

December 2020

Joint submission from the Royal Society and the Joint Mathematical Council of the UK to the Commons Education Committee inquiry into the impact of COVID-19 on education and children's services

1. Key Points

- Our survey of teachers of mathematics suggests that the COVID-19 pandemic has had a significant impact on the teaching and learning of mathematics in the second half of 2019-20 and during the Autumn term 2020.
- Interruption to mathematics teaching and learning is of particular concern because mathematics is a linear, hierarchical and connected discipline and therefore disruption can inhibit progression.
- This is important because mathematical skills provide critical and foundational knowledge that are fundamental to success in other subjects and underpin many career paths.
- Disruption to mathematics learning will have far-reaching impacts that the UK will realise for years to come if action is not taken now to address these.
- Although it is important to recognise that it is not nationally representative, our survey data provide an insight into key national trends in mathematics teaching and learning as a result of the COVID-19 pandemic:
 - Students have fallen behind in mathematics as a result of the COVID19 pandemic
 - Current government interventions to address these challenges are not being well-used
- These findings highlight the importance of further monitoring and assessment of mathematics teaching and learning to inform future government interventions to minimise the impact of this disruption going forward.
- Evidence-informed action will be crucial to ensure that young people in the UK have the skills that they need to succeed in future and that the UK can access the skilled people that it needs to deliver its ambitions as a resilient, successful economy.

2. Introduction

- 2.1 The Royal Society is the national academy of science for the UK. Its Fellows include many of the world's most distinguished scientists working across a broad range of disciplines in academia, industry, charities and the public sector. The Society draws on the expertise of the Fellowship to provide independent and authoritative advice to UK, European and international decision makers.
- 2.2 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. Our strategic priorities therefore are to promote excellence in science; to support international collaboration; and to demonstrate the importance of science to everyone.

- 2.3 The Joint Mathematical Council of the United Kingdom was founded in 1962 to provide a forum for organisations working in mathematics education to assist them in furthering their objects. It meets three times a year and every four years holds the British Congress of Mathematics Education. It is concerned with all aspects of mathematics education at all levels from primary education to higher education. It also undertakes other initiatives for the improvement of mathematics education.
- 2.4 The Society has already responded individually to this inquiry. This supplemental submission shares the findings of a survey of teachers on the impact of COVID-19 on mathematics education. The survey was conducted by the Royal Society's Advisory Committee on Mathematics (ACME) together with the Joint Mathematical Council of the UK.
- 2.5 When reviewing the findings, it is important to note the limitations of the survey. It was conducted between 2 November and 23 November 2020 and completed by 495 teachers of mathematics working in England and Wales, including mathematics subject specialists and senior leaders in schools and colleges who had been invited to respond through teacher networks and social media. This element of self-selection means that the survey does not provide a representative sample, but it does provide a helpful insight into the experiences of teachers of mathematics that highlight growing concerns and can inform policymaking. We do recommend further monitoring and assessment of mathematics education to inform policy interventions going forward. The full survey findings are provided as an annex and available online <https://royalsociety.org/topics-policy/education-skills/mathematics-education/royal-society-acme/maths-education-and-covid-19> .

3. Key findings

The teachers responding to this survey identified the following main issues with the teaching and learning of mathematics in schools and colleges since the COVID-19 pandemic began:

3.1. Students have fallen behind in mathematics as a result of the COVID-19 pandemic

- The survey found that students' engagement and motivation with mathematics was negatively impacted at the start of the pandemic. In these teachers' view, the issue with students' negative engagement and motivation was more detrimental to students' learning of mathematics during the COVID-19 pandemic than lack of access to digital technology.
- More than half of students are three months or more behind in mathematics in the Autumn term as a result of the COVID-19 pandemic.
- Teachers have not been able to use their wider repertoire of effective methods of teaching mathematics due to high levels of staff and student absence and social distancing rules.
- Teachers have also had to reduce and change what they teach – choosing not to cover the full curriculum in the limited time available.
- A concerning consequence highlighted by two-thirds of teacher survey respondents was that A level mathematics students have found the transition from GCSE more challenging this year compared to what would be expected for a similar cohort.

