

MATHEMATICS EDUCATION CHAIRS INITIATIVE

Public Communication Learning Brief

About

THE NRF

The National Research Foundation (NRF) is an independent statutory body setup in accordance with the National Research Foundation Act. Its mandate is to support and promote research through funding, human resource development and the provision of the necessary research facilities in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology, including indigenous knowledge, and thereby contribute to the improvement of the quality of life of all South Africans.

FirstRand Foundation

The FirstRand Foundation was created in 1998 and annually receives 1 % of FirstRand limited's net profit after tax. Since its creation the Foundation has granted over R1 billion for social investment projects. In 2014, it refocused its objectives and adopted a more systemic approach which is designed to confront the root causes of social problems (not only the symptoms) through strategic interventions. The Foundation believes this approach will bring about lasting, system-wide change.

Foreword

We are delighted to present the Mathematics Education Chairs Initiative (MECI) Learning Brief to you. Into its ninth year of implementation (2010 – 2018) and second five-year cycle of funding, the MECI programme has made great strides in its goal of improving mathematics teaching and learning in South Africa. As you will glean from the booklet, the Research Chairs, in their individual and collective capacity have identified, designed, researched and implemented innovative solutions for improving in-service mathematics education.

When we started the programme, we had long-term vision; that vision was to “strengthen mathematics education by fostering collaboration between government, private sector, universities and other civil society organisations. We tapped into the intellectual resources at various universities, the social capital of private sector and civil society to support government tackle the crisis of mathematics education in the country. This is the story of the MECI which has now grown into a strong eco-system involving policymakers, researchers and practitioners in the field of mathematics education.

As the FirstRand Foundation (FRF) we are proud to have led the development of this important booklet in collaboration with our key partners in the initiative; National Research Foundation (NRF) and Anglo-American Chairman's Fund (AACF). As partners we strategically placed emphasis on both research excellence and programme implementation in pilot schools to test efficacy of the Chairs' innovations. Our hope is that this booklet will go a long way towards dissemination of lessons, outputs and outcomes of MECI and serve as an advocacy tool for the models of professional development of mathematics teachers. We also hope that policymakers and practitioners alike will draw from this booklet.

Enjoy.

Professor Mamokgethi Phakeng
FirstRand Foundation Trustee

Executive Summary

The Mathematics Education Chairs Initiative was launched in 2010 in the context of the persistence of low participation and performance by learners in mathematics as a school subject and the lack of any significant improvement, despite numerous interventions. Six academics were appointed to university Chairs – four were in Mathematics Education with a focus on secondary schools and two were Numeracy Chairs focusing on primary schooling.

This Public Communication Learning Brief highlights some of the most important findings of the research and development work of the Chairs, drawing out lessons that can be taken up by education departments, policy makers, funders, parents and others with an interest in improving mathematics teaching and learning. It also makes a wide range of resources and materials developed through the research available for take up more broadly.

This Brief serves as directory or signpost for the main findings and lessons, giving an indication of where further details may be obtained; and are summarized below.

1 Teachers in primary and secondary schools who participated in the Chairs' programmes have been found to have enhanced both their own knowledge of mathematics and their mathematics knowledge for teaching.

As one of the main objectives of MECI, the Chairs researched, developed and implemented a diversity of programmes or courses for practicing teachers in different grades or phases in both primary and secondary mathematics and with different emphases, through which improvements were shown.

To achieve improvements in teacher knowledge, projects from across the Chairs' research in both primary and secondary mathematics, provide several overarching lessons. Effective programme or course design features and delivery conditions include that programmes or courses: make strong mathematical task demands on teachers relative to the targeted grade/phase levels; model the expected mathematical practices; are offered in intensive blocks but over extended periods, preferably not after school when considerable attention and effort is needed; are followed with and integrates in-class support; and involves some forms of assessing teachers, given the wide diversity of mathematics teacher backgrounds.

2 Programmes researched and developed by the Chairs and their findings and outputs are also being incorporated into teacher education programmes for new teachers (pre-service).

This is taking place both within the institutions in which Chairs are located as well as through other higher education system-wide initiatives in which mathematics standards for initial teacher education

qualifications are being developed, to extend beyond practicing teachers.

3 Learners taught by teachers who participated in the programmes or courses implemented by the Chairs, have been shown to have made mathematics learning gains in primary and secondary schools. As a specific objective of MECI, the majority of schools in the projects have shown improvements in mathematics performance. The extent of these gains varied and are subject to several conditions.

The Chairs' projects show that more substantial learner gains in mathematics from teacher interventions take time to show; the whole grade chain needs attention since a focus on one grade/phase was extended to adjacent ones; a majority of teachers of the targeted grade/phase needed to participate in the teacher programmes; and a reasonable or critical level of functionality and resourcing of schools together with support from education district/provincial levels was necessary.

4 Increasing enrolments in the subject of Mathematics in grades 10 to 12 (FET Phase) remains a challenge. The number of learners taking Mathematics (as opposed to Mathematical Literacy) in the FET phase varied within and across the Chairs' projects with three of the four Chairs' project showing a decline in the first phase of MECI. A broad range of factors internal and external to schools may be influencing learner choice of mathematics or mathematical literacy. This issue warrants further deeper and more focused investigation.

5 For the continuous professional and mathematics development of teachers to be sustained during and beyond the programme of the Chairs, teachers in both primary and secondary schools are being supported to establish professional learning communities or networks. The Chairs are researching and using different professional development approaches and models in contributing to creating a professional culture and professional identity among teachers; and have identified certain requirements for their effective and enduring functioning. The latter include ongoing involvement of experts/specialists in professional development and the commitment of teachers, schools and education districts/departments.

Several Chairs have researched and developed a wide range of resources and materials for teacher professional development in both primary and secondary mathematics that are available for take up more broadly and in other contexts.

6 To scale-up and extend the reach of the programmes of the Chairs, different courses or interventions have been specially designed and implemented for Subject Advisors/Facilitators and Leader Teachers in both primary and secondary mathematics and are being offered across whole provinces and in provinces outside those in which the Chairs are located.

Various mathematics teaching frameworks, models and tools have been researched and developed by the Chairs and are being implemented in these programmes.

7 Chairs specifically designed and offered programmes for learners, which showed improvements in learners' mathematics performance. Furthermore, teacher development programmes that dovetail with support for the same learners taught by those teachers, are effective in achieving improved mathematics performance outcomes for primary and secondary learners.

