How did we get here? Timelines showing changes to maths education in England and the United States

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**Introduction**

Timelines enhance comprehension and offer a pictorial aid in organising information in a chronological sequence so that growth, change, recurring events, cause and effect, and key events of historical, social, and scientific significance can be better understood (Moline, 1995). They attempt to offer historical perspectives on theoretical debates, mandates, initiatives and reform movements, standards, bodies, organisations, councils, projects and strategies, as well as key publications, reviews, White papers and Acts at a National level.

The timelines presented here show the journey that mathematics education has gone through over time in both England and the United States of America (US). The starting date for the timelines differs in the two countries, because they both start with key events for education in that country. The England timeline starts from 1861, with the investigation of how schooling should be provided to all children in England. The US timeline starts approximately a century earlier, in 1788, with the publication of a set of teaching protocols for arithmetic. The two timelines detail major changes in mathematics education since those respective dates, including the introduction of, and changes to, curricula/standards and changes to major qualifications. The US timeline also shows major themes throughout the history, such as the “keeping maths in the hands of teachers” theme between 1900 – 1930.

The timelines cannot capture everything that has gone on in maths education in both countries, especially as there are fifty states in the US and different events, movements and initiatives might have happened in each state. Instead, the timelines aim to show how rich and complicated the history of maths education is in both countries and what has happened in general over time.

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1 There is a difference between England and the US in the terminology used to describe documents that contain the subject content to be taught. The documents are referred to as curricula in England and standards in the US.
Summary 1860s - 1920s:
Investigations into the introduction of elementary education led to its implementation in 1870.
The first national curriculum was introduced, but later withdrawn for financial reasons (Brown, 2010).
School leaving certificates (the forerunners of GCSEs and A levels) introduced for 16- and 18-year-olds.
Summary 1930s – 1960s:

Changed practices in primary schools due to changes to teacher training, e.g., introduction of new teaching materials such as Cuisenaire rods, Dienes’ Multibase Arithmetical Blocks.

The Curriculum Study Group (CSG) formed in the 1960s, focusing on organising and coordinating studies into the curriculum (Breakell, 2001).

Summary 1960s–:

Changes towards child-centred education (Brughes et al., 2012).

Dissatisfaction with the curriculum continued.

Reforms led to new material, such as co-ordinate geometry, probability and statistics entering the 11-16 curriculum.

Curricular innovations made possible because of the freedom given to schools to create their own syllabuses – led to several assessments including portfolios.

Post 1965 – sets and multi-base arithmetic appeared and disappeared, data gathering and display, more emphasis on geometry and number patterns, less time on learning arithmetic.

Three major projects: The School Mathematics Project, the Mathematics for the Majority Project and the Nuffield Primary Mathematics Project (Breakell, 2001).

Statistics became an alternative to Mechanics at A Level.
Summary 1970s:
About 1/3 of secondary schools were still following a traditional-style syllabus, 1/3 a modern syllabus and the rest were following hybrid syllabuses. To consolidate this muddled picture, the government created bodies to oversee examinations, which resulted in lists of ‘core’ items that had to be present in all curricula. Differences in what and how it was taught increased, creating greater gaps between students in fee-paying schools and students in state schools.

Summary 1980s:
Over the years of inquiry, a key finding was that of an adult population fearful of maths and incapable of applying maths. This continues and is seen today.
After 1984, the Secondary Examinations Council (SEC) replaced the Schools Council. The 1988 Education Act led to many changes, including year groups being labelled 1-11 and broken into key stages, a NC with a detailed list of mathematics content to be taught, a Task Group on Assessment and Testing established by Ken Baker to plan a journey through levels of mathematics. Further steps towards central control taken by requiring tests in the core subjects to be carried out at each key stage.
2010 - the English Baccalaureate introduced to encourage the study of English, maths, science, a language and history or geography (DfE, 2017).

2010 - Hodgen et al.'s report showed England as an outlier in its provision of mathematics for 16–19-year-olds in (Hodgen et al., 2010).

2010 - landscape of mathematics teacher CPD became fragmented and confused, replaced by NCETM.

2010 - reduced role of local authorities and rise of Multi-Academy Trusts.

2010 - increased level of centralisation, with guidance on maths teaching disseminated through new Maths Hubs.

2010 - National Numeracy Strategy content pushed out of schools and replaced by other DfE recommended schemes.

2012 - strengthened assessment for GCSE mathematics (specification content did not change).

2012 - adoption of the Maths Mastery curriculum and professional development programmes in many UK schools.

2014 - national curriculum made non-compulsory for Academies.