3.2. Current government interventions are not being well-used

- The Government has taken welcome steps to recognise the disruption presented by the pandemic and develop interventions to address this.
- However, the findings of our survey highlight the value of monitoring the extent to which these actions have had the desired effect on student progression and attainment.
- Half of respondents in England were not making use of the catch-up premium and/or the National Tutoring Programme (NTP) for mathematics.

- Many teachers answering this survey reported that they are best placed to support their students but were lacking the resources to teach mathematics effectively during the COVID-19 pandemic.

4. Conclusions

- 4.1. The findings of this survey highlight the importance to further monitor and assess the effect of the COVID-19 pandemic on mathematics teaching and learning to inform future Government interventions to minimise the impact of future disruptions.
- 4.2. There is a need for systematic collection of quality and timely data with swift, safe and ethical access needed to inform government interventions and monitor their uptake. The Department for Education should rapidly publish data on how schools and colleges have spent money provided, any problems that they have encountered, numbers of those who have enrolled, types of tutoring provided and impact of the projects funded on student progression and attainment. This should be used to identify and address barriers and inform the design of future interventions.
- 4.3. In addition, action is needed to ensure research is coordinated and utilised to better meet current and future needs relating to the impact of COVID-19 on young people. This could form part of the remit of the Office for Educational Research recommended by the Royal Society and the British Academy.¹

For further information, please contact public.affairs@royalsociety.org

¹ <https://royalsociety.org/topics-policy/projects/royal-society-british-academy-educational-research/>

Annex. RS ACME/JMC Survey with teachers on the impact of COVID-19 on mathematics education

Summary of key findings

March – August 2020

Students may be behind in their learning as a result of the COVID pandemic.

- Student engagement and motivation were a primary concern of the teachers responding to the survey.
- Patchy access to digital technology meant that teachers were not able to implement teaching strategies conducive to student learning.
- The intended new curriculum was not addressed or was not consistent across providers.

September – November 2020

- High levels of student and staff absence, poor student motivation, concentration and resilience have negatively impacted students' learning of mathematics.
- Teachers responding to this survey considered that more than half their students under age 16 are more than three months behind where they would be expected to be in mathematics.
- Around two thirds of teachers who answered the survey considered that social distancing rules have impacted the quality of teaching and teachers' ability to support students' learning.
- More than half of teachers who answered the survey
 - Are not using the catch-up premium/NLP.
 - Had to change curricula this academic year.
 - Considered that students find transition from GCSE to A level mathematics more challenging this year compared to what would normally be expected.

Survey aims

This survey is part of a collaborative project between the Royal Society and the Joint Mathematical Council of the UK (JMC) investigating the impact of the COVID-19 pandemic on the teaching, learning and assessment of mathematics in schools and colleges in the UK. The survey aims were as follows:

- Investigate the impact of the COVID-19 pandemic on the teaching and learning of mathematics in the second half of 2019-20 and during the Autumn term 2020;
- Understand the challenges and opportunities with current policy initiatives to support the teaching of mathematics (e.g. tutoring programme, online curriculum materials) and identify what else teachers need in the mathematics space;
- Consider possible future impacts of the COVID-19 pandemic on mathematics teaching and learning;
- Explore how teachers have made use of online and blended resources and the challenges of engaging learners at distance;
- Inform teachers, leaders, policy makers and other stakeholders of what is happening and give consideration to how the mathematics education of young people can be best supported in these challenging times.

Survey design

The survey was carried out between 2 November and 23 November 2020 and comprised 12 select response questions and 5 open-ended questions to allow for both quantitative and qualitative findings. The questions were designed to gather information about respondents' work context and experiences with teaching mathematics since the pandemic struck. Most questions allowed teachers the opportunity to provide further information beyond what could be captured in the options provided.