These programmes for learners spanned those offered in-school and those offered after-school or on weekends. After-school programmes and activities for learners were developed and implemented by Chairs for both primary schools (e.g. After School Mathematics Clubs) and secondary schools (e.g. Top-Learner and Peer Support) and demonstrated how self-directed learning may be harnessed to improve learner performance in mathematics.

8 Programmes that were researched and developed using technology for secondary school teachers and learners, have demonstrated mathematics learning gains. Laptops, tablets and cell phone technology using available programmes (e.g. GeoGebra) and those specifically designed for the South African School Mathematics Curriculum (NSC) were included and implemented. The availability of offline ICT and quality digital material were found to be an important lever for improving teaching and learning.

9 A variety of activities and programmes were developed for parents and families in supporting the early development of mathematical ideas and concepts of young learners in Reception and Foundation phase grades. Their value and impact are demonstrated through the growing interest and participation in the range of parent and family-oriented activities and the testimony of participants. Providing education and training opportunities for parents in shaping their interactions with their children in building interest and enjoyment of mathematics from early schooling are shown to have considerable untapped potential.

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Learners taught by teachers who participated in the programmes or courses implemented by the Chairs, have been shown to have made mathematics learning gains in primary and secondary schools.

The Mathematics Education Chairs Initiative

It is in the context of the persistence of low participation and performance by learners in mathematics as a school subject and the difficulty of any significant improvement, despite numerous interventions, that the Mathematics Education Chairs Initiative (MECI) was established in 2010, in which six university academics were appointed to research Chairs.

The overarching goals of MECI is to improve mathematics teaching and learning in schools, to broaden participation and improve performance in mathematics for improved economic competitiveness and wider social development.

These Chairs are unique in two respects. Firstly, unlike traditional university chairs which only focus on research, these Chairs include both a research and an explicit development agenda. Secondly, the Chairs are jointly co-funded in a public-private partnership by the Department of Science and Technology through the National Research Foundation, together with the FirstRand Foundation, Rand Merchant Bank and the Anglo American Chairman's Fund.

MECI comprises two components – Mathematics Education Chairs and Numeracy Chairs.

The four Mathematics Education Chairs were set up with a focus on improving mathematics education mainly in secondary schools, especially in the Further Education and Training (FET) Phase (grades 10-12); and the two Numeracy Chairs were to focus on primary schools, mainly in the Foundation Phase (grades 1-3).

This Public Communication Learning Brief highlights some of the most important findings and outputs of research and development work of the following six Chairs:

Mathematics Education Chairs (Secondary):

- Prof Jill Adler (University of Witwatersrand)
- Prof Cyril Julie (University of Western Cape)
- Prof Werner Olivier (Nelson Mandela University)
- Prof Marc Schäfer (Rhodes University)

Numeracy Chairs (Primary):

- Prof Mellony Graven (Rhodes University)
- Prof Hamsa Venkat (University of Witwatersrand)

The rationale underpinning MECI is for the Chairs to improve mathematics teaching and learning in the public schooling system through a close partnership with a selection of schools (10) for the duration of the project.

The specific objectives for the Chairs was to focus on: training and development for practicing (in-service) teachers to improve the quality of their teaching; to improve the mathematics results in schools; to research sustainable and practical solutions to the mathematics challenges in the country; and to provide leadership on mathematics education and increase dialogue around the solutions. This Public Communication Learning Brief is part of the response to the last objective.

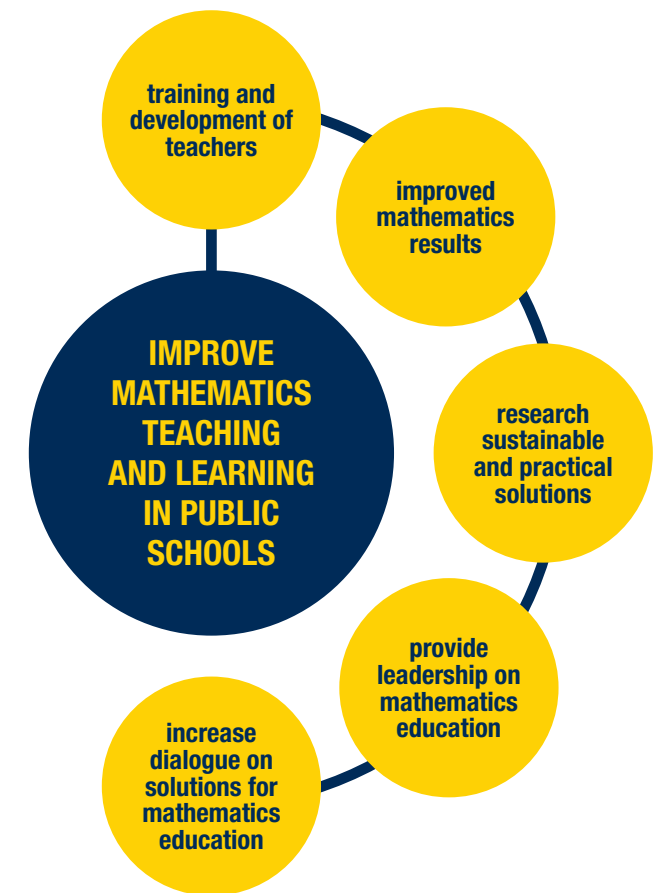
MECI has completed the first 5-year phase and has entered the second phase. It is therefore an opportune time to share the findings from the research together with the lessons learnt to benefit the education system as a whole. The Chairs have, through their research and development projects, investigated different aspects of the problem to explore solutions, and produced different programmes or courses and materials, which can be shared and taken up in other similar contexts.

This Public Communication Learning Brief provides a synopsis of these efforts in support of wider dissemination and distribution of the outcomes of the research and development work of the Chairs. It draws on a variety of reports produced by the Chairs, various MECI progress and evaluation reports, as well as interviews and discussion with the Chairs. The findings and the related lessons, resources and materials are underpinned by the Chairs collective body of over 380 research publications and the research of 140 postgraduate students which span both primary and secondary mathematics.

The Chairs have researched different (but overlapping) aspects of the long-standing problem of improving mathematics education - from teacher development to technology, involving learners, education department officials and even parents - and generated a wide range of possible solutions which underwent research and development processes.

These findings and the lessons that derive from them, may be of use and value to government education departments, policy makers, funders, school leaders and practitioners, parents and general public who have an interest in improving the quality of mathematics teaching and learning in schools.

While several of these projects are still ongoing, this Public Communication Learning Brief serves as a kind of directory or signpost for interested readers about the findings and lessons. It also provides information to access the resources and materials that have been carefully developed through the research of the different Chairs for both primary and secondary mathematics and shown to have worked.



