on public-sector net debt




*Central case: 6% improvement in educational attainment

Source: TBI calculations

# Endnotes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4 This could include partnering partnering with social-impact investors (through organisations such as Better Society Capital), where the government only pays the cost of the programme if educational attainment is proved to improve as a result of the technology's rollout.

5 For example, Kumar et al (2023) find that large language models positively impact learning concepts in the short term on mathematics education although no effect size is reported: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4641653. Choi et al (2023) assess AI assistance on human legal analysis, revealing that GPT-4 improved law students' speed and marginally improved their work quality (albeit inconsistently): https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4626276.

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