Responses

This was an opportunity sample of teachers of mathematics in primary, secondary and further education contacted using teacher networks and social media. In total, there were 495 responses from teachers of mathematics, including mathematics subject specialists and senior leaders in England (88%) and Wales

(12%). Table 1 shows the number of respondents for each Key Stage. Teachers of Key Stages 3 to 5 opted to answer about only one of these stages.

Table 1. Respondents for each Key Stage

Key stages	%
1-2	19.1
3	10.3
4 – GCSE	39.5
5 – A level mathematics	23.8
5 – GCSE/Functional Skills	7.13

Findings

Nearly 500 maths teachers from across the UK told us about their experience of teaching maths, and of their students' learning, since the COVID-19 pandemic began. The main issues they identified were:

1. Student motivation, participation and attainment

- Students' engagement with mathematics and motivation for learning was negatively impacted at the start of the pandemic.
- Teachers responding to this survey found that students' negative engagement and motivation was more detrimental to students' learning of mathematics during the COVID-19 pandemic than lack of access to digital technology.
- More than half of students are three months or more behind in mathematics as a result of the COVID-19 pandemic.
- A level Mathematics students have found the transition from GCSE more challenging this year compared to normal.

2. Teaching of mathematics

- More than half of the teachers responding to this survey have had to change what they teach which is likely to impact on students' learning this academic year.
- Social distancing rules are likely to impact on students' learning since mathematics teachers are not able to provide the same range of interactive learning environments for students.

3. Teaching workforce

- High levels of staff and student absence this academic year are likely to have further negative impact on students' motivation and progress in mathematics.
- The mathematics teaching workforce may suffer as a result of the COVID-19 pandemic – teachers are ill, leaving the profession, feeling undervalued and under resourced.
- Teachers require funding to better support students' learning of mathematics, e.g. for resources for manipulatives which cannot be shared in the usual way, digital technology or online mathematics learning materials.

4. Current Government interventions need to be monitored to ensure they have desired impact

- Half of respondents in England were not making use of the catch up premium and/or the National Tutoring Programme (NTP) for mathematics.
- Teachers recognised the utility of online resources available for mathematics but highlighted the challenges with using them with diverse groups of students for whom they were not necessarily designed.

Analysis

1. Student motivation, participation and attainment

1.1. Students' engagement with mathematics was negatively impacted at the start of the pandemic

- From March to the Summer term 2020 when most students were learning remotely, teachers used mainly online asynchronous strategies (such as recorded videos and online quizzes) and

paper-based activities. Live lessons and online chats (synchronous activities) were used to a much lesser extent (**Figure 1**).

- Group work and interactive approaches to teaching were used less often. Since interactive approaches are a staple of effective mathematics teaching, teachers in this survey considered that live online (**synchronous**) teaching involving teacher-student interaction is more conducive to improving students' attainment than classes where lessons were pre-recorded and sent by email (**asynchronous**). However, due to safeguarding concerns and lack of digital technology, teachers were not always able to use such strategies. Further research is required to synthesise existing evidence regarding how best to deliver blended learning ^{2, 3}.