Findings and Lessons

The findings and lessons presented are distilled from the research and development projects of all six Chairs. They are aggregated and interpreted thematically for the general public, including education departments and schools.

For each finding, a selection is made from the large projects of individual Chairs, to provide an indication of the evidence and details on the findings (shown in boxes). The findings and lessons are cast in broad brush strokes, which can then be read together with the information on the individual Chairs. The findings

distinguish between primary and secondary school mathematics where appropriate, and provide the relevant evidence and examples from the work of the respective Chairs

The section on the resources, courses and materials that were researched and developed by the Chairs, provides an overview of the work and interests of the individual Chairs as well as details about these services and products, which can then be followed up with the Chairs by interested readers.

1 Teachers' knowledge enhanced through participation in Chairs' programmes in primary and secondary mathematics

Teachers in primary and secondary schools who participated in the courses and programmes researched and developed by the Chairs have been found to have enhanced both:

- their own knowledge of mathematics and
- their mathematics knowledge for teaching

The Chairs researched, developed and implemented a diversity of programmes or courses for teachers in different grades or phases and with different emphases, through which improvements were shown, using a variety of approaches and methodologies

(e.g. pre-test/post-test; comparisons with control groups). (See Evidence Boxes and the section on Resources and Materials reflecting the work of the individual Chairs)

To achieve improvements in teacher knowledge, these programmes and courses share certain features and provide overarching lessons for their design and delivery. Drawing from projects across the Chairs in primary and secondary mathematics, a selection of programme or course features and conditions for achieving gains in teacher knowledge enhancement are identified in Table 1.

| | |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| strong mathematical task demands on teachers | The courses or programmes for teachers engage a strong mathematical focus and make high mathematical task demands on teachers, relative to particular targeted grade/phase levels in primary and secondary mathematics. That is, to be effective it is necessary to emphasise mathematically-driven activities and conversations as opposed to a generic focus. |
| modelling the mathematical practices expected | The courses or programmes model the mathematical demands and practices expected of teachers in the classroom and require active engagement on the part of teachers. A diversity of mathematics teaching and learning models or frameworks were researched and developed by the Chairs. |
| intensive block intervention but over extended periods | Course or programme interventions offered in intensive blocks (e.g. one day or a weekend) but over extended periods (from a few months to a year or two) were shown to be effective. |
| after school sessions less well attended and less effective | Given the strong mathematical demands of the programme on teachers, after school sessions were less well attended and less effective than whole-day sessions. Learning mathematics and learning to teach it is hard work requiring consistent effort and energy. |
| assessment necessary for optimal teacher development | Not all teachers benefitted to the same extent from any particular course or programme. One size does not fit all, given the different levels of mathematical knowledge among teachers teaching a particular grade or phase. Different forms of assessing teachers before, during and/or after an intervention were utilised for teachers to benefit optimally. |
| in-class/in-school support is crucial | Providing follow up through in-class/in-school support is crucial to assisting teachers in integrating and translating mathematical knowledge and skills acquired in the courses into actual classroom practice. |

Table 1

Secondary | Adler



The Wits Maths Connect Secondary project worked with 134 teachers in two professional development courses across Grades 8-12. Since 2015 the focus has been on Grades 8-10.

- Transition Maths 1 Course (TM1) – for teachers of Grades 8, 9 and 10 mathematics, focusing on developing their mathematics knowledge for teaching and their pedagogical skills in the transition from Grade 9 to 10 mathematics. Completed by 107 teachers.
- Transition Maths 2 Course (TM2) – an advanced mathematics course for FET teachers has been completed by 27 teachers.

Ongoing qualitative studies of teachers' "take-up" from TM1 in particular show engagement with and valuing of the mathematics learned and of the teaching practices in focus vis: selecting and sequencing mathematical tasks, examples and representations; coherent mathematical explanations; opportunities for active learner participation in mathematics lessons.

Adler, J. & Sfard, A. (Eds.) (2017) *Research for educational change: Transforming researchers' insights into improvement in mathematics teaching and learning*. Routledge: London. Chapters 1, 2, 4 and 8

Ntow, F. & Adler, J. (2017) *An exploration into teachers' take up of professional development teaching resources*, In B. Kaur, W.K. Ho, T. L. Toh, & B. H. Choy (Eds) *Proceedings of the 41st Conference of the International Group for the Psychology of Mathematics Education*, Vol. 3, pp. 313-320. Singapore: PME

Adler, J. 2017). *Mathematics Teachers' "take-up" from professional development*. In Th. Zachariadis, D. Potari, G. Psycharis (eds.). *Proceedings of the 7th Greek Conference of the Greek Association of Researchers of Mathematics Education: Mathematical knowledge and teaching practices* (pp. 24-35), Athens: GARME <http://enedim7.gr/>

Secondary | Julie



The Local Evidence-Driven Improvement of Mathematics Teaching and Learning Initiative

(LEDIMTALI) focuses on the development of the practice of teaching for the specific enhancement of achievement in high-stakes school mathematics examinations. It is based on "best evidence" emanating from systematic reviews of research on strategies and tactics that improve achievement and ways of offering continuous professional development to teachers. The programme was taken by teachers and subject advisors and targets grades 7 – 12.

- Analysis of the classroom teaching of participating teachers demonstrated shifts towards incorporating those aspects of teaching in their classroom that are known to impact positively on learner achievement in mathematics.
- Participating teachers, who were all qualified, addressed their mathematics knowledge gaps by declaring these and engaging in appropriate mathematical tasks; and then reflected on their learning through self-evaluations as expected of professionals.

Julie, C. (2014). *Emergences and affordances as opportunities to develop teachers' mathematical content knowledge*. *International Journal of Mathematical Education in Science and Technology*, 45(3), 428 – 437.

Julie, C. (2016) *Does a CPD initiative focusing on the development of teaching to enhance achievement outcomes in high stakes examinations work? A report on the first 5-year phase of the Local Evidence-Driven Improvement of Mathematics Teaching And Learning Initiative—LEDIMTALI*. Belville: University of the Western

Primary | Graven



Grade R to 4 Teachers from 19 primary schools participated in various teacher development programmes that were researched and implemented:

- Early Number Fun programme for Grade R teachers (35)
- Early Numeracy Inquiry Community of Leader Educators (eNICLE) programme for Grade 1 and 2 teachers (61)
- Numeracy Inquiry Community of Leader Educators (NICLE) programme for Grade 3 and 4 teachers (42)
- 11 district officials have participated in these programmes

Evidence shown of

- improvements in teacher attitudes, knowledge, and in-class time spent on more advanced numeracy operations; and
- improved learner numeracy scores in Annual National Assessments.

