‘Solving Together’: Investigating the potential of online games for increasing parental engagement with mathematics

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Schools seeking to increase parental engagement with mathematics face challenges including low parental mathematical confidence levels, lack of subject knowledge and awareness about current teaching approaches, and limited parental time and resources. To help to address these concerns, NRICH investigated increasing parental engagement through collaborative online mathematics games and tasks. Six secondary schools across England set a collaborative online activity as a weekly homework task for their 11-12 year-old students. Parental support was provided through email reminders about the set tasks, video clips modelling effective use of the activities and accompanying parental guidance notes. To address concerns regarding parental confidence and awareness of current teaching methods, the activities were chosen for their potential to reinforce previous classroom learning rather than introducing new topics. Data collection methods included pre- and post-intervention student drawings, questionnaires, student focus groups and teacher interviews. The findings indicated that parental engagement significantly increased during the collaborative Solving Together intervention.

Keywords: mathematics; parental engagement; drawings; online games and tasks; collaboration

Background

Increasing parental engagement is often regarded as a key strategy for raising student attainment, “Parents play a crucial role in supporting their children’s learning, and levels of parental engagement are consistently associated with children’s academic outcomes” (EEF, 2020). Effective parental engagement has been shown to increase student attainment by three months over the course of an academic year (EEF, 2018). However, schools may need to clarify their understanding of parental engagement to ensure effective support since “it may take many forms, from establishing structures for homework performance to teaching for understanding and developing student learning strategies” (Hoover-Dempsey et al., 2001, p.1).

Increasing parental engagement with mathematics often poses specific barriers for schools. These might include overcoming negative attitudes towards mathematics persisting among many families (Williams, 2008) and addressing parental insecurity regarding current teaching approaches for mathematics, which may result in parents relying on their children to explain mathematical concepts which their children themselves might be struggling to understand (McMullen & de Abreu, 2010).

NRICH (nrich.maths.org) investigated the impact of collaborative online mathematical games and tasks on increasing parental engagement with mathematics. NRICH is a mathematics education outreach project based in the Faculty of Mathematics at the University of Cambridge. It adopts a ‘low threshold, high ceiling’

design approach to its online activities. This is intended to ensure that its activities are easily accessible to most students yet also offer a level of challenge where appropriate, an approach inspired by the thinking behind the pioneering Logo programming language (Papert, 1980).

Approach

Six online collaborative mathematical games and tasks were chosen for their potential to overcome possible parental engagement barriers regarding teaching new subject matter; parents did not require a detailed knowledge of the curriculum to support their children to engage with the activities since they reinforced existing knowledge and skills. The activities were deemed suitable for developing strategic thinking, building resilience and working collaboratively. Several featured a 'Setting' tab which enabled players to adjust their playing conditions, such as their starting number or the player order.

To further build parental confidence, and increase their understanding about the mathematical skills they would be helping to develop with their children, short video clips were recorded sharing useful hints and tips for engaging with each of the games and tasks. These video clips were kept as short as possible in acknowledgement of the time pressures of family life. Transcripts of the videos was also made available to the parents. Where possible, printable resources were developed for those families who preferred to explore the activities offline.

Sample

Participants were 11-12-year-olds (N=710) attending six secondary schools. Priority was given to schools located in Category 5 and 6 locations (areas where UK government data indicated school-aged students were making the least progress and had the poorest access to a high-quality education). Since the number of schools in those areas expressing an interest in the project exceeded the number of available places, the final selection was a convenience sample determined by ensuring a balance of schools in different locations across the country.

Data collection

The data collection was conducted in the autumn term 2019, concluding three months before lockdown. The data included website metrics and pre- and post-pilot questionnaires, teacher feedback and a case study in one of the schools which included pre- and post-project student drawings, student focus groups and teacher interviews. Although using drawings is not a new approach towards data collection, it is far less common than using interviews or questionnaires. Drawings have enabled researchers to explore students' perceptions and attitudes towards their classroom mathematics lessons (Borthwick, 2011), but there appeared to be a gap in the evidence relating to homework. Hence the case study students were asked to sketch themselves pre-project completing a typical homework and later completing a 'Solving Together' task.

Results

Website metrics

The website metrics indicated sustained engagement with the activities across several weeks (Figure 1).

	Week Number						
Activity	1	2	3	4	5	6	Average Time (min/sec)
Frogs	1411	497	314	82	65	45	4:52
Got It!	-	1139	458	143	49	28	3:13
Square It	-	129	592	634	160	78	4:05
Treasure Hunt	-	-	106	297	540	416	4:58
Estimating Angles	-	-	-	57	283	464	5:07
Combining Lengths	-	-	-	-	127	261	3:56

Figure 1: Number of visits to the games, and time spent exploring them

As the term progressed, the overall figures indicated a downward trend which may have been due to distractions provided by end-of-term festive celebrations.

Video clips

Each video clip attracted more than a hundred viewings (Figure 2). During the pilot, the number of viewings steadily decreased which may have reflected increasing confidence engaging with the activities, rendering video support much less necessary in the later weeks.

Questionnaires

Altogether 360 pre- and post-pilot pairs of questionnaires were available for analysis. The results indicated a significant increase in parental engagement, $t(359)=9.10$, $p<0.0001$.

Pre-project, almost two-thirds of the students (65%) indicated that the most important way that their parents supported them with their homework was helping them understand a question or when they got stuck. Other useful forms of support included encouraging them to complete their homework (10%), removing distractions (8%) and checking that the homework was completed (7%). Very few responses (<1%) referred to their families routinely working together on homework. Some students felt that the most important thing that their parents did to support their homework was leaving them alone to get it done (8%). This was a key finding which may have reflected the high stakes assessments that the students may have experienced just six months earlier.