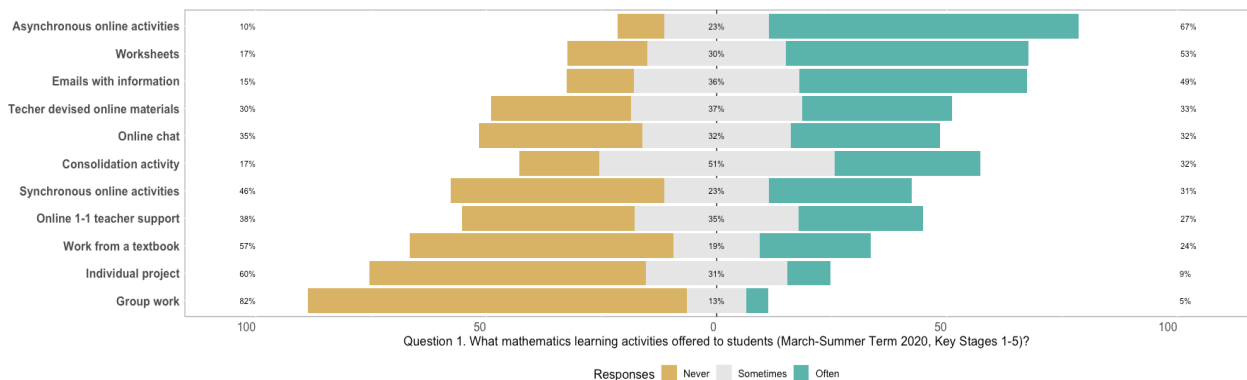


Figure 1. What mathematics teaching activities were offered to students (March to Summer term 2020)

- The survey results suggest that challenges with access to digital technology and students' home environment may mean that teachers were not able to implement strategies which, in their view, would have supported students' learning and engagement with mathematics during lockdown (**Figure 2**).

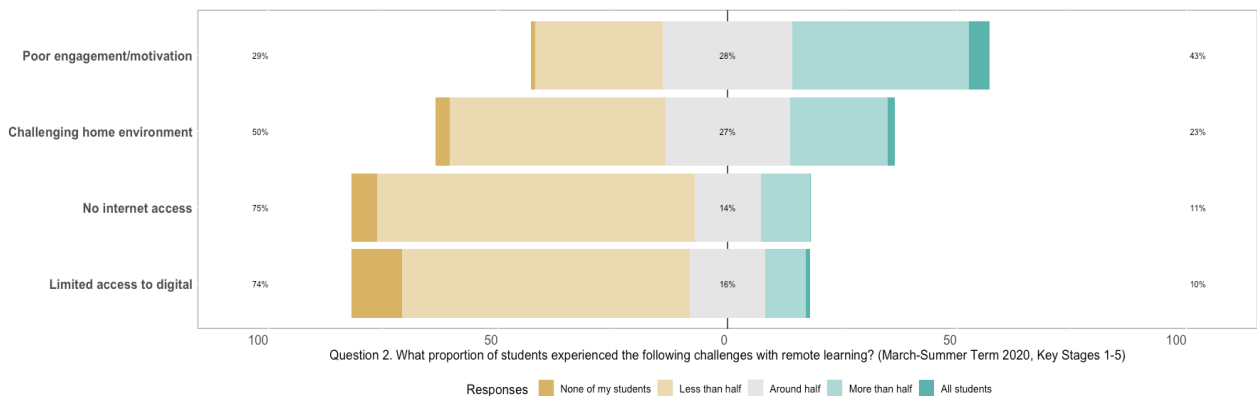


Figure 2. What proportion of students experienced these challenges with remote learning (March to Summer term 2020)

- In these teachers' views, the main challenges for students were poor engagement, motivation and maths anxiety. For teachers, the main challenge was monitoring student progress.

² https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3565608

³ <https://business.senedd.wales/documents/s104636/CYPE5-20-20-20-Paper-20to-20note-2021.pdf>

- The results of the survey suggest that low student motivation and anxiety as well as difficulties with monitoring progress remotely may have a longer-term negative impact on student attainment and progression in the subject across all stages of education.⁴

*Maths needs time to embed and consolidate and that is what we do not have, the time to give children the practical experiences they need. The pandemic has also meant that resources cannot be shared and we do not have the funds to purchase essential manipulatives for all children.
[Mathematics Teacher Key Stage 1, State Funded Primary School]*

Covid has created big gaps between students, in the amount they have covered, the success with which they have been able to work successfully independently and their confidence and enjoyment of mathematics. Students from disadvantaged backgrounds have disproportionately experienced the negative effects. [Mathematics Teacher, Sixth Form college]