Graven, M. & Venkat, H. (2017) (Eds.), *Improving Primary Mathematics Education, Teaching and Learning Research for Development in Resource-Constrained Contexts*. (pp. 217–234). Hampshire, UK: Palgrave Macmillan UK. http://doi.org/10.1057/978-1-137-52980-0_4

Graven, M., & Pausigere, P. (2017). *Learning affordances and participation enablers within a primary mathematics in-service community of practice*. *South African Journal of Childhood Education*, 7(1), 11

Pausigere, P., & Graven, M. (2014). *Learning metaphors and learning stories (stelos) of teachers participating in an in-service numeracy community of practice*. *Education as Change*, 18(1), 33–46. doi:10.1080/16823206.2013.847027

Primary | Venkat



Primary Mathematics Knowledge for Teaching course

- Offered over 20 days in three iterations to 112 Gauteng teachers showed a 12-14% mean gain between pre-tests and post-tests. The number of teachers participating in the course from the project schools increased year on year, as did the mean gain
- A 10-day abridged version of this course offered to 100 Free State teachers produced mean gains of 8.4% across two cycles
- Primary teachers' mathematical knowledge for teaching can be improved with appropriate models: 'We were taught with patience, expertise and no humiliation'

'I Hate Maths' Annual Public Seminars

- High numbers and positive response to these seminars indicate the need for platforms for primary teachers focused on engagement with content, practices and norms of mathematics – a shift from a teacher discourse of "I can't do; I won't do" to "I can do; I will do".

Venkat, H., Askew, M., Abdulhamid, L., Morrison, S. & Ramatlapana, K. (2016). *A mediational approach to expanding in-service primary teachers' mathematical discourse in instruction*. Keynote paper presented in TSG49 ICME13 Conference, Hamburg, July 24-31.

Askew, M. & Venkat, H. (2017). 'I hate maths': *Changing primary school teachers' relationship with mathematics*. In Xolocotzin, U. (Ed.) *Understanding Emotions in Mathematical Thinking and Learning*. London: Academic Press, Elsevier. (339–354)

2 Impacting teacher education programmes for new teachers

The programmes researched and developed by the Chairs and their findings and outputs are being incorporated into teacher education programmes for new teachers (pre-service).

This is taking place both within the institutions in which Chairs are located as well as through other higher education system-wide initiatives in which mathematics standards for initial mathematics teacher education qualifications are being developed.

It also provides a further means of scaling up and sustaining the work of the Chairs beyond practicing teachers of mathematics (in-service).

“

We were taught with patience, expertise and no humiliation

3 Learners taught by participating teachers showed mathematics learning gains in primary and secondary schools

Learners taught by teachers who participated in the programmes or courses implemented by the Chairs, have been shown to have made mathematics learning gains in both primary and secondary schools.

- All four Mathematics Education Chairs' projects in Secondary Schools showed an *increase in the number of learners in project schools passing the NSC Grade 12 mathematics with a quality pass of 60% or higher.*

In the period between 2010 and 2014, starting from a low base of between 0% and 10% of learners with passes of 60% or more in mathematics in the different Chair's projects, the percentage improvements varied between 3% and 7%.

MECI REPORT

| | |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| learner gains in mathematics take time to show | More substantial learner gains in mathematics, as a direct result of teacher interventions, are not only difficult to establish due to the range of factors that impact learner performance beyond teacher knowledge and competence, but take time to show. Learning gains were observed towards the end (or after) phase one of the Chairs' programmes. There are no quick fixes. |
| the whole grade chain needs attention | A focus on one part of the education pipeline such as the FET phase (Grades 10 to 12) or Foundation phase (Grades 1 to 3) was not sustained. Chairs extended their programmes to adjacent phases and focused on transitions between phases (e.g. Senior to FET phase; Foundation to Intermediate) to increase effectiveness and impact. The whole grade chain needs attention. A focus on only a few grades cannot significantly increase the mathematics learning gains given the incremental and hierarchical nature of mathematics, and its teaching and learning. |
| majority teacher participation needed | For substantial mathematics learning gains to be made in schools, the majority (if not all) of the mathematics teachers (of the targeted grades, phase or mathematics department) need to participate and commit to the programme. |
| reasonable levels of functionality and resourcing of schools necessary | A reasonable or critical level of functionality and resourcing of schools; and support (with participation) at education District and Provincial Department levels allowed for effective design, development and implementation of the Chairs' programmes and to observe improvements in mathematics teaching and learning. |

Table 2

A majority of schools in the projects demonstrated improvements in mathematics performance but the extent of these gains varied and are subject to several conditions which provide lessons for achieving mathematics learning gains through teacher development programmes (see Table 2).

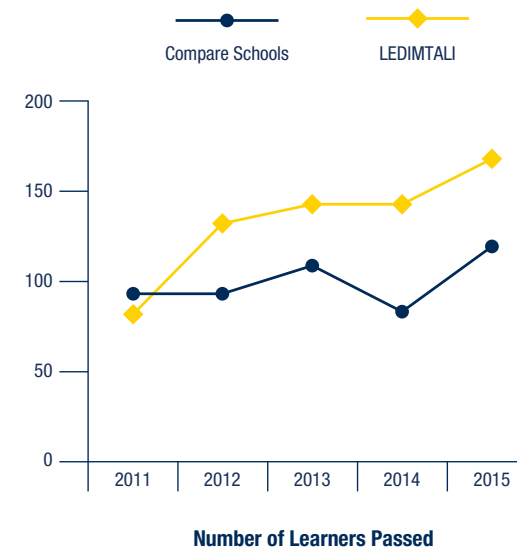
Drawing from projects across the Chairs in primary and secondary mathematics, it is possible to identify a selection of conditions for achieving gains in mathematics learner performance through implementing teacher interventions (see #1).

LEDIMTALI Project | Julie



When comparing the LEDIMTALI project schools to a stratified sample of another 9 schools (matched by school district, circuit and similarity of socio-economic conditions), the number of learners in the project schools who passed NSC Mathematics surpassed those in the comparable schools.

The LEDIMTALI project schools showed on average a 3% increase in pass rate in NSC Mathematics; and marginal increases in the average percentage marks (0.4% for the year on year model and 2% from the baseline start in 2011). When examined against the sample of comparable schools, the project schools performed slightly better in mathematics pass rates and in average percentage marks than the sample of comparable schools. Although the shifts are positive, they are not pronounced.