2014 – Mathematics free schools opened in some cities and areas of the UK.

2015 – a new curriculum for Maths GCSE and English introduced, with a new grading scale of 1-9.

2015 – new Core Mathematics qualifications introduced for first teaching as an alternative pathway to AS/A Level Mathematics for students with good GCSE pass grade who do not intend to progress to HE courses or employment that does not require significant use of mathematics.

2015 – new A Levels in Mathematics and Further Mathematics first introduced for teaching.

2017 – after a primary assessment consultation, plans made to introduce a statutory Reception Baseline Assessment (RBA) in autumn 2021 (postponed from 2020 due to COVID-19) to show progress from reception to the end of KS2. The RBA to assess language, communication, literacy and mathematics.

2017 – the reformed 2015 GCSE has more content and emphasis on problem solving. Examined for the first time in 2017.

2017 – first year for reformed 9-1 graded GCSEs. Subject content changed, new grading system covers higher tier grades (9-4) and foundation tier grades (5-1). Fewer formulae provided and no formulae sheet in exams, additional content, some topics moved from higher to foundation tier.

2017 – the National Reference Test for maths and English language introduced, testing changes in performance standards over time.

2019 – first assessment of the new Mathematics A Level.

2020 – the first T Levels (new, more practical level 3 qualifications) available in some colleges in England. More T Level courses to become available in 2021.

Summary 2010-2020:

A Level grading in recent years used a combination of examiner judgement and statistical information, with the process being overseen by Ofqual to ensure comparability of standards between exam boards and over time.

The new A Level in Mathematics has increased emphasis on mathematical modelling, reasoning and problem solving, but did not intend to make the qualifications more difficult. Despite a large growth of students taking Mathematics and Further Mathematics since 2005, Hodgen et al. (2010) suggested that many students do not choose to continue to study mathematics post-16 compared to the rest of the world.

NFER contracted to develop and deliver the RBA assessment, which was postponed from Autumn 2020 to 2021 due to COVID-19. Schools have 6 weeks to administer the assessment upon students’ entry to reception.

2017 – the first T Levels (new, more practical level 3 qualifications) available in some colleges in England. More T Level courses to become available in 2021.

2020 – intended introduction of the multiplication tables check (MTC) assessment for key stage 2 students, assessing year 4 pupils’ recall of multiplication tables. Postponed to 2022 due to COVID-19.

2020 – the first T Levels (new, more practical level 3 qualifications) available in some colleges in England. More T Level courses to become available in 2021.
US mathematics education timeline

1788 - Traditional Teaching
the New and Complete System of Arithmetic – Composed for the Use of the Citizens of the United States by Nicolas Pike provided a scripted set of teaching protocols: first - state the arithmetic rule, then - exemplify the rule, before finally encouraging students to complete a set of practice exercises.

1820 - Discovery Learning
Warren Colburn’s First Lessons in Arithmetic – was one of the first attempts to change the teaching approach from the traditionalist to more progressive (“new math”), encouraging pupils to discover rules themselves.

1831 - The Southern and Western Calculator (Bridge) declared that rules are needed, and pupils cannot invent them.

1832 - The Common School Arithmetic (Bates Botham) emphasised direct instruction, memorisation, and skill practice. Other publications at the time strengthened this popular perception.

1845 - the Activity Movement (drawing on the writings of Kilpatrick) encouraged integration of subjects in elementary schools and argued against separate instruction in mathematics and other subjects.

1845 - societal hope in progress through scientific method applied to classrooms through streamlining mathematics education.

1892 - Committee of Ten
National Education Association (NEA) appointed the Committee on Secondary School Studies. The Committee of Ten produced a report that established the traditional high school sequence of algebra, geometry, and advanced algebra as separate courses.

1899 - The School and Society: Being Three Lectures (1899) by Father of Progressivism John Dewey promulgated many key precepts of later education reform.

Summary 1780 – 1900:

Present day mathematics education remains profoundly influenced by the dominant cultural beliefs, ideas and stereotypes about teaching and learning first articulated and developed during the mid- to late-nineteenth century. The pendulum swings between traditional “good old fashioned” maths teaching and the early progressive movement. In 1840s-50s, the American society mostly viewed mathematics as used solely for social utility. In 1880s, G. Stanley Hall’s child studies were important for promoting the use of manipulatives and experience in teaching and for motivating research in cognitive development. Period characterised by two questions:

- should teachers offer students rules and facts to memorise (teacher-oriented approach)?
- or
- should they give students material to reason about to discover and develop understanding of underlying mathematical principles (student-oriented approach)?
1900 – 1930s

KEEPING MATHS IN THE HANDS OF TEACHERS

1920 - Kilpatrick (protégé of John Dewey) published *The Problem of Mathematics in Secondary Education* (one of the most influential documents for education in 20th Century).