1.2. Students are behind in mathematics as a result of the COVID-19 pandemic

- Teachers in this sample considered that most students were behind in mathematics in the Autumn term compared to where they would expect them to be under normal circumstances (**Figure 3**). At Key Stages 1 to 4, more than half of students are more than 3 months behind in mathematics in these teachers' view. Two in three A level mathematics students are 1 to 6 months behind compared to where these teachers would expect them to be at the start of term. Teachers in this survey reported that they are only beginning to understand the extent to which students' learning and engagement with mathematics has been affected by the pandemic.
- Teachers' qualitative answers to the survey suggest that reduced engagement due to the home learning environment, availability of IT and limited new content taught during this period often slowed students' progress. However, for a significant minority of students the home learning environment was beneficial as they could focus better at home if they had the right level of support.

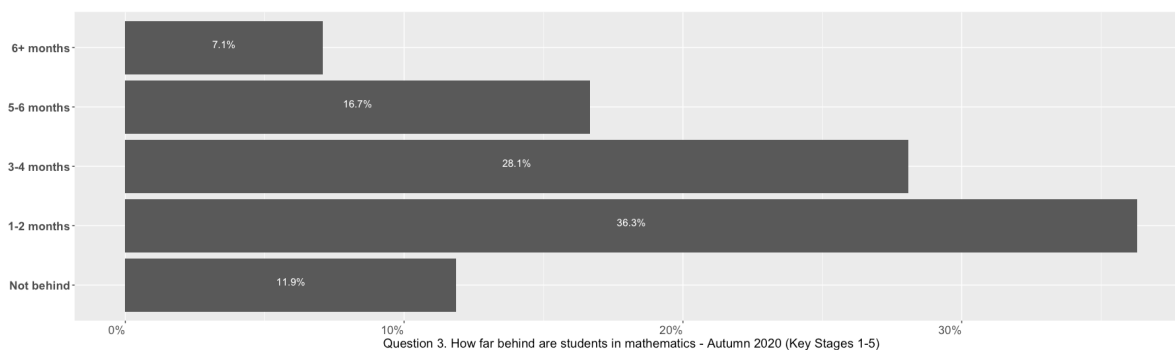


Figure 3. How far behind are your students in mathematics (Autumn 2020)?

1.3. High levels of staff and student absence this academic year are likely to further impact students' motivation and progress in mathematics

- Teachers report low student confidence and poor concentration this academic year, which are likely to further impact on students' progress in mathematics (**Figure 4**).
- The main constraints to teaching mathematics at present are reported to be student absence and isolation, low student confidence, motivation and poor concentration.

⁴ http://www.acme-uk.org/media/18410/issue_1_blueprint_final_version_10june.pdf

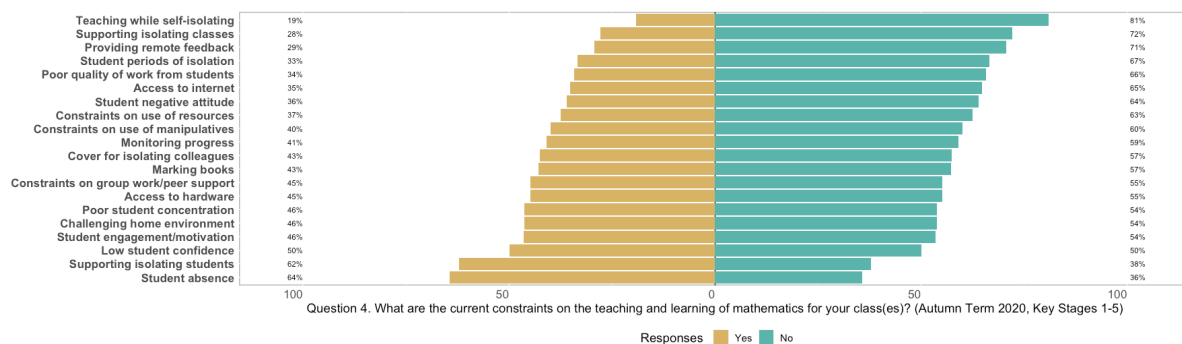


Figure 4. What are the current constraints on teaching and learning of mathematics for your class(es)? (Autumn 2020)