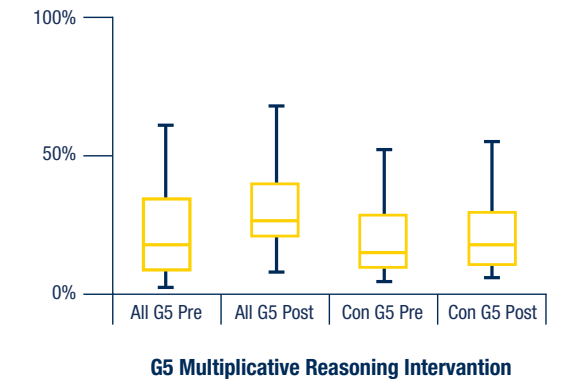
Julie, C., Simons, M. & Mbekwa, M. (2016). "The effect size of an intervention focussing on the use of previous National Senior Certificate Mathematics examination papers". *Journal of Educational Studies*. 15(1), 1–9.tt

Primary | Venkat



Carefully planned and structured interventions with primary teachers that are mathematically focused were found to improve learner performance:

- Lesson Starters Project: an intervention model consisting of three annual workshops with grades 1-3 teachers with follow-up in-class observation and coaching showed gains in early number performance of grades 1-3 learners drawn from the 10 project schools
- Additive/multiplicative Word Problems Project: an intervention model involving a carefully designed sequence of lessons (minimum 4 lessons), and including pre- and post-tests across grades 1-7 has shown improved learner performance in the four operations



Venkat, H. & Askew, M. (2018). *Mediating primary mathematics: theory, concepts and a framework for studying practice. Educational Studies in Mathematics*. 97(1), pp71-92. 10.1007/s10649-017-9776-1.

Venkat, H. & Mathews, C. (forthcoming). *Improving multiplicative reasoning in a context of low performance, ZDM*

4 Mathematics enrolments in grades 10 to 12 phase remain a challenge

Increasing enrolments in the subject of Mathematics in the FET phase (Grade 10 to 12) remain a challenge.

- The number of learners taking NSC Mathematics (as opposed to Mathematical Literacy) in Grade 12 varied within and across the Chairs' projects with three of the four

Chairs' projects in secondary schools showing a decline in the first phase of MECI.

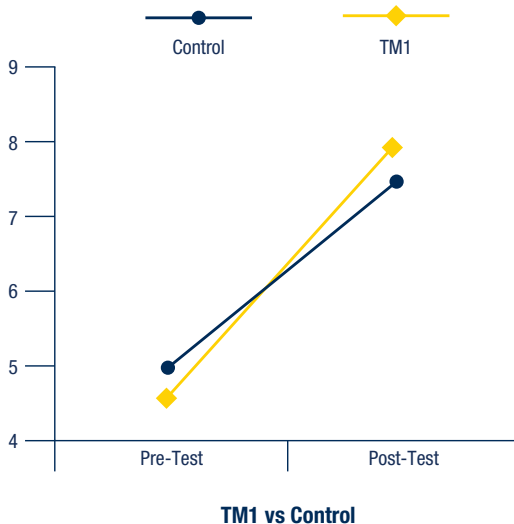
There appear to be a broad range of factors, both internal and external to schools, influencing learner subject choice of mathematics and mathematical literacy. This issue warrants further deeper and more focused investigation.

Secondary | Adler



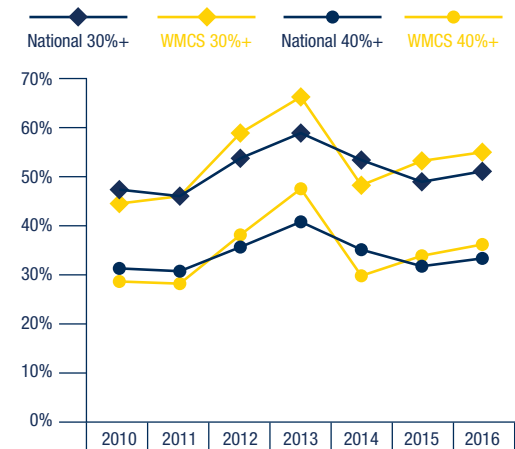
Evidence of improving teachers' knowledge of mathematics leading to learning gains.

CASE 1
Statistical analyses of pre- and post-test results of 568 Grade 10 learners from 5 secondary schools taught by teachers (14) who had participated in a year-long professional development course (Transitional Mathematics 1) outperformed learners in the same schools taught by teachers who had not done the course. The effect size was approximately 3 months of additional progress.



CASE 2

Grade 12 NSC results in the Wits Maths Connect Secondary project schools were below the national results in 2010 at both the 30% and 40% levels. Once the interventions began, the performance of learners in project schools improved year-on-year with the exception of 2014, the year in which Euclidean geometry was re-introduced at Grade 12 level. Since 2012 project schools have outperformed the national results except for 2014.



Comparing WMCS Schools and National cohort Percentages of learners above 30% and 40% (2010 - 2016)

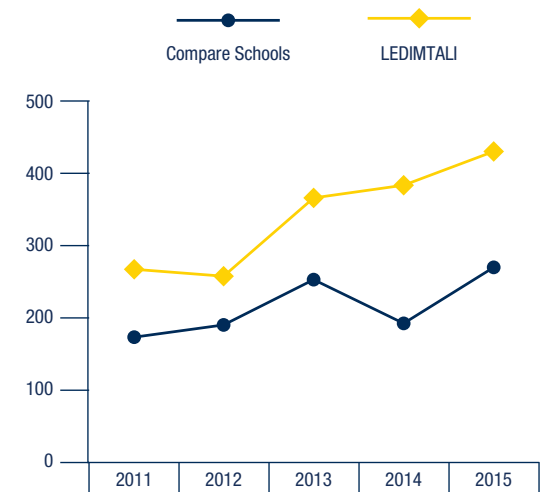
Pourmara, C., Hodgen, J., Adler, J., & Pillay, V. (2015). Can improving teachers' knowledge of mathematics lead to gains in learners' attainment in mathematics? *South African Journal of Education*, 35(3), 1-10. doi: 10.15700/saje.v35n3a1083

LEDIMTALI Project | Julie



In the LEDIMTALI project the number of learners who wrote Mathematics increased on average by at least 10% for both models - year-on-year and from the baseline at the start of the project.

When comparing the LEDIMTALI project schools to a stratified sample of 9 schools (according to school district, circuit and similarity of socio-economic conditions), the graph below shows that the absolute headcount measure of learners who wrote the NSC Mathematics examination in the LEDIMTALI project Schools was higher.



