Reviewing 15 years of research in UK mathematics education: Continuity, change and lessons for the future

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This paper provides an overview of work on a commissioned review offering a critical reflection of BSRLM conference proceedings from the last 15 years (2003-2017). We give a statistical overview of the 773 Informal Proceedings papers published during this period, examining trends in research, highlighting strengths and identifying gaps. We present our coding system, methodology and rigorous approach to inter-coder reliability. We find a heavy focus on empirical studies, early support for seminal projects and a strong interest in specific topics such as geometry and teacher development. There are limited papers addressing the Early Years Foundation Stage (EYFS) and students with Special Educational Needs and Disabilities (SEND). We contrast these findings with the previous BSRLM proceedings review (1995-2002).

Research trends; Conference proceedings; Review methodology

Background

As Inglis & Foster (2018, p.462) note, mathematics education research 'has a long history' with the authors identifying 1968 as the crucial year in which a 'new phase' emerged and international journals in the field began publishing. The British Society for Research into Learning Mathematics (BSRLM) could therefore be considered relatively young, being established in 1985. Yet, since its inception, three Day Conferences per year have resulted in around 1750 Informal Proceedings (IPs). This extensive corpus of IPs provides a substantial insight into the work of members of the society and the shape of Mathematics Education research in the UK. However, when viewed as individual papers, much that this corpus can tell us as a collective – particularly with respect to trends and changes over time – is lost. It is therefore prudent to pause at times and reflect on the bigger picture. A previous review of BSRLM IPs (Nickson, 2003) examined proceedings from 1995-2002. 15 years later it is worth revisiting this review and examining where things sit now, hence BSRLM commissioning a review of IPs from 2003-2017. This paper presents a statistical review from this study. A full report will be published in January 2019.

A review of BSRLM research 1995-2002

Nickson's review (2003) covered eight years and 319 IPs. Her key findings were that papers predominantly reported empirical classroom-based research, examining what students were doing in the classroom. Little attention appeared to be paid to research-informed CPD. Of the classroom-based studies, the majority examined secondary classrooms, with Nickson recommending a stronger primary focus in future work.

Perhaps unsurprising given the secondary classroom focus, many studies focused on mathematical topic areas, with a strong preponderance of papers looking at algebra and geometry (and to a lesser extent, numeracy, potentially influenced by

the inception of the National Numeracy Strategy in England). Interestingly, although algebra focussed heavily, Nickson's nuanced analysis noted a paucity of papers examining either pre-algebra or the teaching of algebra with technology.

Further reviews of mathematics education research

Since BSRLM commissioned our review in 2017, two significant reviews of the state of the art of mathematics education research internationally (Inglis & Foster, 2018) and in Europe (Dreyfus, Artigue, Potari, Prediger, & Ruthven, 2018) have been published. While space precludes a thorough analysis of these here, we will be contrasting our present review for BSRLM with both publications in our full report.

Methodology

Analysis of the corpus of proceedings was completed using a systematic approach, with 19 specific characteristics identified for each IP and added to a database. These characteristics included basic descriptors such as paper title, author(s), author location(s), keywords, study country, and conference location. Characteristics describing the nature of the paper were carefully extracted (see Table 1 for examples).

Characteristics	Examples / exemplification
Paper Type	empirical, methodological, literature review, theoretical
Approach	case study, ethnography, grounded research, meta-analysis, thought piece
Phase	EYFS, Primary KS1, Secondary KS4, HE, Adult education
Study Population	students doing mathematics, trainee teachers, workplace, practising teachers
Keywords	2003-2008 IPs: three keywords assigned; 2009-2017: author keywords included (generic terms e.g. mathematics or education & keywords captured elsewhere, e.g. primary excluded)
MESC Codes	Two codes for each IP from the 16 broad MESC codes complemented the tracking of keywords
Data	quantitative, qualitative, mixed methods
Research Methods	interview, video, observation, work scrutiny
Analysis	Discourse analysis, thematic analysis, descriptive statistics, inferential statistics

Table 1: Selection of paper characteristics coded and some examples of each

The research team, consisting of four mathematics education lecturers, commenced coding each of the 2002 BSRLM papers as a pilot study using the characteristics outlined. The team met regularly to compare notes on key elements of the coding process and agree any adjustments to the processes or codes involved. This process ensured that the general approach taken to this phase of analysis was refined and improved before coding of the corpus of papers produced during the period of 2003 to 2017. A range of papers were selected and coded independently by all four coders. These were then checked and discussed for inter-coder reliability, i.e. checking that the team applied the coding consistently across fields. Thereafter, any difficulties in coding were flagged on the database and discussed within the team. The research team initially planned to code each IP from the abstracts but it was quickly determined that scrutiny of the full papers was necessary for accurate coding. Notes were kept in relation to the suitability for a paper to be included in subsequent

thematic analysis of the corpus of papers. This will be included in the final report. In the latter stages of coding, the 174 keywords identified were transitioned into a more manageable list of 14 thematic groupings in preparation for analysis. The analysis of the data was completed by compiling descriptive statistics on the identified categories and using statistical tests to compare within and across groups.