1.4. A level Mathematics students have found the transition from GCSE more challenging this year compared to normal

- Although our data suggest that the uptake of A level Mathematics this year compared to last year may not be a concern, it is possible that low motivation, high levels of anxiety and poor-quality learning will impact participation and attrition in the longer term.
- A concern highlighted by two-thirds of those respondents who are teaching A level Mathematics was that their students have found the transition from GCSE more challenging this year compared to what would be expected for a similar cohort (Figure 5).
- This survey provides a snapshot of current challenges and there is a need to further monitor students' participation in post-16 mathematics qualifications over the next five years, including supporting adult learners, individuals with SEN and underrepresented groups at level 3 such as girls, BAME and socially disadvantaged students.

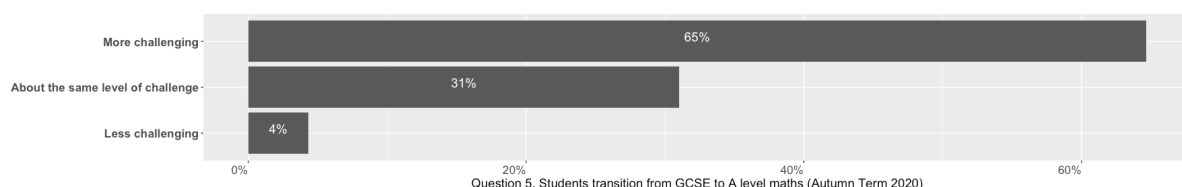


Figure 5. Compared to last year, how have your A level mathematics students coped with the transition from GCSE?

Considering that [students] finished learning maths in March for most of our current year 12's this is to be expected and we are providing support for getting the students up to speed. [A level Mathematics Teacher, FE College]

Y12 students, on average, this year have far more gaps in understanding on key topics than grade 6-9 students would normally. [A level Mathematics Teacher, Academy 11-19]

Students do not have the same level of algebra skills as in the past and many Year 12 students are out of the habit of learning/keeping to deadlines. [A level Mathematics Teacher, Sixth Form College]

1.5. Teachers require funding to better support students' learning of mathematics

Teachers responding to this survey reported that they are lacking the range of resources to teach mathematics effectively during the COVID-19 pandemic. Qualitative responses from teachers indicate that they urgently require appropriate levels of funding so that they can use their experience and expertise in addressing challenges with loss of learning since March 2020, including investment in

- Programmes that address students' low motivation and confidence with the content such as a national mentoring programme to help students overcome maths anxiety.
- Digital CPD.
- Core maths (including for adults).
- Online resources.
- Resources for manipulatives.
- Additional time for preparation, planning and assessment.
- Provide digital resources to students and teachers for remote and blended learning.

I didn't have the necessary equipment to make online teaching work originally. It was just me clicking through a powerpoint which was really ineffective and didn't allow students to make progress. In the end, it was so difficult and hard to provide [students] work I paid for my own equipment out of my own money. [Mathematics Teacher, State Funded Secondary]