Julie, C. (2016) Does a CPD initiative focusing on the development of teaching to enhance achievement outcomes in high stakes examinations work? A report on the first 5-year phase of the Local Evidence-Driven Improvement of Mathematics Teaching And Learning Initiative—LEDIMTALI. Belville: University of the Western Cape, School of Science and Mathematics Education.

| 9 Schools | WC | 2011* | 2012 | 2013 | 2014 | 2015 |
|--------------------|--------------------|-------|------|------|------|------|
| Headcount | Number | 256 | 248 | 358 | 375 | 422 |
| | Increase | - | -12 | 110 | 17 | 47 |
| Year-on-Year | % Increase | - | -3% | 44% | 5% | 13% |
| | Average % Increase | - | - | - | - | 15% |
| From 2011 Baseline | % Increase | - | -3% | 40% | 46% | 65% |
| | Average % Increase | - | - | - | - | 37% |

*Baseline Year

Comparing WMCS Schools and National cohort Percentages of learners above 30% and 40% (2010 - 2016)

5 Professional Learning Communities for sustained teacher development

For the continuous professional and mathematics development of teachers to be sustained, both during and beyond the programme of the Chairs, teachers are being supported to establish professional learning communities or networks in their schools or as a cluster of schools.

The Chairs are researching and using different professional development approaches and models in contributing to creating a professional culture and professional identity among teachers for ongoing learning of mathematics and mathematics for teaching.

Important lessons that have emerged for professional learning communities or networks in mathematics to be functional, effective and endure over time is that they require:

- sourcing and involving experts/specialists (such as researchers) to participate in the professional learning community to innovate, challenge and stretch teachers' knowledge and practices; and
- the commitment of mathematics teachers themselves as well as sustained active support of the School and respective Districts and Departments of Education.

Secondary | Adler



The Wits Maths Connect Secondary (WMCS) project researched and adapted a mathematics continuous professional development model – “Lesson Study” – that originated in Japan but is widely used the world over.

Groups of teachers in the project schools together with WMCS researchers formed a professional community and met once a week after school for three consecutive weeks to:

- plan a lesson on a topic of concern for teachers in week 1;
- observe a teacher teaching the lesson to a class of learners, then reflect and revise the lesson in week 2; and finally
- observe another teacher teaching the revised lesson to a different class of learners in week 3.

Critical to the success of the lesson study work in WMCS was the additional time to think about and discuss the lessons, its content and pedagogy; what they wanted learners to know mathematically and be able to do; the selection of examples and tasks for

learners, with explicit attention to how and why these would enable mathematical learning; the nature of the mathematical ideas to be explained and related language to use; and to share supporting materials during group deliberations. A Mathematics Teaching Framework that was researched and developed in the project, served to focus the attention of the group during their planning and reflection.

Adler, J. & Alshwaik, J. (in press) A case of lesson study in South Africa. In Huang, R., Takahashi, A. & Pedro da Ponte, J. (Eds.) Theory and Practices of Lesson Study in Mathematics: An international perspective. Springer

Pillay, V. & Adler, J. (2015) Evaluation as key to describing the enacted object of learning. International Journal for Lesson and Learning Studies. 4, 3, 1-22

Adler, J. & Ronda, E. (2017) A lesson to learn from. In Adler, J. & Sfard, A. (Eds.) Research for educational change: Transforming researchers' insights into improvement in mathematics teaching and learning. (pp. 133-143) Routledge: London.

Touchtutor | Olivier



Using technology in establishing sustainable communities of practice of in-service mathematics teachers via Professional Learning Networks. This programme is based on a structured series of 8 short learning programmes (SACE accredited) offered over two years using the TouchTutor® Teaching & Learning Package incorporating an integrated technology, pedagogy and content knowledge (TPACK) model. The Professional Learning Network programme, which was successfully tested with groups of teachers in the Eastern Cape, includes a complete set of NSC curriculum-aligned teaching and learning resource materials for the mathematics classroom.

Establishing Tablet and TouchTutor® based mathematics resource centres in secondary schools to provide quality after school NSC curriculum-aligned scaffolding for teaching and learning of mathematics.

MTEP | Schäfer



The Mathematics Teacher Enrichment Programme that galvanised mathematics teachers into forming functional communities of practice, focussed on teaching strategies that enhanced both proficiency and confidence as well as supported the growing of a positive professional identity.

Graven, M. and Schafer, M. (2014). A love for mathematical playfulness as a key ingredient of mathematical knowledge for teaching. In Venkat, H., Rollnick, M., Loughran, J. & Askew, M. (Eds.), Exploring Mathematics and Science

LEDIMTALI Project | Julie



LEDIMTALI project developed a continuous professional development model that focuses on the development of teaching to enhance learner achievement outcomes in high stakes mathematics examinations (National Senior Certificate) with a range of characteristics.

Julie, C. (2016) Does a CPD initiative focusing on the development of teaching to enhance achievement outcomes in high stakes examinations work? A report on the first 5-year phase of the Local Evidence-Driven Improvement of Mathematics Teaching And Learning Initiative—LEDIMTALI. Belville: University of the Western Cape, School of Science and Mathematics Education.

Julie, C. (2013). Can Examination-Driven Teaching contribute towards meaningful teaching? In D. Mogari, D.; Mji, A. and Ogbonnaya, U.I. (Eds) Proceedings of the 2013 ISTE international conference on mathematics, science and technology education: Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology, 1–14. Pretoria: UNISA Press.



Important lessons have emerged for professional learning communities or networks in mathematics to be functional, effective and endure over time

6 Scaling up through Mathematics Subject Advisors and Leader Teachers

To scale-up and extend the reach of the programmes of the Chairs, different courses or interventions have been specially designed and implemented for Subject Advisors/Facilitators and Leader Teachers in both primary and secondary mathematics.

The success of these courses and programmes is evident in the invitation to Chairs to offer these to mathematics subject advisors across whole provinces and in provinces outside those in which the Chairs are located.

In these programmes or courses various mathematics teaching frameworks, models and tools have been researched and developed for use by subject advisors and leader teachers for the supporting the continuous professional and mathematical development of teachers.

Secondary | Adler



Senior Phase Mathematics Subject Advisors course providing knowledge and skills to lead the professional development of mathematics teachers. Attended by 20 Mathematics Subject Advisors across Gauteng.

Mathematics Teaching Framework – a tool designed to support teaching is being used by teachers and Subject Advisors to improve teachers’ in-class practice.

