ITT 537-2 BRIEF

MATHEMATICAL FUTURES PROGRAMME. MATHEMATICS IN THE FUTURE (LOT 1 & LOT 2)

# Introduction

The Royal Society (the Society) is a registered charity, the national academy of science in the UK and a self-governing Fellowship of many of the world’s most distinguished scientists drawn from all areas of science, engineering, and medicine.

The Society’s fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity. The Society has played a part in some of the most fundamental, significant, and life-changing discoveries in scientific history and Royal Society scientists continue to make outstanding contributions to science in many research areas.

A major activity of the Society is identifying and supporting the work of outstanding scientists. The Society supports researchers through its early and senior career schemes, innovation and industry schemes, and other schemes. The Society facilitates interaction and communication among scientists via its discussion meetings and disseminates scientific advances through its journals. The Society also engages beyond the research community, through independent policy work, the promotion of high-quality mathematics, science and computing education, and communication with the public.

As the national academy of science in the UK, the Royal Society feels that it is time to consider and debate the role of mathematics in education in securing prosperity and wellbeing for individuals and our society. The Society has therefore established the Mathematical Futures programme (MFP) which aims to build a new vision of mathematics education that anticipates and supports the role of mathematics for individuals, education, economies, and society, strengthening diversity and reducing inequity. The Society is committed to excellence in all that it undertakes and asks all its partners and Suppliers to share this commitment.

The purpose of this Tender is to engage a Supplier or Suppliers to provide research which shall detail evidence to inform its Mathematical Futures Programme. The Services are described in detail in the specification and broadly comprise the following two work packages:

Work package 1

1. Evidence synthesis of studies concerned with changing nature and importance of mathematics in the 21st century.
2. Evidence generation for the importance of mathematics to education, society, the economy, and citizenship.

Work package 2

1. Scenario planning of the importance and value of mathematics to education, economy, society, and citizenship in the future.
2. Use outputs from Work Package 1 and Work Packages 1 and 2 in ITT 537-3 to inform scenario planning.
3. Expert views based on interviews and survey.
4. Engagement with experts through workshops.
5. Identify emerging policy challenges and opportunities for mathematics and education in the future.

The Society will work with the Supplier/s to confirm timeframes and start dates based on delivery of the other Work Packages in this ITT (537-2) and in ITT 537-3. The timeframes will be discussed and updated in regular project management meetings with the project team. The timings of these projects which are provided in Section 5 will need to run in sequence as follows:

* ITT (537-2) Work Package 1, ITT (537-3) Work Packages 1 and 2; followed by
* ITT (537-2) Work Package 2.

# Context

The Royal Society’s work in education policy focusses on creating the conditions for young people to receive a broad, balanced and connected education. It aims to equip them with the knowledge, skills and resilience that will enable them to successfully navigate and thrive in an uncertain world that is being transformed by digital technologies that are expected to change the types of jobs that will be available in future. This policy work addresses priority areas such as mathematical and quantitative skills, sciences, and computing education. Digital technologies are transforming our lives, including changing the types of jobs that will be available in future.[[1]](#footnote-2) Whilst there has been a rapid increase in the demand for data science skills, there is uncertainty about when and which jobs will cease and what new types of jobs there will be. The mathematical needs of people in the UK should be better understood than they are now, and our education systems configured to provision them.

Accordingly, the Royal Society’s Mathematical Futures Programme (MFP) Board has determined that the main aims of the MFP are to:

1. Understand the mathematical competences that will be needed by students leaving compulsory education and training in the future.
2. Consider the implications of reshaping mathematics education for 4–19-year olds.
3. Recognise the skills required for teachers who would teach these curricula.

These aims are centred around two core questions:

1. What mathematical competences will be needed for society to thrive in the future?
2. How should education systems develop these mathematical competences?

In the MFP, the term mathematics is used inclusively, covering a variety of ways of thinking, reasoning, and solving mathematical problems which touch on many aspects of everyday life, work and study (in mathematics as well as in other subjects/disciplines). It includes quantitative skills and other activities of a mathematical nature such as those associated with numeracy, statistics, computing, and data analysis. Mathematical competences cover the way mathematical concepts, skills and understanding as well as attitudes are brought together when applying mathematics to solve problems.