2. The teaching of mathematics.

2.1. More than half of the teachers responding to this survey changed the mathematics schemes of work

- Teachers in this survey report that they are very worried about not being able to cover the curriculum and supporting students' learning which may lead to widening of attainment gaps even further. In the qualitative answers, they made a plea for reducing pressure from Ofsted. Teachers were also asking for clarity around examinations in 2021 such as SATs, GCSE and A levels.
- Three in four teachers from Reception to Year 11 (and equivalent) are teaching an adapted scheme of work in order to accommodate gaps in student learning or blended teaching for isolating students. Only a minority of teachers have done so due to the normal changes to school curricula. Sudden changes to curricula are likely to impact teacher workloads and stress levels during a very challenging time for schools and colleges (**Figure 6**).
- A level mathematics contains high level content delivered over a short period of time with limited flexibility. Students who opt to do this qualification are expected to have a good level of mathematics when they start since the qualification is high status and high stakes for students. However, this academic year, more than half of the A level mathematics teachers changed the Scheme of Work this academic year in order to accommodate students' learning gaps and requirements for blended learning. This data suggest that students are finding the A level mathematics content particularly challenging as a result of the pandemic, which may have implications for examinations policy in the Summer 2021 and very likely for the next several series. There is a need for implementing measures that ensure rigorous standards for GCSE, A level, and Further Mathematics examinations are achieved in future series.

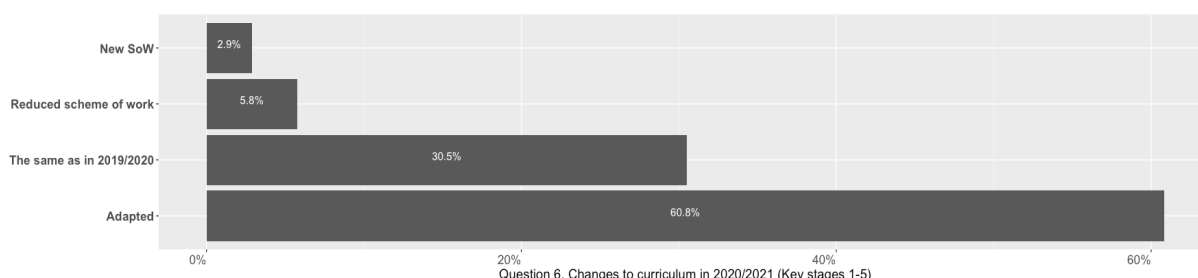


Figure 6. Which of the following statements best describes your mathematics scheme of work since the start of this academic year?

2.2. Social distancing rules are likely to impact on student learning since mathematics teachers are not able to provide an interactive and supporting learning environment for students.

- Although teachers consider that students need additional support this academic year, they consider that social distancing rules are negatively impacting their teaching and students' learning (**Figure 7**).
- In their comments, teachers report challenges with using or accessing resources in mathematics lessons, e.g. online resources while in school, cleaning and organising equipment, difficulty accessing mathematical instruments for manipulatives, no mini whiteboards, challenge to write mathematics while teaching remotely.
- Teachers also report a perceived lack of understanding from senior leaders about challenges with teaching mathematics in current context.
- Not being able to hand out classroom equipment puts some students at a disadvantage.

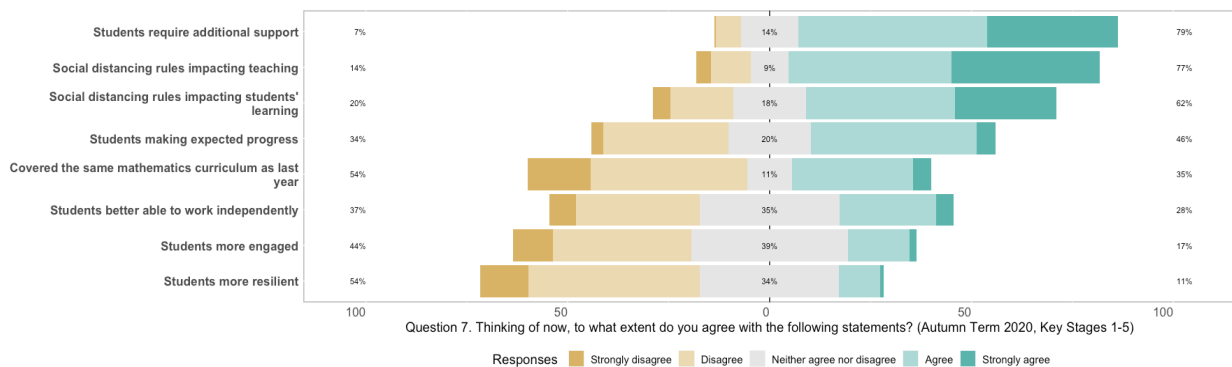


Figure 7. To what extent do teachers agree with the following statements? (Autumn Term 2020, Key Stages 1-5)