The post-project questionnaires featured a noticeable increase in the proportion of comments referring to working together on homework. Almost a fifth of the students (19%) described how they explored the activities with their families. Typical comments included:

•They helped me by not making it too easy to beat them so that I had to think about different strategies

•We did it together, and my dad found the activities fun and wanted me to enjoy them as well

•When it got hard, they helped me and encouraged me to carry on. Mainly they were very competitive which meant it pushed me to be more competitive as well

Although many of the students, and their families, clearly enjoyed exploring the activities together, just under 10% of the families did not work together. In a few cases (1%), the students preferred to work alone, "I wouldn't have liked them to help me, I work better alone," wrote one student. Another noted, "I'm fine on my own."

Teacher feedback

Feedback indicated the value of game playing for encouraging collaborative working. Teacher A commented, "Staff noticed better engagement, improved reading and pair work with some students." Several teachers felt that it would be beneficial to incorporate a half-termly block of homework activities addressing mathematical skills in the annual timetable for each year-group, complementing their existing homework scheme:

> Finding a way of interweaving them both would, I think, would be fantastic. If you try and contrast it with how the normal skills-based homework is done, I think it's quite refreshing for them because, like, when you look at GCSE how its split as well you've got your skills-based questions and you've got your problem-solving questions, and we hammer them with the skills-based stuff and then by the time they get to Y10 and Y11 they can't problem-solve well enough. So, I think targeting that at an early age is beneficial.

One school noted that it would have been useful to know whether their students accessed the modules on their mobile phones, laptops, tablets and so on. However, this data was only available from the drawings collected from the case study school.

Student drawings

The drawings indicated an increase in parental engagement compared to the usual mathematics homework for four of the 30 families (13%). This figure was lower than the average for the schools involved in the pilot, but perhaps reflected the challenging circumstances faced by the school.

The drawings revealed the extent that other family members or friends were engaged with the activities, and there was evidence of increased engagement for five of the families (17%). For example, Student B's pre-project drawing showed them working alone in their bedroom. They were smiling, and noted that they sometimes received help with homework. Their post-project drawing was very different; they were no longer alone in their bedroom, the drawing showed them sat with three friends in the living room exploring their homework task together by connecting a mobile phone with the family television. (Figure 2).

The post-project drawings and annotations revealed the extent that the students appeared to be enjoying the activities compared to their usual homework activities. Five out of the 30 students (17%) wrote comments on their drawings about enjoying them. For example, Student A's annotations highlighted her enjoyment of the activities and Student C reported that, "I tried the Frog one, it is definitely fun to do with my family." Two other annotations made positive comments about the games compared to their usual homework tasks. Student D commented, "I pretty much like it because there's less stress about it" and Student E wrote that the games were "Better than normal homework."

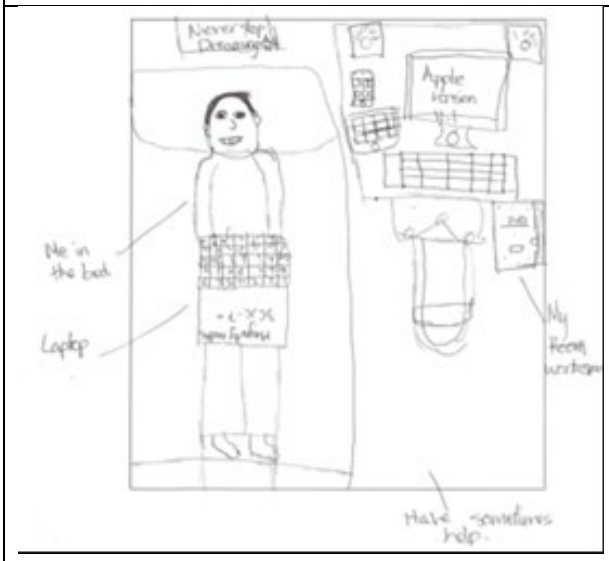
Pre-project drawing	Post-project drawing
	

Figure 2: Student B's pre- and post-project homework drawings.

Just under half of the students (47%) whose pre-project drawings indicated that they usually did their homework alone, appeared to work alone on the tasks too. These figures were much higher than the average across the six schools. Again, they may have reflected the very challenging circumstances faced by the school. In three of the drawings, adults seemed to be monitoring the tasks playing rather than working on them together as a family. "My nanny asked how I was doing but I did not necessarily need any help," noted Student F. Similarly, Student G's drawing indicated adult monitoring rather than collaborative learning, "My mum checked up on me to see how I was." Meanwhile, Student F wrote, "My mum didn't want to do it with me."

Discussion

The content of the six modules in this pilot focused on promoting mathematical skills. This approach was welcomed by the teachers, some of whom suggested that the project should be embedded within their usual homework planning and extended to embrace both older and younger year groups who might also benefit from engaging with problem-solving activities on a more regular basis. The teachers tended to view the modules as being a useful additional homework six-week unit to supplement, rather than replace, their ongoing homework provision.

The pilot was designed around six engaging mathematical games and tasks, an approach which appeared to be successful since the students who engaged with them tended to regard them as fun and enjoyable, and the online metrics indicated sustained engagement for many students. This was a very promising finding, especially considering one teacher's comment that around half of their cohort held negative views about their usual mathematics homework, sometimes audibly groaning when it was set.

The findings also indicated an increase in parental engagement in very challenging locations. Again, this was a promising result. However, it should also be acknowledged that some students appeared resistant to working with their families and some parents declined to participate. Further work may be required to promote mathematics as a collaborative activity for families. Moreover, some families

struggled to provide internet access, initiatives such as Homework Clubs can address inequalities such as broadband access, but their organisation may need to be revisited to ensure all students can experience collaborative homework tasks.

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