The programme seeks to look at mathematical competences across disciplines, not only from different areas of mathematics and natural science, but also from the social sciences and humanities. The scope covers the phases between the start of compulsory education and entry into higher or further education.

The MFP is concerned with the mathematical needs of young people progressing through compulsory education and preparing for diverse futures, including those who in their daily lives require:

1. basic functional numeracy for personal decision making.
2. mathematical literacy to understand and critique numerical claims.

and/or who work in:

1. traditionally non-quantitative jobs/professions, but requiring mathematical expertise: e.g., lawyers, journalists, civil servants, politicians, health practitioners, administrators, teaching practitioners (not mathematics), technical and vocational professions – including technicians.
2. jobs/professions where mathematical competences are a core component, e.g. analysts, engineers, financial professionals, scientists, social scientists.
3. mathematical sciences, e.g. mathematicians, mathematics teachers.

In Phase I, the MFP has initiated three projects in the first instance, to collect evidence and findings. Phase I is interested in how the genesis of mathematics and mathematics education policy, which plays a major role in the orientation on present and future, can inform and shape a future vision of mathematics and its education for the next generation. The evidence gathered in Phase I will then be used to shape the next set of projects in Phase II which is seeking to provide a vision for what the mathematical education landscape should be for the next generations of students.

In this Invitation to Tender (ITT 537-2), the Royal Society seeks tender submissions from Suppliers for Project 2 of the MFP, which is separated into Work package 1 and Work package 2. The Society has appointed Suppliers for Project 1, and a separate Invitation to Tender (ITT 537-3) has been launched for Project 3 at the same time as this tender.

**Project 1** (RFQ 537-1). Call for Views on the changing nature of mathematics and implications for education

1. The Call for Views was launched on 9 October 2020 and closed in mid-January.
2. Over 150 responses were received from members of the public in a range of industry sectors.
3. The analysis of the Call for Views responses and evidence due to be completed in May 2021 will inform Projects 2 and 3.

**This Service: Project 2** (ITT 537-2). Mathematics in the future: Evidence and scenarios for the importance and value of mathematics in the future

1. This project seeks to investigate the importance of mathematics (as defined above) to citizens’ future lives and jobs.
2. It is concerned with understanding the changing nature of mathematics and the impact such changes may have on education.
3. The evidence will involve foresight planning to propose several alternative scenarios for the future of mathematics.
4. Scenario planning will be informed by outputs from Project 3 (ITT 537-3).
5. The project aims to make recommendations relating to each scenario and inform the next phase of the MFP.

**Project 3** (ITT 537-3). Mathematics education in the future: Landscaping mathematics education policy

1. This project is an evidence synthesis which aims to bring together information from a range of sources to provide an accurate, concise and unbiased synthesis of national education policy patterns and approaches to enacting change and impact in education over the past few decades (e.g. since the emergence of GCSEs in England). [[2]](#footnote-3)
2. The project uses horizon scanning techniques and aims to identify key mega-trends in mathematics education policy in international jurisdictions and to consider the opportunities and threats to achieving the vision based on understanding of educational change.
3. The project aims to inform scenario planning in Project 2 (ITT 537-2).
4. The project aims to draw implications for future policy planning and realising the MFP ambitions.

# Research Services Requirements

The purpose of this Invitation to Tender is to engage a Supplier to provide Services in accordance with the details and specification enclosed herewith for Project 2: *Evidence and scenarios for the importance of mathematics in the future and the implications for education*.

The successful Tenderer/s shall provide research consultancy services to review and synthesise existing evidence on the importance and value of mathematics for education, society, the economy and citizenship in the UK over time and implications for education. The synthesis will then be used to inform future scenarios, each with a set of recommendations against each scenario. The findings and recommendations will be used to inform the MFP in Phase II and will help shape the MFP’s vision for mathematics education in the future. The detailed timeline for the completion of the Services is at Item 5 of this Brief.