1920 - Reacting to Progressivism
National Council of Teachers of Mathematics (NCTM) founded, mostly through the instigation of the Mathematical Association of America (MAA).

1920 - First NCTM president (C. M. Austin) promised that NCTM would “keep the values and interests of mathematics before the educational world” and urged that “curriculum studies and reforms and adjustments came from the teachers of mathematics rather than from the educational reformers” (1920).

1922 - Edward L. Thorndike’s *The Psychology of Arithmetic* emphasised extensive practice of isolated skills.

1923 - NCTM published *Report of the National Committee on Mathematical Requirements* - exerted some influence on public education. It proposed curricula for schools, documents the training of mathematics teachers in other countries, explored issues related to the psychology of learning mathematics, and justified the study of mathematics in terms of its applications as well as its inherent value. NCTM played an important role in disseminating what became the 1923 Report.

1925 - *Foundations of Method* (Kilpatrick) became a standard text for teacher education courses across the country.


Heightened Progressivism: The *Progressive Education Movement* helped boost American public schools from a promising idea to the established norm.

NCTM created partly to challenge the progressivist movement in mathematics.

Summary 1900 – 1930s

Teaching as Social Activity:

In the 1930s, the education, textbooks, and courses for administrators and teachers encouraged the foremost premises of progressivism. The school curriculum was to be determined by the needs and interests of students, as decided by professional educators, and not by academic subjects.

There was a rapid spread of the *Activity Movement* amongst elementary schools though high schools were more resistant because teachers were trained in specific subject areas and less willing to jettison their specialties in preference for a rather vague holism. Some exponents of the *Activity Movement* did not even concede that reading and learning the multiplication tables were genuine activities. However, in light of neo-traditionalist scrutiny and growing public dissatisfaction with life-adjustment education, the *Progressive Education Association*, the principal administrative organ of the *Progressive Education Movement*, closed its doors in 1955.
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**Summary 1950s-1960s:**

For more than a century, between the 1840s and the 1950s, American society predominantly regarded the function of mathematics as exclusively for social utility. The Second World War revealed that many American army recruits did not have adequate basic computational and problem-solving skills. The army provided training in arithmetic needed for basic gunnery and bookkeeping.

The 1950s and 1960s witnessed a significant upheaval in the content and perspective of school mathematics. The disturbance coincided with the increasing influence of educational psychology.
**1950s – 1970s**

**1958 - American Mathematical Society set up the School Mathematics Study Group (SMSG), led by Edward G. Begle (Yale), to develop new high school curriculum.**

**1959 – NCTM set up its own curriculum committee – Secondary School Curriculum Committee.**

**1963 - Cambridge Conference**
First phase of reform movement aimed at college students. The Cambridge Conference marked a second phase which saw the redesign of instruction for all grades and all levels as important.

**1965 – the Elementary and Secondary Education Act continued to offer funding for new developments.**

**1970: Two important questions in mathematics continued:**
- What mathematics should students learn – facts, skills and procedures or concepts and understanding?
- How should students learn: teacher-directed with focus on memorisation or student-centred through reasoning and discovery?

**1970s**

**BACKLASH TO ‘NEW MATH’**

**Mid-to late-1970s: many education experts conceded New Math as not a success. New Math failed because it was unable to raise computational skills. Though not an objective of New Math developers, perception popularised in books like Why Johnny can’t add: The failure of new math (Kline, 1973).**

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**Summary 1950s – 1960s:**

New Math, which focused more on conceptual understanding of mathematics over rote memorisation of arithmetic.

Throughout 1950s and 60s, backlash against New Math continued due to a belief that it lowered computational skills.

Many important National Science Foundation (NSF) funded projects, including School Mathematics Study Group (SMSG), University of Maryland Mathematics Project (UMMaP), University of Illinois Committee on School Mathematics (UICSM).

The SMSG was very influential and created junior and senior high school maths programmes and elementary curricula. They also developed textbooks.

The New Math movement introduced calculus courses in high schools. Although there were important successes, some of the New Math curricula were seen as very formal and not helpful in developing basic skills or applications of mathematics. Many teachers did not appear equipped to deal with the demanding content of the New Math curricula and public criticism grew.

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**Summary 1970s:**

This time saw emphasis on procedural arithmetic skills, direct instruction aimed at students, mastering the objectives, extensive use of local and national standardised assessments to measure student attainment of mostly low-level, skill-oriented objectives.