Adler, J., & Ronda, E. (2015). A framework for describing Mathematics Discourse in Instruction and interpreting differences in teaching. African Journal of Research in Mathematics, Science and Technology Education. 19, 3, 237-254. doi:DOI:10.1080/10288457.2015.1089677

Primary | Venkat



Mathematics Subject Advisors’ “Coaching for Development Course” is a 16-day course offered over 2 years focused on a combination of improving primary mathematics knowledge for teaching and supporting primary mathematics teaching development in schools.

LEDIMTALI Project | Julie

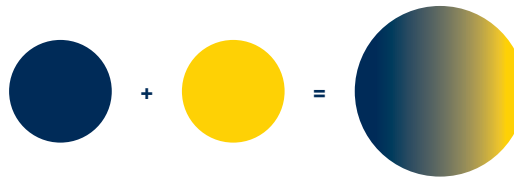


The LEDIMTALI project schools that showed the best improvement in mathematics performance were those where the School Mathematics Department was functioning well. Hence the project focused on supporting school Mathematics Departments as a whole and as a professional learning community.

A course for Developing Mathematics Departments created.

The support and active involvement of **Mathematics Curriculum Advisors** was found to be important for project credibility among teachers.

Julie, C. (2016) Does a CPD initiative focusing on the development of teaching to enhance achievement outcomes in high stakes examinations work? A report on the first 5-year phase of the Local Evidence-Driven Improvement of Mathematics Teaching And Learning Initiative—LEDIMTALI. Belville: University of the Western Cape, School of Science and Mathematics Education.



7 Primary and secondary programmes for learners in- and after-school improved mathematics performance

Chairs specifically designed and offered programmes for learners (in addition to programmes for teachers), which showed improvements in learners’ mathematics performance. That is, programmes that focus directly on supporting learners in both primary and secondary schools, were shown to achieve mathematics learning gains for those learners.

Teacher development programmes that dovetail with support for the same learners taught by those teachers are effective in achieving improved mathematics performance outcomes for learners.

These programmes for learners spanned those offered in-school and those offered after-school or weekends; and were introduced by Chairs in both primary and secondary schools.

After-school programmes and activities for learners were also developed and implemented by Chairs for both primary schools (e.g. After School Mathematics Clubs) and secondary schools (e.g. Top-Learner and Peer Support). These demonstrated how self-directed learning may be harnessed to improve learner performance in mathematics.

MTEP | Schäfer



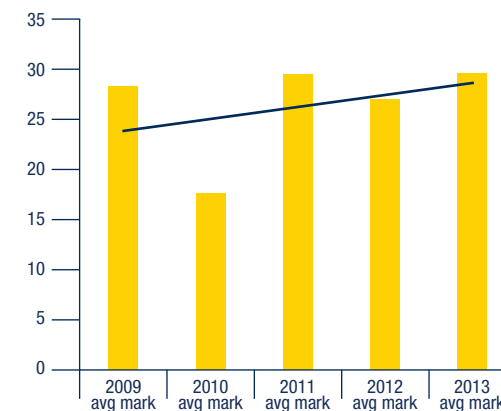
In the project schools, which were all under-resourced township schools, both a programme for learners and for teachers was developed and implemented:

Learner Catch-Up programme based on research of learner mathematics backlog in specific topics and benchmark testing to track learner performance in Grades 10 to 12;

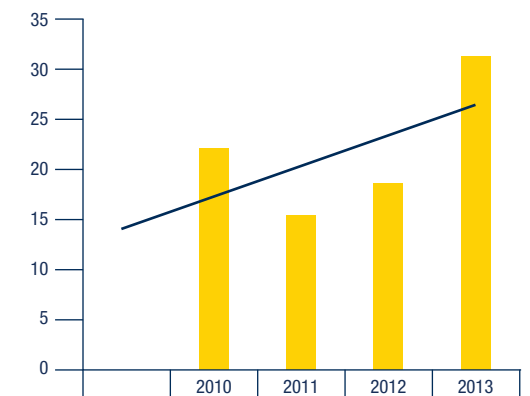
and

Mathematics Teacher Content Enrichment programme using multiple technologies and in-school support.

Schools in which the mathematics teacher enrichment programme AND the learner catch-up programme were implemented showed an upward trajectory in NSC matric Mathematics performance.



Average mathematics marks in Grade 12 of participating project schools



Grade 12 learners achieving above 40% in NSC mathematics examinations

Primary | Graven



- After School Maths Clubs for grades 1 to 6 as a fun programme for learning mathematics have impacted learners and teachers and expanded to 4 provinces.
- Number of Maths Clubs: 43
- Number of learners in those Clubs: 420
- Number trained to set up and run Maths Clubs: 81 Teachers and 3 Department of Education officials
- In 2016, 234 learners in Grades 2, 3 and 6 in 30 clubs underwent a pre-test and post-test for a 15-week programme on the four operations (addition, subtraction, multiplication and division). The overall percentage across all operations was 21%, with the biggest changes in multiplication and division.

The table below shows the percentage point change for each grade and province.

| Area | Pre-test Average | Post-test Average | Overall % Point Change |
|--------------|------------------|-------------------|------------------------|
| ECK-Gr2 | 43% | 51% | 8% |
| ECK-Gr3 | 41% | 70% | 29% |
| ECU-Gr6 | 37% | 61% | 25% |
| NWW-Gr3 | 41% | 58% | 17% |
| Total | 40% | 61% | 21% |

Percentage point change for each grade and province.

Graven, M & Venkat, H (2017) (Eds.), *Improving Primary Mathematics Education, Teaching and Learning Research for Development in Resource-Constrained Contexts* (pp. 45–60). Hampshire, UK: Palgrave Macmillan UK. http://doi.org/10.1057/978-1-137-52980-0_4

Secondary | Olivier



After-School learner programmes using Tablet-assisted TouchTutor® Mathematics Teaching and Learning Digital Package with printed guides for self-directed learning:

- Top Learner Incubator School programme: in which top performing grade 10, 11 and 12 learners from under resourced schools are offered Saturday or school-based afternoon reflection and support classes
- Tablet-assisted Peer Support programme for learners: run by teachers as tutors after school, using structured printed mathematics guides for secondary school mathematics learners with potential

Increase in the number of learners passing mathematics; and in quality of mathematics passes

Increase of more than 10% in learner matric mathematics performance for 7 of the 10 project schools.

8 Technology used to improve teaching and learning in secondary mathematics

The introduction and use of technology in several programmes was researched and developed to improve mathematics teaching and learning. These were implemented for both teachers and learners in secondary schools, and have shown mathematics learning gains.