The research commissioned shall enable the Royal Society’s MFP Board to produce a comprehensive report that addresses the following questions:

1. What contributions does mathematics make to the scientific, technological, economic, societal developments and citizenship over time and how is this changing?
   1. Has the nature of these contributions changed current societal, economic, occupational, and labour market trends and what do they suggest for changes in demand for mathematics competences?
   2. What are the implications for the future?
2. What are the plausible or possible future economic, societal, and labour market scenarios of the mathematical needs of citizens?
   1. Are these needs different across different categories of citizens under different plausible scenarios?
   2. Is there a 'skills gap' in the level of mathematical competence (in some categories)?
   3. What might be the economic returns and social benefits from obtaining these mathematical competences?
   4. What are the implications for the education system in the future?

At the end of the Service it is envisaged that the successful Tenderer/s shall provide the Society with a detailed and thorough written report(s) and other outputs (see Sections 4.1.2 and 4.2.2 below) containing the findings that have emerged from the research and shall have the opportunity to discuss the findings informally with the research team(s) in a dedicated meeting and present the findings to the MFP Programme Board in a meeting.

The Royal Society intend to then create an action plan based on the findings, in order to carry out individual projects with suitably expert partner organisations in the following 24-36 months and help education policy makers develop the policies needed to adapt to the increasing need for mathematical competences in the future. This study will thus provide the evidence base for the subsequent stage of the MFP.

# Services Work packages

There are two discrete work packages (or Lots) in this Specification (537-2). Tenderers are invited to submit tenders for one or both work packages which are detailed in sections 5 and 6 below.

1. Work package 1 (WP1) is related to the first research question and involves the production of an evidence synthesis concerned with the changing nature and importance of mathematics in the 21st century.
2. Work package 2 (WP2) is concerned with the project’s second research question and involves planning scenarios that predict the value of mathematical competences to education, the economy, society and citizenship in the future and draw implications and recommendations for mathematics education.

## Work Package 1

## WP1 Approach

Following on from Project 1. *Call for Views*, WP1 the Society asks the successful tenderer to identify evidence about the mathematical competences citizens and employers believe they need and their projected needs in the future. In identifying such evidence, the project will consider the value of mathematics to citizens’ future lives and employment and the implications of future social and economic conditions on mathematical education.

WP1 is an evidence synthesis of studies concerned with the changing nature and importance of mathematics in the 21st century. Evidence synthesis refers to the process of bringing together information from a range of sources and disciplines to inform debates and decisions on specific issues.[[3]](#footnote-4) An accurate, concise and unbiased synthesis of the evidence will make valuable contributions in shaping the MFP in Phase II. Using desk evidence synthesis, WP2 is intended to provide a comprehensive account of the evidence on the changing nature of mathematics and related policy issues.

It is envisaged that the evidence synthesis of studies investigating the nature of the contribution that mathematics has been making to society, economy and citizenship in the past as well as those which are seeking to make forecasts about future mathematical needs will provide context for scenario planning in WP2. The evidence synthesis will further inform Project 3: *Landscaping national and international mathematics education policy* and shape the MFP’s second phase.

## WP1 Outputs and timescales

The successful Tenderer/s shall deliver the following outputs:

| **Deliverable** | **Deadline for submission** |
| --- | --- |
| An evidence synthesis draft report to include the following topics:   1. Current context:    1. Identify significant assumptions or changes regarding the nature of mathematics as a discipline in the 21st century.    2. The contributions of mathematics to the economy, society, and citizenship in the 21st century contexts (e.g. public health, politics, risk, predictions for climate change and reduced biodiversity).    3. Whether and how the mathematical needs of different categories of citizens are different (especially in the UK).    4. The 'skills gap' in the level of mathematical competence in some categories in the UK.    5. The benefits from obtaining mathematical competences.    6. Validate and potentially amend the five categories of citizens from the proposed framework above.    7. Identify important areas, challenges and trends which may influence mathematical needs in education, society, economy, and citizenship in the future. 2. Possibilities for the future    1. How the nature of this contribution has changed and is changing over time and predictions for the future.    2. Identify evidence (quantitative or qualitative) for how mathematics might be important in the future for different categories of citizens:       1. Mathematical competences citizens and employers believe they need and their perceived needs in the future.       2. Value of mathematics to citizens’ future lives and employment.       3. Implications of future social and economic conditions on mathematical education       4. The needs of the education system for delivering mathematical competences in the future. 3. An in-depth interpretation of the findings in the context of current debates in education, research, society, and economy in the UK and abroad. | 10 September 2021 |
| A final report of the detailed analysis of the evidence | 27 October 2021 |
| Presentation of analysis | End November 2021 |