The NSF discontinued funding programmes.

A call to "go back to basics" in mathematics and in other subjects.

Progressive education regained its momentum with books such as Summerhill.

Open Education Movement – a repetition of progressivist programmes promoted in 1920s encouraged the idea of letting children choose what to learn.

Effects of the Open Education Movement on children with limited resources, from inner-schools or low-income families, were criticised by some due to lack of access to supplementary education or tutoring in basic skills out of school being available to those children and families.
STANDARDS-BASED REFORM

**1970s**


- **1972 - National Institute of Education (NIE) established then transferred Office of Educational Research and Improvement, US Department of Education in 1980.** Provided leadership in conduct and support of scientific inquiry into educational process of the time. NIE generated educational research and development and sponsored several studies including the Beginning Teacher Evaluation Study (1972-1978).

**1980s**

- **1980 - Agenda for Action (NCTM) recommended that problem solving should become main instruction of school mathematics curriculum.**

- **1983 - NCTM established Commission on Standards for School Mathematics (CSSM).**

- **1986 - Missouri Mathematics Effectiveness Project explored efficacy of experimental teaching programme.**

- **1987 - The Psychology of Learning Mathematics (Skemp)** contended that progress in the areas of learning and teaching mathematics can only be made when such factors as the abstract and hierarchical nature of mathematics, the relation to mathematical symbolism and the distinction between intelligent learning and rote memorisation are considered and instituted in the classroom. Skemp’s thinking underscored the standing of knowledge organisation and function of conceptual understanding in well-developed schema.

- **1989 - NCTM’s Curriculum and Evaluation Standards for School Mathematics promoted a variation of progressivism - “constructivism”.** By the end of the 1980s, a number of cognitively-oriented mathematics researchers were already inclined towards constructivist theory. Their labours resulted in attempts to re-emphasise the meaning and role of conceptual understanding in mathematics. National Science Foundation was the primary driver for implementing the NCTM Standards across American schools.

**Summary 1970s-1980s**

‘Back to the Basics’ – A New Reactionary Phase:

Over this period, cognitive research was becoming a dominant framework in mathematics education.

In the mid-1980s, cognitive research was the dominant framework in mathematics education.

The end of 1980s saw a number of cognitively-oriented maths researchers move towards more constructivist theories. Cognitive researchers demonstrated efforts to re-emphasise meaning and role of conceptual understanding in mathematics, which coincided with broader education policy statements.

The 1989 NCTM *Curriculum and Evaluation Standards for School Mathematics* inaugurated the first set of voluntary content standards in any subject and underlined understanding and reasoning. The cumulative influence of the various sets of standards during this period were responsible for engendering the Standards-Based Education Reform initiative.
1990s: Widespread recognition that the quality of mathematics and science education has been deteriorating. Further calls for "excellence" in schools and a few experimental programmes in some schools for some students occurred. Problem solving became a central theme in mathematics education.

1990s saw support for constructivism from the writings of Piaget and Vygotsky. "Integrated" high school maths books contributed to this child-centred approach by encouraging student discovery and problem solving.

By the mid-1990s, 41 states constructed state standards or curricular frameworks consistent with the NCTM Standards.

INTERNATIONAL COMPARISONS

1997 – NSF sponsored the K-12 Mathematics Curriculum Centre.

1998 – final TIMSS report compared students at the end of high school. Maths achievement of US 12th grade students along lowest of participating nations.

1997 - second TIMSS report compared 4th grade students in maths, US students slightly above international average.

1996 - first available results of the Third International Mathematics and Science Study (TIMSS), in which US 8th grade students scored slightly below international average in mathematics.
1990s continued

1990s continued:

NSF sponsored several mathematics programmes for K-12. In addition to aligning state maths standards to the NCTM Standards, NSF attempted to encourage approaches up to university level. Its funding of a “reform calculus” book (Harvard Calculus) encouraged calculators and discovery work by students. It minimised the level of high school algebra needed for the programme.

Mid 1990s saw a focus of attention on international comparisons of student maths achievement. The late 1990s saw criticism of the Standards, with claims that the new standards did not sufficiently emphasise procedural skills, direct instruction, practice and memorisation.

California’s 1997 standards were met with severe criticism from both NCTM and NSF immediately after their release. Standards received support from parent and mathematician groups. By the end of 1990s, California’s mathematics programme threatened the progressive movement of the last century.

