Mathematics Education Centre and the Centre for Mathematical Cognition, Loughborough University

2021 Studentships Competition suggested research areas

Below are some descriptions of research areas and potential projects that academic staff are interested in supervising for this year's round of studentships.

If there is a research area that you are particularly interested in, then we encourage you to make contact via the email address given before preparing your application.

We also welcome applications for projects focusing on any other area of mathematics learning and teaching.

If you have any questions, then you can contact Priti Meredith at p.meredith@lboro.ac.uk

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Improving the communication of quantitative information to teachers and policymakers

Supervisor: Hugo Lortie-Forgues (h.lorties-forgues@lboro.ac.uk)

In the last decade, there has been a growing effort to produce high-quality evidence in education (e.g., Lortie-Forgues & Inglis, 2019) and to make this information easily accessible for teachers. Despite this effort to improve the quality and availability of evidence in education, very little attention has been devoted to evaluating whether the information is communicated to teachers in a way that maximises their ability to make informed decisions. The present project will explore questions such as:

· What information teachers find most useful when selecting an intervention to implement in their classroom?

· What type of interventions teachers are seeking for their classroom (e.g., What impact? What cost? What intensity?)

· Does the metric used to communicate an educational intervention's impact influences how effective the intervention is perceived by teachers?

· What metrics do teachers prefer for reporting the impact of interventions? For example: additional months of progress? additional number of students expected to pass a certain test?

· Are the findings above similar for other consumers of educational evidence (e.g., policymakers)?

Assessing nebulousness with comparative judgement

Supervisor: Ian Jones (i.jones@lboro.ac.uk)

A programme of research conducted at Loughborough University has resulted in novel methods for assessing mathematical learning that are now used widely in research and practice. The methods are based on an approach called comparative judgement in which experts make holistic, pairwise judgements of mathematical artefacts. The power of the method is that mathematical artefacts, which can vary from examination scripts through to videos of lessons, are often complicated and varied and so difficult to assess reliably using traditional methods. Moreover, comparative judgement enables us to use such artefacts to construct scales of nebulous but important criteria such as conceptual understanding, quality of teaching and problem-solving skills.

This project will have a methodological focus in which the student identifies further artefacts and nebulous criteria, and studies how comparative judgement can be used to construct reliable scales. There are no barriers on the direction the project might take, and much scope for creativity. For example, the student might explore artefacts from across mathematical learning, or other educational subjects, or even artefacts from other areas of the social sciences altogether.

Interaction and feedback in online university learning resources

Supervisor: Ian Jones (i.jones@lboro.ac.uk)

University courses increasingly involve online learning resources. In mathematics these resources can be underpinned by sophisticated computer-algebra systems enabling automated and personalised interaction and feedback for students. However, research findings do not always offer a clear and consistent message about how to maximise learning, and it can be challenging to translate research findings into tangible design principles. In this project the student will review the literature and undertake research using a variety of methodologies in order to design and test online mathematics resources. The focus will be on maximising learning through the use of automated interaction and feedback, including automation based on sophisticated computer-algebra systems.

The project would suit a student interested in the psychology of learning university-level mathematics, and confidence with learning and programming online systems is essential.

Ties of maths and language

Supervisors: Iro Xenidou-Dervou (i.xenidou-dervou@lboro.ac.uk), Julia Bahnmüller

A growing body of research suggests that different aspects of language influence the way we think about, represent, and apply numbers and mathematical concepts. One aspect of language that has repeatedly been shown to affect numerical processing concerns the way numbers are named. Indeed, number-naming systems vary significantly across languages. For example, in English, two-digit numbers above twenty are named in the same order as they are written: first the tens and then the units. In Dutch or German, however, it is the opposite (“48” in Dutch or German is named “eight and forty”). Increasingly more studies show that such irregularities in number words negatively impact children's mathematical development but also affect numerical processing in adults. Given that bi- and multilingualism is becoming increasingly common in our globalised world, considering how language influences the processing of numerical information in bilingual speakers and second language learners becomes increasingly relevant.

This project aims at increasing our understanding into how the languages that we speak affect numerical and mathematical cognition which will in turn inform interventional approaches for multi-lingual language contexts and enhance educational practice.