## Work Package 2

## WP2 Approach

Current debates have focused on the positive value of mathematics to society, the economy and citizenship from the rise of algorithms and machine learning or the increase in jobs relying on mathematical and quantitative skills. However, public perception of the social value of mathematics may be less positive due to concerns relating to how algorithms might be held to account in areas affecting the public sphere. WP2 intends to contribute to the programme’s focus on the future interrelationship between mathematics in education, society, economy, and citizenship. WP2 further aims to understand the implications of future changing social and economic conditions in the UK to better understand the likely consequences of mathematics education policy reforms being investigated in Project 3: *Landscaping mathematics education policy*.

WP2 is intended to stimulate thought and inform the MFP debate about system-wide national and international issues related to mathematical needs of citizens, focusing on the future, and setting plausible paths to 2040.

The successful Tenderer shall deliver the following activities to forecast the social and economic importance and value of mathematics in the future:

1. Validate and potentially propose amends to the five categories of citizens from the proposed framework above.
2. Identify what and how changes in mathematics and education could interact and impact future paths.
3. In addition to the evidence synthesis in WP1, identify evidence (quantitative or qualitative) for how mathematics might be important in the future for categories of citizens:
   1. mathematical competences citizens and employers believe they need and their perceived needs in the future.
   2. value of mathematics to citizens’ future lives and employment.
   3. implications of future changing social and economic conditions on mathematical education.
4. Since the ways in which mathematics might be important in the future is assumed to be uncertain, produce and describe a diverse set of possible scenarios.

## WP2 Outputs and timescales

The successful Tenderer shall deliver the following outputs:

| **DELIVERABLE** | **DEADLINE FOR SUBMISSION** |
| --- | --- |
| 1. Evidence generation for the importance of mathematics and its education in the future across different categories of citizens.    1. Expert views based on (virtual) interviews.    2. Expert views based on survey data (UK and international).    3. Engagement with experts through workshops. | 30 September 2021 |
| 1. A report of the detailed analysis of the evidence on the future scenarios to include some of the following:  * Scenarios planning to include 3-5 scenarios based on the evidence synthesis in WP1 and evidence generated in WP2. * Employ outputs from Work Package 1 and Work Packages 1 and 2 in ITT 537-3 to inform scenario planning. * Report to include   + Introduction, questions addressed in the research, methods, analysis, discussion, conclusions.   + Current importance and value of mathematics in society, economy, citizenship, and education.   + Future trends likely to shape mathematics and potential implications for mathematics education.   + Preliminary recommendations in the context of each scenario.   + Development of case studies.   + Development of personas of members of each category with different mathematical needs. | February 2022 |
| 1. Presentation of analysis | February 2022 |
| 1. Visualisations and other media (e.g. videos) of the possible future needs of the different personas. | 31 March 2022 |

# Project Timescales

The timelines are provided at Item 6 of the **Instructions to Tenderers** document.

The table below details the key dates for the delivery of the Services. A programme Gantt chart is in Appendix 1.