At the end of 1990s, mathematics education policies in public schools were in a state of fluidity, with tensions between parents/mathematicians and professional educators. Widespread implementation of NCTM reforms created resistance, resulting in some schools/districts replacing standards-based curricula.
2000s – 2020s: Resolving the Mathematics Wars

### Standards-Based Reform

- **2000 (April)** - NCTM released *Principles and Standards for School Mathematics* - a revision of the 1989 NCTM Standards. It intended to address some of the criticisms of the first version.

- **2001** - Congress passes the No Child Left Behind (NCLB) Act. The Act aimed for all students to succeed and to reduce gaps. The Act authorised financial incentives for schools with good performance.

- **Mid-2000s**: Increasing objection to the Common Core Standards (e.g., from UCLA’s Gary Orfield and Mathematically Correct).

- **2008** - National Mathematics Advisory Panel Report provided recommendations based on research literature. It suggested that research did not support instruction that is either completely 'student-centred' or 'teacher-directed'. The curriculum should simultaneously develop conceptual understanding, computational fluency and problem-solving skills.

- **2010** - President Obama administration release blueprint for reform of the Elementary and Secondary Education Act (ESEA), which replaced the NCLB Act. NCLB considered controversial because it punished schools that did not demonstrate improvement. The incoherence of fifty different sets of standards, tests, and passing scores provoked by NCLB, together with exaggerations of student learning on state tests compared to NAEP results (Achieve, 2015), created fertile ground for the concept of the Common Core to gain traction.

- **2010** - President Obama relaxed very strict accountability measures determined by percentage of students at or above the proficient level in the NCLB legislation. Assessments modified for English language learners, minorities and special needs students.

### Common Core State Standards

- **2000s** - Adoption of the Common Core Standards for Mathematics – partially based on NCTM’s earlier work.

- **2001** - First attempt at finding peace in Maths Wars. National Research Council published *Adding It Up*, which suggested that pitting skill against understanding creates a false dichotomy.

- **2008** - Introduction of the Race to the Top grant programme by President Obama. The programme aimed to support schools in reducing gaps between students.

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- **2011** - By 2011 most states adopted the Common Core Standards.

### International Comparisons

- **2012** - Program for International Student Assessment (PISA) – US performed better than other progressive nations in mathematics, ranking 36/65. Found to have a high number of students who memorised.

- **2015** – TIMSS study – 4th graders’ average maths score higher than the average of students in 34 education systems, 4th and 8th graders – long-term improvement since 1995.

- **2015** – PISA tests – examined students’ understanding of mathematics and other subjects. US average score in maths decreased by 11 points.

### Support for Common Core State Standards

- Support for Common Core State Standards initially very strong. Published in 2010, a bipartisan amalgam of organisations representing parents, teachers, business leaders, educators, support vision and content of Standards.

### Objections

- Objections: mistaken belief that the Common Core is a federal initiative; confusion between standards and testing of standards; challenges of authentic implementation; social media – opinion versus evidence.
**Summary 2000s – 2020s:**

Between 2002 and 2010, mathematics instruction was focused more on content that is assessed on state tests. This time saw a system of 50 different sets of standards, tests and passing scores across the states.

The time period between 1967 – 2010, from First International Mathematics Study to ongoing developments and implementation of the Common Core Standards constituted most unbroken time period of K-12 curricular focus in mathematics education history in the US.

With increased societal aspirations, government legislation encouraging college readiness for all emerged. US high schools and colleges/universities became more outcome-based and focused on student growth measures.

**Common Core as a ‘Scapegoat’:**

The Common Core continued to be the focus of a growing countrywide resistance from an unusual coalition of right-wingers, liberals, teachers, and parents with pockets of defiance uniting into a national movement to eradicate the Core standards. The political ‘Tea Party’ once labelled the Standards as “Obamacore”, portraying the new Core assessments as an intolerable intrusion of the federal government into local control of schools. Parents were increasingly tired of the testing culture and drew a line with the new Core assessments. Some states even recoiled at the increased time and costs of the assessments. Surprisingly, teachers’ unions were split. On the one hand, some local groups, including the Chicago Teachers Union and the New York State United Teachers, disputed the new standards unreservedly. On the other, the two national unions - the National Educators Association (NEA) and the American Federation of Teachers (AFT) - supported the Core standards but wanted delays in their implementation.

**Breaking the Cycle of Resistance: Bringing the Pendulum to Rest**

The two historic, yet obdurate and seemingly interminable questions still require answers that will satisfy a potential raft of stakeholders (in particular, parents):

1. What should be the nature of mathematics that students learn – facts, skills, and procedures or concepts and understanding?
2. How should students learn mathematics – teacher-directed with a focus on memorisation, or student-centred through reasoning and discovery?
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