Research into Playing Maths Games in the KS2 Classroom:
Race To Infinity!

Jenny Field and Grace Olugbodi discuss their research, which took place in nine schools, focussing on Games Based Learning in Lower KS2.

In 2016, Hainley et al conducted a meta-analysis of empirical evidence from 45 high quality research papers into Games Based Learning (GBL) in primary education. The key findings were that GBL develops knowledge acquisition and content understanding, alongside positive motivational and social skill outcomes. Although many similar studies have also provided powerful arguments for incorporating games into the maths curriculum, there is little evidence of any structured inclusion of GBL. Oldfield (1991) argues that games are not taken seriously and seen as *'wet play'* activities and that the word *'game'* is often associated with *'play'*, creating a non-serious connotation.

This article aims to contribute to previous pedagogical research into GBL. It is an exploratory case study which took place in nine Greenwich and Lewisham primary schools in 2022. It focusses on the efficacy of the award-winning maths board game *Race to Infinity*, and the important, and often-overlooked role of playing games in the KS2 classroom.

The Journey

When I first spoke to Grace Olugbodi in 2020, I was immediately struck by her passion for mathematics and her genuine wish for all children to enjoy it. In 2019, she had won the *'Micro to Small Business'* category in the *Best of Greenwich Business Awards*, as founder of her company BeGenio, specialising in mathematics education. She had also received a prestigious honorary doctorate from London Metropolitan University in recognition of her work in helping young children love mathematics.

Some years before, Grace had invented the board game *Race To Infinity!* which had received much national acclaim, including an interview with *BBC News* on *BBC Business Live*… so why had she approached me at this point in her career? As an ethical businesswoman, interested in research, Grace wanted to know more about the efficacy of her game - if it was an effective way of encouraging learning, engagement and positivity, and what were its strengths and limitations.

This was an unusual measure, and I felt somewhat inspired to undertake this research. She was also in the processes of creating a digital version and wanted to understand and publish guidance on the best ways to play it, founded on research. To me, this demonstrated integrity and a drive for discovery, and I felt compelled to take on the challenge.
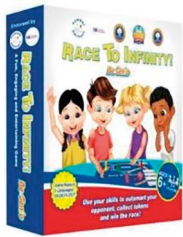
As a professor at *The Institute of Life Course Development* within the *University of Greenwich*, I am acutely aware of inventor bias, and the need to separate inventor from research. I agreed to lead this process, as an unbiased researcher who had not seen the game before and had no previous opinion of it. After the rigorous process of gaining ethical approval, the research process began. What we discovered is of interest, not only to this specific game, but also to the efficacy of Game Based Learning in general.

The Game

Race To Infinity! is a board game in which children take turns to roll two 12-sided dice and choose whether to add, subtract, multiply or divide their values in order to move around the board, based on where it is strategically best to land. The objective of the game is to be the first to land on the *Race To Infinity!* space in the centre on the board. Before this, children need to move around the outside circular path, collecting 200 credits in money. If they wish, they can collect mathematical *Luck Cards*; this might indicate willingness to take risks; for example, it might state that you can only move forward if you throw an even number.

The Research

This exploratory case study took place in nine schools with at least nine groups of lower KS2 children (schools could choose to play it with more than one group). Of those leading the research in schools, 33% were Mathematics Leads and 67% classroom teachers. One group of the same children played the game, at least once a week, over at least one term - 89% of participants fully met the research design requirements, 11% partially.

The first research question was based on the three aims of the National Curriculum for mathematics and the second related to Covid-19 'catch-up' - a pertinent question to ask during the pandemic.

1. What are your perceptions of the progress (or lack of progress) that children have made in FLUENCY, PROBLEM SOLVING and REASONING as a direct result of playing this game? (this was presented as three separate questions)

2. As a result of COVID-19 many children have faced the prospect of needing additional support to 'catch-up' with their learning. Do you believe that regularly playing this game could have a role in that 'catch-up' programme?

We wanted to keep research tight to these areas, due to time and parameters, however we did ask participants to record any other notable findings.

Data were gathered through teacher observations of children playing the game, and were recorded via *'Teacher Questionnaires'*, *'Teacher Interviews'* and *'Transcripts'* of children's conversations.