|  |  |  |
| --- | --- | --- |
|  | Project stage | Dates |
| 1 | WP1: Contract signed and executed | w/c 26 April 2021 |
| 2 | WP1: Kick off meeting | 26 April 2021 – 30 April 2021 |
| 3 | WP1: Evidence synthesis | 3 May 2021 – 9 July 2021 |
| 4 | WP1: Drafting of report | 12 July 2021 – 10 September 2021 |
| 5 | WP1: Peer review of report by the MFP Board members | 13 September 2021 – 27 September 2021 |
| 6 | WP1: Finalisation of report | 28 September 2021 – 26 October 2021 |
| 7 | WP2: Contract signed and executed | 25 April 2021 |
| 8 | WP2: Kick off meeting | 26 April 2021 – 30 April 2021 |
| 9 | WP2: Evidence gathering for scenario planning | 3 May 2021 – 30 September 2021 |
| 10 | WP2: Scenario planning | 1 October 2021 – 17 December 2021 |
| 11 | WP2: Drafting of report | 20 December 2021 – 31 January 2022 |
| 12 | WP2: Peer review of report by the MFP Board members | 1 February 2022 – 14 February 2022 |
| 13 | WP2: Finalisation of report | 15 February 2022 – 3 March 2022 |
| 14 | WP2: Production of visualisations/media | 31 March 2022 |

# Governance

The programme is overseen by the [Royal Society Advisory Committee on Mathematics Education](https://royalsociety.org/about-us/committees/advisory-committee-on-mathematics-education-acme-5/) and the Mathematical Futures Programme Board, both chaired by Professor Sir Martin Taylor FRS.

# Resources

The successful tenderer shall:

1. Demonstrate a systematic approach to project management and adhere to project milestones and timelines;
2. Deliver the work within the agreed budget and timeframe; and
3. Be flexible to the changing needs of the Royal Society and the programme and be able to adjust to reasonable requests and/or demands within reason.

The Society shall provide guidance and support to the successful tenderer in all matters relating to the working practices of the Royal Society. The successful Tenderer/s shall work in partnership with the internal programme team, who have resource in the following areas:

|  |
| --- |
| THE SOCIETY INTERNAL TEAMS/RESOURCE & ROLES |
| 1. Programme lead and oversight. |
| 2. Programme coordination. |
| 3. Press and media relations. |
| 4. Access to expertise in the areas of interest to the programme (either by open invite or invitation only depending on audience group). |
| 5. External promotion and reporting of the project outputs on social and other marketing/media channels. |
| 6. Design of event collateral and some animated content (if required). |
| 7. Liaison with the Royal Society’s internal teams, colleagues, and external stakeholders. |
| 8. Participation in project and planning meetings. |
| 9. Sign-off and authorisation of all project outputs, materials, and communications. |
| 10. Speaker liaison for participation in stakeholder workshops (as required). |

# Budget

The estimated budget for the Services for both work packages in this project is up to a cost of £80,000 (VAT inclusive). The budget split is as follows:

1. WP1 - £30,000 to £35,000 (VAT Inclusive)
2. WP2 - £40,000 to £45,000 (VAT Inclusive)

Tenderers shall state which of the work packages they are tendering for in their submission by using the Pricing Schedule at Attachment 5 of the tender pack. Please provide justification for your proposed costs in line with your research approach by providing a detailed breakdown of your offering and associated costs.

Tenderers are asked to bear in mind that the Society is a registered charity and the MFP is partially funded by government grant funding. Tenderers are requested to provide as much detail as possible in their pricing.

# Appendix 1. Programme Gantt Chart

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2021 | | | | | | | | | | | | 2022 | | |
| Project and work package | April | May | June | July | August | September | October | | November | | December | | January | February | March |
| Project 1 (ITT 537-1) |  |  |  |  |  |  |  | |  | |  | |  |  |  |
| **Project 2: WP1 (ITT 573-2) (this tender)** |  | | | | | | | | |  | | | | | |
| **Project 2: WP2 (ITT 573-2) (this tender)** |  | | | | | | | | | | | | | | |
| Project 3: WP1 (ITT 573-3) |  | | | | | | | | | | |  | | | |
| Project 3: WP2 (ITT 573-3) |  | | | | | | |  | | | | | | | |

1. https://royalsociety.org/news/2018/09/the-impact-of-ai-on-work/ [↑](#footnote-ref-2)
2. Note that the primary focus of the Mathematical Futures Programme is on England, with a wider interest in the UK policy developments and changes. [↑](#footnote-ref-3)
3. https://royalsociety.org/topics-policy/projects/evidence-synthesis/ [↑](#footnote-ref-4)