Understanding of mathematical equivalence and negative signs in the transition from arithmetic to algebra

Supervisors: Iro Xenidou-Dervou (i.xenidou-dervou@lboro.ac.uk) & Ian Jones

Understanding of mathematical equivalence and the negative sign are foundational and difficult concepts necessary for success at all levels of mathematics. It is well established that understanding of equivalence has significant and long-lasting effects; it predicts arithmetic and algebra achievement throughout school years. The ability to solve sophisticated equivalence problems is bound to the ability to reason with the negative sign. Surprisingly, little research has examined reasoning with negative signs, let alone its link with equivalence understanding in the arithmetic-algebra transition. To address these issues, this project will investigate primary and secondary students' understanding of mathematical equivalence and the negative sign in arithmetic and algebraic problems. The project aims to (1) establish a developmental model of the transition from arithmetic to algebra, and (2) explore how features of arithmetic and algebraic equations influence problem difficulty and students' interpretations of the equals sign and negative sign.

What do young children know about multi-digit numbers?

Supervisors: Julia Bahnmüller (j.bahnmuller@lboro.ac.uk), Iro Xenidou-Dervou

Once children have become proficient in using small numbers, they are faced with new challenges as soon as numbers get bigger. One of these challenges concerns the so-called place-value structure of multi-digit numbers. The place-value structure requires to understand that any digit in a multi-digit number informs about both the size (via the digit face value) and the bundle it represents (i.e., units, tens, hundreds, etc.; by its position in the digit string). Place-value knowledge is essential whenever multi-digit numbers are processed and seems to be one fundamental building block for later arithmetic performance.

This project focuses on broadening our knowledge with respect to the development of multi-digit number knowledge in young children (kindergarten through the first years of elementary school) by investigating its developmental trajectories, its relation to later arithmetic performance as well as differences and commonalities across schooling systems and/or language groups.

Maths anxiety diagnosis in a broader context

Supervisor: Dr Krzysztof Cipora (k.cipora@lboro.ac.uk)

Maths anxiety (MA; i.e., negative emotional states related to math) is an important factor impeding maths learning and achievement. Individuals characterized by high MA not only experience negative emotional states when they are facing maths problems: They are actively avoiding maths, maths-related career opportunities, and perform in maths tests below their actual skill level.

Recent studies bring some hints that high MA differently affects individuals differing in anxiety profiles (i.e., configuration of MA, test anxiety level, trait, and state anxiety and other traits). For instance, in individuals characterized by elevated level of several anxiety types, the observed negative effect of MA on maths performance is lower, than in individuals characterized by elevated MA, whose other anxiety types remain low.

This project will explore different anxiety profiles to better understand links between MA and maths performance. It will apply these insights into individual diagnosis instruments. In a further perspective, this work can inform interventions aimed at reducing negative effects of MA, by identifying individuals, who would benefit most from a certain intervention type.

On the prevalence of Spatial-Numerical Associations

Supervisor: Dr Krzysztof Cipora (k.cipora@lboro.ac.uk)

Numbers and space are tightly linked in the human mind. For example, the SNARC effect (Spatial-Numerical Association of Response Codes effect) describes the finding that small numbers are usually associated with the left whereas large numbers are associated with the right side of space. This SNARC effect is just one out of many so-called Spatial-Numerical Associations (SNAs) used to describe and evaluate bi-directional links between spatial and numerical processing.

Traditionally SNAs have been considered an important cornerstone for number processing and mathematics learning in humans. However, recent evidence suggests for example that less than 50% of participants reveal a reliable SNARC effect at an individual level. This not only questions the generality of the SNARC effect but also the role SNAs play in mathematics learning more broadly. Put more plainly: Can SNAs be a cornerstone of mathematics learning if only less than half of us reveal them?

This project will investigate the individual prevalence of different SNAs and further aims at answering the question of whether different SNAs reflect the same underlying mechanism.

Out of the classroom, and into the wild: Mathematics anxiety in real-life contexts

Supervisors: Krzysztof Cipora (k.cipora@lboro.ac.uk) & Kinga Morsanyi

Mathematics Anxiety (MA) is a feeling of dread, which arises when an individual faces mathematics. Although it is expected that MA (just as poor numeracy) can have negative consequences on people’s everyday life, this is a relatively neglected area of research, as most studies on MA are conducted in educational contexts. Nevertheless, there is evidence, for example, that MA is linked to making suboptimal assessments of risks in health-related contexts, which could have dramatic consequences on an individual’s life prospects. In this project, we further explore the everyday consequences of MA, focusing on the ecological validity of methods. We will use both correlational and experimental approaches, and a variety of measurement techniques (e.g., experience sampling, in addition to the traditional questionnaire-based approaches) to provide a thorough picture of how MA affects daily life in adults once they leave formal education.