Overview of Key Findings

Perceptions of progress in the aims of the NC: Fluency, Problem Solving and Reasoning

89% of participants felt children made at least *'some'* progress against all three aims. Fluency was most efficacious, with the highest percentage of participants perceiving progress to be *'good'* or *'exceeding'* expectations.

'the children's fluency has definitely improved over the course of the term, especially with regards to the four operations'

'fluency, yes fluency was the thing ...definitely see them getting better with that and quicker at working things out'

'some children improved at problem solving, they were able to reason and decide where to move and why'

These findings concur with research by Russo et al (2021), conducted with 248 teachers in Australia, which found that traditional games were highly effective in developing the key proficiencies highlighted in the Australian Curriculum: fluency, understanding, problem solving, and reasoning.

Covid-19 'catch-up'

100% of participants perceived that, as one of several measures, it could provide additional support for Covid-19 'catch-up', specifically for practice of the four operations in ways that might reduce anxiety: 33% felt this could be a 'good' role and 67% perceived it could provide 'some' role.

'It provides the opportunity to continually use their core number skills, adding, subtraction, sometimes multiplying and dividing'

'could be useful as a tool to engage those pupils who experience anxiety in maths, as it is a non-threatening way of developing maths skills, with low risk'

Although there is no previous research on GBL and Covid-19, a recent study by Alanazi (2020) also found a positive correlation between GBL and reduced anxiety and improved performance in young children.

Notable Findings: The development of social skills and oracy

Although this was not our key focus for this particular research project, the strongest evidence was actually related to this finding; teachers were highly positive about the development of general social skills, including oracy, communication, collaboration, and enjoyment without pressure:

'Children used their oracy skills to discuss through problems they faced … there were great discussions developed through talk, working out how to travel around the board when calculating larger numbers'

'Children became better at helping each other and exploratory talk'

'Through teamwork children were able to support each other when they encountered difficulty'

'It also develops oracy, pushing them to use terminology that they may not already know or need support with using'

'they were definitely verbalising better … that was a new thing…really helpful for maths …you could hear them talking through their thought processes'

Child: 'I want a 1…2-2? 1?' '2÷2=1, 2-2=0' 'Oh yeah… ha-ha, thank you'

Child: 'You got 3 and 2…times? 6.' 'Actually wait, no 5' 'How come you got 5?' '2+3' 'ahh right' 'yes I know what I'm doing!'

Research by Mani (2015) concurs, stating that GBL had many additional benefits, including increased engagement, motivation and learning through social skills. Hainley et al (2016) also cite positive motivational and social skills development as key.

A further notable finding was the conflicting evidence on whether best practice would be to group children with similar attainment or mixed attainment; there was no clear consensus and further research is needed in this area.

'It was useful to pair more able children with those less confide, this in turn improved fluency and confidence from both groups'

'those pupils with quite secure knowledge did become increasingly frustrated when playing with other players that were not so secure and this led to a lot of pauses in the game'

Limitations

In relation to 'calculation', some participants felt that although it was an effective method *'to practise'* what was already known, unless time is available for teachers to provide scaffolding, teachers felt that there is less likely to be *'new learning'* in the four operations.

'It hasn't directly taught them methods… but it has provided them with opportunities to put their knowledge into practice'

Time to facilitate GBL within a highly prescriptive curriculum was also cited as a limitation.

'you've got to set time aside to do it… curriculum is already jam packed'

One participant also cited a possible issue for EAL and SEN children, around reading the *Luck Cards*.

These findings are now supporting Grace with her business – both in knowing what to celebrate and considering what might be further honed.

The research into GBL is also timely; after the pandemic it has become increasingly clear that, that (alongside delays in mathematical learning), social skills, including oracy, have been significantly affected by reduced contact with peers. For this very reason alone, based on the outcomes of this research, I believe GBL would be a valuable regular addition to the primary classroom.

'they don't really play games very often … they were learning about turn taking and all sorts'

My Research Journey by Grace

After I won a Royal Greenwich Business Award in 2019, the Mayor, Denise Hyland, contacted me to ask how the Council might support me with my future plans. I said that I would really like to conduct ethical research into whether my flagship maths game, *Race To Infinity!* did increase maths-confidence over time, and what its strengths and limitations might be.