Findings

Here we present some key findings from the statistical analysis conducted as the preliminary stage of the review. This allows us to say something broadly about the full corpus of 773 IPs, to discuss trends, highlight strengths, and identify gaps. The issues examined here will be discussed in depth in the full review. It is important to note that our review is of published IPs and not of BSRLM Day Conference Presentations. For example, in the last 5-year period (2013-2017) there were 474 presentations at BSRLM Day Conferences but this translated into only 237 IPs. Interestingly, the translation of only half of presentations into IPs does not appear to skew the data; for example, while the number of IP authors not affiliated to universities is low (around 4% of the corpus), they are not significantly less likely ($p=0.65$) to produce IPs than authors affiliated to universities.

To enable exploration of trends over time, we split the corpus of IPs into three 5-year time phases: 2003-2007, 2008-2012 & 2013-2017. Similar IP submission levels were found in the first and third time phases (235 and 237 papers respectively). A data 'bulge' in 2008-2012 (301 IPs) is likely to be reflective of the statistically significant ($p<0.001$) increase in papers stemming from BCME7 (38 papers) compared with standard Day Conferences, in addition to a third of Day Conferences in this period being held in London, Oxford and Cambridge. BCME6 and BCME7 papers are included within our data set as they replace the Day Conferences held in Spring 2005 and 2010. Our analysis shows that there are no statistically significant differences (at $p=0.001$) in the authorship, approach, or focus of BCME papers compared with traditional BSRLM IPs. To allow for meaningful comparisons, we present all trends as percentages.

Authorship: scope and distribution

The 773 IPs have between one and seven authors ($M=1.74$). 55% are sole authored. 659 individuals have written IPs (solely or jointly) from 2003-2017. Many authors have written on multiple occasions with 14 authors writing on ten or more occasions. Examining the papers by these authors gives an insight into the various ways in which BSRLM supports mathematics education research and mathematics education researchers. We can identify researchers' passions (e.g. geometry: Jones, Fujita, & Ding, 2005), the work of collaborative groups (e.g. the Subject Knowledge Quartet: Rowland & Turner, 2008) and the developmental trajectory of now seminal projects (e.g. ICCAMS: Hodgen, Küchemann, Brown, & Coe, 2008).

While BSRLM supports the work of UK researchers, 17% of IPs are authored by or in collaboration with individuals from outside the UK, representing countries from all continents (except Antarctica!). This is an increasing trend, with international writers accounting for 14% of authors during 2003-2007, rising to 19% in 2008-2012 & 2013-2017. Notably, a sizeable number of IPs are written by authors from the Republic of Ireland and Turkey. Notwithstanding the caveats of cross-cultural research, we might argue for further international collaboration, pooling understanding in an era of 'evidence' and 'big data'.

Of the 83% of UK authors, we were alarmed to note two features: only 1.6% represent Wales, Scotland and Northern Ireland *combined*, while 62% represent institutions in London and the South (50% of UK universities are in London or the South). While clearly dependent on the research focus, we question the transferability or applicability of some research conducted with populations in London or the South to The Highlands of Scotland or the North East of England for example.

Population characteristics: who are the studies about?

The IPs address mathematics education research across age phases (Table 2). Phases attracting the largest number of papers are secondary (35%) and primary (26%). Despite the relatively strong focus on primary mathematics, EYFS attracts only 1% of papers; we will explore this further in the full report.

Age phase	% of papers
Early years (EYFS)	1%
Primary	26%
Secondary	35%
KS5 (A/AS level)	8%

Age phase	% of papers
FE (College)	2%
HE	13%
Adult learners (post-18)	1%
Cross phase	15%

Table 2: age-phase representation across all IPs (n.b. due to rounding, % do not always sum to 100)

Of IPs where a specific study population was identified, almost half focus on students engaged in mathematical activities. Trainee teachers and teachers account for the next two most frequently studied populations at 18% and 12% respectively. Of note is that classroom teaching assistants are very infrequently the focus. This group are referenced in the titles of five IPs only and are the main focus of just four of these.

While few trends are evident across this time period, analysis by five-year band reveals a slight increase in the number of IPs focusing on professional development (CPD) for practising teachers and in those addressing teachers and pupils in a joint focus, for example examining teacher/pupil interaction. Each of these contributes 7% of the papers over the fifteen-year period.

Paper types and research approaches

The majority (72%) of IPs present outcomes from empirical studies. Of these, approximately one quarter present interim or preliminary findings of work in progress. Beyond empirical papers, the next largest group of papers is those presenting reports, including reports of working groups; these account for 13% papers altogether. A small proportion (8%) present theoretical discussions, with the remaining 7% comprised of reviews (e.g. of literature, resources or policy) and discussion of methodological issues.