Mathematics is about collaboration and discussion and social distancing has impacted on this greatly. [Primary Teacher, State Funded Primary School]

This is the most challenging time in teaching. Trying to look after the mental health of young people has become a priority. [Mathematics Teacher, FE College]

Online teaching made me a better and a more understanding maths teacher. [Mathematics Teacher Sixth Form College]

3. The mathematics teaching workforce

3.1. The mathematics teaching workforce may suffer as a result of the COVID-19 pandemic

- Some of the teachers responding to this survey highlighted the following:
 - The challenging times for the teaching profession. They reported higher levels of stress, poor mental health, illness, low morale following the Summer 2020 awarding, and increased workload.
 - Concern for their students' wellbeing in mathematics lessons since due to social distancing rules students are required to work independently, without peer or teacher support.
 - Teacher shortages due to staff illness or leaving the profession, although it was not possible to quantify the extent of the problem.

- A serious concern emerging from these teachers' responses is that mathematics is taught by non-specialists teachers to even greater extent than normal.
- The social distancing rules are impacting collaboration amongst staff, reducing team teaching, and observations which could support teacher development.
- Teachers of mathematics may need CPD in blended learning and teaching and enhanced support for subject-specific mathematics and non-mathematics specialist teachers, although some teachers also welcomed the increased of online CPD.
- Before the COVID-19 pandemic, there was a shortage of appropriately qualified mathematics teachers across all phases of education.⁵ Further monitoring of mathematics teacher retention and wellbeing is required and, if necessary, implementation of interventions to help improve teacher retention and development.

3.2. The COVID-19 pandemic has also offered opportunities for teachers

- Online CPD more widely available at times to suit teachers.
- New ways of teaching using online resources, daily interventions to address gaps, cross curriculum working and being more creative with maths tasks.
- Government guidance in association with NCETM was found to be useful.
- New technology has been made available to some teachers (e.g. tablets) although others had to use their own devices and technology.

4. Current Government interventions are challenging to implement

4.1. More than half of our respondents in England were not aware of making use of the catch up premium and/or the National Tutoring Programme (NTP) for mathematics

- More than half of teachers responding to this survey did not make use of the catch up/NTP offer for mathematics because teachers
 - Did not have confidence in this system in which schools buy in subsidised tuition from external agencies.
 - Did not know how to make use of the programme or
 - Have implemented their own interventions already as more suitable for their cohorts.
- The teachers who did use this funding were either in the process of setting up interventions for a small number of students in their school or were already using it.
- Although schools have flexibility over how they use the catch-up funding, the National Tutoring Programme and the tuition fund, it is concerning that a high proportion of respondents did not make use of the funds available because they are **not** able to deliver this through their teaching staff who already know their students.
- Teachers recognised the utility of online resources available for mathematics (e.g. from NCETM and Oak Academy) but highlighted the challenges with using them with diverse groups of students due to lack of tailoring to classes and the digital divide.

Half of the maths department either currently have tested positive for COVID or have recovered from an earlier bout. We have no head of department, no 2nd in department, and are struggling to stay on top of demands with most of the remaining teachers being non-specialists. Trying to get younger, inexperienced teachers to maintain distancing and develop new techniques has been problematic. Not being able to hand out classroom equipment with a socially-deprived intake for our school is a REAL problem. [Teacher of Mathematics Key Stages 3-5, Academy 11-19]

⁵ <https://royalsociety.org/~media/policy/Publications/2018/14-03-2018-maths-snapshot-teaching.pdf>