

### Transforming Children’s Mathematical Learning through Digital Games

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#### Why is this issue important?

Although maths is a skill that everyone needs, and its principles form an integral part of our everyday lives, many people find it tough. Difficulties with the subject can impact grades, finances, and career prospects.

Research studies have shown that attitudes, feelings, and stereotypes, especially among girls, greatly affect how well pupils do in maths. Students who think or feel negatively about maths will avoid it. This is an issue for Irish educators as international studies like PISA and TIMSS highlight that Irish students seem less interested in, and more worried about, maths. This suggests a need to identify effective strategies to promote a positive attitude towards maths from an early age.

Social factors influence students’ attitudes towards maths. Thus, there is a need for policymakers, researchers, and educators to develop strategies to work together in order to tackle challenges in maths education and help children to excel in the area.

The [Arithmós Project](#), a collaboration between University College Dublin and Technological University Dublin, and funded by the Irish Research Council, addresses the multifaceted challenge of promoting maths education.

The Arithmós project actively engages pupils, parents, teachers, and policymakers, in order to raise awareness and highlight best practices. It has also developed, and tested, innovative strategies to promote a positive attitude towards maths from an early age and improve maths performance.

#### The Major Outcomes

**Development of a cartoon video:** [Facing a fear of maths: learning strategies to deal with maths anxiety for kids](#). In order to help pupils to deal with emotions in maths class, we used a metaphor portraying [maths anxiety](#) as a little monster symbolising worrisome thoughts and emotional distress that children with maths anxiety may experience. The narrative then imparts strategies to confront it highlighting the role of maths in several careers.

**Workshop with teachers:** We ran a teachers’ workshop where we worked on concepts, symptoms, neurobiology, and demographics of maths anxiety, and identified strategies to deal with this anxiety in the classroom.

**Tested the impact of digital games in the classroom:** The project engaged 446 pupils from six primary schools in Dublin and Mayo to explore the effectiveness of Seven Spells, an educational digital game, in improving maths performance and alleviating maths anxiety. Pupils enrolled in third and fourth class (217 girls and 186 boys), with a mean age of 9.24 ( $\pm$  0.91) took part in the research.

**Conducted online surveys with parents** to examine the influence of parents’ attitudes and feelings towards maths on children’s maths learning and home activities.

**Conducted online surveys with teachers** to measure teachers’ nervousness about teaching maths, their education levels, and their years of teaching.

**Assessed children’s maths performance** using number comparison, calculation, and number line tasks. We also assessed children’s maths anxiety.

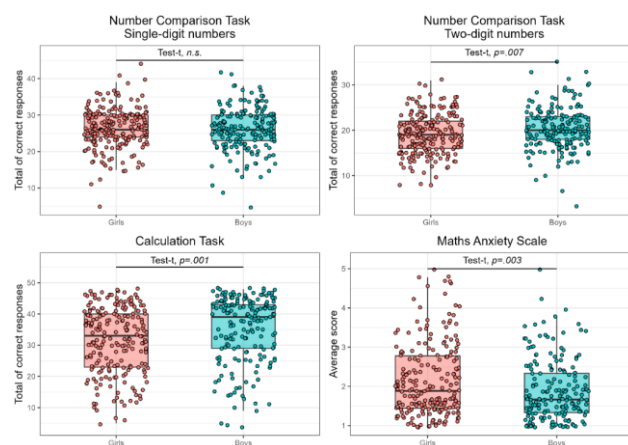
## Research Findings

**MATHS PERFORMANCE:** Most children achieved mean scores in the number comparison task, with fewer achieving extremely low or high scores. In the calculation task, most scored below average, with fewer notably high scores.

**MATHS ANXIETY:** Concerning maths anxiety, children reported low to moderate levels. However, almost 4% experienced higher levels of maths anxiety. The higher their level of maths anxiety, the lower was their performance on number comparison ( $r=-.14$ ) and calculation task ( $r=-.23$ ) tasks.

**PARENTS' RESULTS:** Parents engaged on a weekly basis in maths-related activities with their children at home. Parents' attitudes toward maths were mostly positive. Like children, parents reported low to moderate maths anxiety. Parents with lower educational attainment showed higher maths anxiety compared to highly educated parents. Elevated levels of maths anxiety in parents were associated with significantly increased maths anxiety in their children ( $r=.15$ ) and decreased maths performance ( $r=-.24$ ).

**Figure 1: Comparison between the scores of boys and girls in the mathematical tasks and maths anxiety scale**



**SEVEN SPELLS INTERVENTION:** We found that playing an educational digital game engaged students in spontaneous maths practice. The interventions in the three studies were carried out through a series of experimental designs, including a randomised controlled trial (RCT).

In our small-scale Study 1 (N=78), we found that the pupils in fourth class that played the original Seven Spells game showed a significant improvement in the two-digit comparison task from pre-test to post-test in comparison to pupils from the control group.

In Study 2, we used a three-arm design (N=164). Children in fourth class that played the augmented version of Seven Spells outperformed passive and active control groups in two-digit comparison and the Calculation tasks.

In Study 3, participants were in third and fourth class, we compared the use of gameplay and active control in three time points (N=264). Both intervention groups showed similar increases from pre-test to follow up. Interestingly, 49% of the pupils continued spontaneously playing at home after the intervention, including 37% of highly anxious students.

## Policy Recommendations

Learning experience is enhanced when enjoyable activities are built collaboratively so educators should **integrate engaging and collaborative activities in the classroom.**

**Increase support services for children with maths difficulties,** including the allocation of resources (wifi, tablets, etc.) and specialised services to schools in order to ensure the provision of specialised assistance tailored to the needs of children.

**Screening for Maths Difficulties.** There is a need for early recognition of learning challenges, and early interventions and support, which, in turn, improves learning and reduce low grades. **There is a need for standardised cognitive assessment tools for the Irish context.**

**Provide teachers with applied continuous professional development.** For instance, workshops like our [Maths Anxiety Classroom Management](#) should be nationally available for teachers in the same manner as training on how to use digital games in the classroom.

**Empower teachers** by equipping them with the best pedagogical strategies, technological tools, and resources tailored to diverse learning needs.

**Challenge gender stereotypes in maths.** This involves developing strategies to foster change perceptions, showcasing successful women in maths and science, and empowering girls to thrive in mathematical pursuits, for example through grants and other incentives.

**Engage with teachers and parents to encourage positive attitudes towards maths** to show that maths is a skill that can be developed and enhanced through practice. This involves fostering awareness on how parents and teachers inadvertently convey negative feelings about maths and illustrating strategies for them to redirect.

**Promote the use of evidence-based technology, such as digital games, in the classroom and at home to encourage enriched learning experiences.** This is an important strategy to improve maths skills, promote maths practice in a more engaging way, and to make maths learning more enjoyable.

\*The full report: Santos, F.H., Gomides, M., Rocha, M., Dondio, P. (2024). Arithmós Project: Transforming children's mathematical learning through digital games Report. ISBN 978-1-910963-71-5



## Project Team

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