Empirical papers employ a wide range of methodological approaches and data collection methods. Where a methodological approach is clearly stated, the most common is case-study, accounting for 31% of all empirical papers. Action research, at 4%, is the next most common approach. A large proportion – 38% of empirical papers – do not specify a research approach. Data collection methods, however, are explicit. Of the empirical papers, 66% generate qualitative data, with mixed methods and quantitative methods accounting for 21% and 14% respectively. The four most frequently adopted methods are interviews (28%), questionnaires/surveys (15%), observations (14%), and the specific use of video recording (10%). Analytic methods vary; again, a large proportion of empirical papers (48%) do not specify the analytic

approach used. Where these are detailed, the most common is thematic analysis (18%). Quantitative data is most frequently analysed with descriptive statistics (13%).

IP focus

Table 3 shows the proportions by which the thematic keyword groups were applied to keywords within the corpus of 773 IPs.

Thematic group	Proportion	Thematic group	Proportion
Teachers	16%	Educational Research	6%
Mathematical topics	12%	Classroom talk & Interaction	6%
Affect	9%	Assessment & Accountability	5%
Classroom Approaches	8%	Social Context	5%
Pedagogic Tools	8%	Phases	5%
Mathematical thinking	7%	Cognition	5%
Curriculum & Pedagogy	7%	Dev. Trajectories & SEND	3%

Table 3: Proportion of IP keywords assigned to each thematic category

The two most common thematic groups – Teachers and Mathematical Topics – are perhaps not surprising for a society that addresses learning in mathematics. A significant proportion of IPs allocated the thematic group of 'Teachers' focused on Initial Teacher Training or CPD which seems to be an encouraging finding. We note the limited focus on Developmental Trajectories & SEND despite this being a broad group encompassing keywords such as misconceptions and memory. It is concerning that just eight papers (1% of the total) across the 15 years address SEND or mathematical difficulties specifically.

Keywords in 'Topic'	Occurrence	Keywords in 'Topic'	Occurrence
Algebraic reasoning	14%	Probability	2%
Geometry	14%	Written methods	2%
Calculus	7%	Division	2%
Fractions	6%	Equivalence	2%
Functions	6%	Number sense	2%
Modelling (mathematical)	6%	Proportional reasoning	2%
Arithmetic	6%	Equations	1%
Calculation	5%	Mechanics	1%
Numeracy	4%	Randomness	1%
Number	4%	Classification	1%
Multiplicative reasoning	3%	Area	<1%
Trigonometry	3%	Number theory	<1%
Statistics	3%	Set theory	<1%
Mental mathematics	2%	Subtraction	<1%

Table 4: Percentage occurrence of keywords within the mathematical topic thematic group

In relation to 'Mathematical Topic', Table 4 gives the frequency of keywords within this thematic group. Both algebra and geometry represent specific topics of interest. Within these, it is interesting to note that over a third of the algebra IPs and half of the geometry IPs also focused on technologies (such as the use of dynamic geometry software). There are several mathematical topics considering similar issues – particularly those related to numeracy and arithmetic – and the content of these IPs

requires deeper qualitative analysis in our full report, particularly in relation to policy/curricular changes over the last 15 years.

Discussion: Continuity, change and lessons for the future

It is worth examining the extent of continuity and/or change in BSRLM's IPs from Nickson's 1995-2002 review to our 2003-2017 review. There continues to be a preponderance of research that is empirical in nature and focussed on what students are doing in the mathematics classroom. This is neither concerning nor surprising, but the executive may wish to consider ensuring potential presenters are aware of the wider range of papers which might be presented; our report will consider some of the positives these non-empirical papers bring to the corpus.

Nickson identified that the majority of 1995-2002 papers focussed on the secondary classroom. This is no longer the case, although the greatest focus is still on this sector. It is heartening to see a rise in papers focussing on the primary sector – a recommendation of Nickson's report – but we now raise the concern of a limited focus on EYFS. We question why this might be, including it still being an emerging field within mathematics education (Dreyfus et al., 2018).

In relation to positive change, we also note a discernible improvement on Nickson's concern that a focus on teachers' professional development, and particularly research-informed CPD, was lacking. CPD will be a theme of our full report where we will examine the nature this takes, how it has changed over time, and the factors that may contribute towards its success.

As noted above, there is both continuity and change in the mathematical topic areas examined. Algebra and geometry still dominate, yet pedagogic approaches within these have changed, particularly in terms of the incorporation of technologies. There is further work to be done to understand the nuanced changes here, as well as examining the crossover between topics and phases, such as research into early algebra. We also intend to explore the trajectory of various linked mathematical topics (in particular with respect to numeracy) in relation to policy changes such as the NNS and National Curriculum. Our full report will appear in January 2019.

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