She was able to kindly refer me to the Greenwich Council Leader, Danny Thorpe, who, as a former teacher himself, connected me to schools in the borough who might be interested in becoming involved in this research. One of those schools was Mulgrave School, and their Maths Lead, Vicky Buzoku and headteacher Martha Holder, introduced me to the work of Professor Jenny Field, a professor of Mathematics Education and HEA National Teaching Fellow at University of Greenwich … and so began my research journey.

When I spoke to Professor Field, I explained that I wanted some ethical research into the game, so that I could get research-based feedback from teachers and schools about *Race To Infinity!* At this stage I had been selling the game on Amazon UK, Amazon USA and in 10 other countries. I had over 1,000 positive testimonials, and thousands of schools in the UK and in the US were already using the game as a teaching tool, but I really wanted to know what was happening at a classroom level.

For me, Professor Field agreeing to be the main researcher was a big deal. I was also elated to partner with University of Greenwich for this research. After much discussion into exactly what we should be researching and why, the research title became: *'Research into the Efficacy of the Race To Infinity! game'*, exploring any links between *Race To Infinity!* and the development of the three key aims of the National Curriculum for maths - fluency, reasoning and problem solving.

Professor Field mentored me, and I learned a great deal about the research process; the whole experience was incredible. From my perspective, it was great to understand how different research is from the numerous testimonials I have received

from parents and teachers; although they are very welcome, they are not based in academic research, and do not provide such rich detail.

The research was conducted in nine schools across the Royal Borough of Greenwich and London Borough of Lewisham. Professor Field prepared the Participants Information Sheet and a Consent Form, and there were very tight ethical rules around the research. Each school was given six *Race To Infinity!* games to be used in lower KS2. Professor Field created a teacher questionnaire, which she sent direct to the teachers. She also interviewed participants, and I was able to observe this process. Once she collated the data, I saw the results, and it has been eye opening to engage with these key findings.

An aspect that I found particularly interesting was that, even though the research was focussed on maths fluency, reasoning, and problem solving, some teachers seemed more focussed on fluency in relation to preparation for the MTC:

'I was in year 4 … looking at Multiplication Tables Check… we had that as our target really'

'the game was aligned to the MTC, they did actually get better at their times tables'

'it was really helpful because they did have to use their times tables'

It was pleasing to find that most teachers felt they had seen progress against the three aims of the NC:

'this group have shown greater fluency and reasoning and confidence'

'they were engaged in logical thinking … they had to know how to manipulate their results'

'children were engaged in decision making, conjecture, mapping out the best scenario'.

One teacher said that she was not sure if the children had improved over time, or just become better at playing the game.

'I cannot tell if the game improved reasoning – or if they just got better at playing the game'

I hope that either way, children can practise their maths skills, and have fun without realising they are learning.

What surprised me the most, was the overwhelmingly strong evidence that *Race To Infinity!* encouraged and developed social skills to such an extent. I had been more focussed on maths skills and enjoyment, and it made me think about the power of games in the classroom – particularly post Covid, when many children missed out on the development of social skills.

I am also glad that research findings demonstrate that children were excited to play *Race To Infinity!*

'Children really enjoyed the game … both the competitive side and being able to support one another with the best move to make'

Another aspect which emerged was the need to scaffold the learning; for the teacher to ask prompting questions about why they were making certain decisions, without telling them the answers.

'I think they needed some leading'

'scaffold it for them … that would've been helpful'

'I would have jumped in a bit sooner … just to like open the door a bit'

As a result of this, I am now creating a prototype of a digital *Race To Infinity!* game, using the lessons learnt from this research to improve the model – for example I am creating an App that uses an *Artificial Intelligence Teaching Assistant* to scaffold the learning. I am hoping that this will be particularly useful if children play it with their parents at home.

It was great to see that Maths Leads and teachers were keen and excited to be part of the research process, and to introduce the game to the children.

They all said that they would continue to play it after the research process had ended.

What a great experience! I definitely understand more about the importance of the role of research in the classroom. Through research I now know that, although there will always be limitations, this game does have a positive impact on maths development, related to the National Curriculum. GBL can also support with Covid catch-up and has a strong positive influence on social development in the classroom.

Most importantly, this process has helped me to develop my ideas further and to improve my future ventures. Onwards and upwards!

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Professor Jenny Field and Dr Grace Olugbodi presented their findings at the Joint Conference of Mathematics Associations (2023) held at Warwick University.