Laptops, tablets and cell phone technology using available mathematics programmes (e.g. GeoGebra) and those specifically designed for the South African School Mathematics Curriculum (NSC) were included and implemented.

The availability of offline ICT and quality digital material were found to be an important lever that contributed to teaching and learning gains.

TouchTutor® | Olivier



Technology-Blended Mathematics Development Model for support in secondary schools

- An offline customized (grade 8-12) mathematics curriculum-aligned TouchTutor® Digital Teaching & Learning Package - available on laptops, tablets and cell phones
- Based on a model integrating technology, pedagogy and mathematics content knowledge for teachers
- Implemented across 80 under-resourced schools in the Eastern Cape

Olivier, WA (2017) *Quest for a Modern Technology-assisted Model for Mathematics Teaching and Learning in South Africa*. In *The Pedagogy of Mathematics – is there a unifying logic?* Published by the Mapungubwe Institute for Strategic Reflection (MISTRA) ISBN 978-0-9870347-1-7

MTEP | Schäfer



VITALmaths project involved the production and dissemination of short silent video clips for the visual conceptualization of mathematical concepts that can be viewed on cell phones or laptops. Studies on the use of these visual technologies by teachers and learners showed a wide variety of impacts such as increased active engagement and participation, enthusiasm, autonomy, motivation and facilitation of exploration and investigation of mathematics.

The use and evaluation of physical manipulatives and resources (e.g. construction kits, wooden cubes) to enhance conceptual learning and teaching of mathematics was promoted. For example, research on the use of physical manipulatives for the teaching and learning of area and volume showed an 8% improvement in grade 8 learners' performance.

Schäfer, M. (2017). *A relook at the use of visualisation in the mathematics classroom using short video clips*. In *The Pedagogy of Mathematics in South Africa. Is there a unifying logic?* 197–204. Johannesburg, Mapungubwe.

Kellen, M., Schäfer, M., & Linneweber-Lammerskitten, H. (2017). *An analysis of mathematical reasoning and collaborative argumentation through interactions with VITALmaths video clips*. Presented at the 25th Annual Meeting of The Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE), 17 – 20 January 2016, Central University of Technology, Bloemfontein, South Africa.

Kangwa, L., & Schäfer, M. (2016). *An investigation of how VITALmaths video clips on mobile phones can be used by student teachers as a visualisation tool in the teaching of Number Sense*. Presented at the 24th Annual Meeting of The Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE), 12 – 15 January 2016, Tshwane University of Technology, Pretoria, South Africa.

9 Programmes for parents and families to enhance primary mathematics learning

A variety of activities and programmes were developed for parents and families in supporting the early development of mathematical ideas and concepts of young learners in Reception and Foundation phase grades.

Their value and impact are demonstrated through the growing interest and participation in the range of parent and family-oriented activities and the testimony of participants.

Providing education and training opportunities for parents (or care givers) in shaping their interactions with their children in building interest and enjoyment of mathematics from early schooling are shown to have considerable untapped potential.

Family Math Project Graven



Family Math Story Time Programme: for Grade R parents, learners and teachers on reading early number stories.

Family Math Fun Day Community Events: for families, parents and learners to do together – families move from maths station to math station participating in different mathematical activities and games, which they can take home

Total of 19 Family Math events and other family engagements took place in 2016/17 and continue to be researched and developed

Parents report this has changed how that interact with their children and as a family in positive ways; and they are able to assist their children at an age-appropriate level

Programmes are being extended and introduced in after care centres

Emergent evidence that these programmes have enormous potential to increase awareness and participation of parents (or care givers) in numeracy activities to enhance young learners' attitude, interest and engagement with mathematics activities, especially in the early grades.

Graven, M., & Jorgensen, R. (2018) Unexpected outcomes of a family mathematics story-time program. Proceedings of the 41st Annual Conference of the Mathematics Education Research Group of Australasia. Auckland: MERGA

Graven, M., & Stott, D. (2015). Families enjoying Maths together-organising a family Maths event. Learning and Teaching Mathematics, 19, 3–6.


Mathematics Education and Numeracy Chairs Research

The findings and lessons presented in this Public Communications Learning Brief are underpinned by considerable research. References have been provided in respect of each Chair's work.

The Chairs have collectively generated a research output of over 380 publications and 140 postgraduate students.

This research and development work has resulted not only in the diverse findings and lessons but also in a wide range of teaching and learning resources and materials.

 **111**
Journal Articles

 **51**
Chapters in Books

 **4**
Complete Books

 **214**
Conference Proceedings

 **18**
Post-Doctoral

 **30**
Doctoral

 **54**
Masters

 **38**
Honours

“
The Chairs have collectively generated a research output of over 380 publications and 140 postgraduate students.”

Resources and Material



Adler | Secondary School Mathematics

| Course Name | Course Description/ Objective | Target Audience | Duration | Accreditation Status (SACE) | Availability |
|--------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------|----------------------|--------------------------------|----------------------------------------------------------------|
| Transition Mathematics 1 | Bridge transition from GET to FET phase | Teachers Grade 8, 9 & 10 | 16 days over 1 year | SACE endorsement 20 credits | Contact: Jill.adler@wits.ac.za Craig.pournara@wits.ac.za |
| Transition Mathematics 2 | Advanced Mathematics for improving FET learners pass quality | Teachers Grade 11 & 12 | 16 days over 1 year | - | Contact: Jill.adler@wits.ac.za Craig.pournara@wits.ac.za |
| Senior Phase Subject Advisors Course | Developing knowledge and skills to lead professional development | Senior Phase mathematics subject advisors and leader teachers | 16 days over 2 years | - | Contact: Jill.adler@wits.ac.za Craig.pournara@wits.ac.za |

| Materials/Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability |
|--------------------------------|-----------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mathematics Teaching Framework | - | Teachers, Subject advisors, teacher educators | https://www.wits.ac.za/wits-maths-connect/wits-maths-connect-secondary/ |
| Selected mathematics tasks | Mainly algebra and function; integers | Teachers, Subject advisors, teacher educators | https://www.wits.ac.za/wits-maths-connect/wits-maths-connect-secondary/ |



Julie | Secondary School Mathematics

| Materials/ Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability/ Weblinks |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Classroom-tested school mathematics tool kits | 1 toolkit on introduction to integers - grade 7. 1 module on the real numbers system - grade 10. 5 toolkits on spiral revision and deepening mathematics thinking activities based on topics specified in School Mathematics Curriculum CAPS for the first term for grades 7 – 12. The toolkits are activities, with or without annotations to supplement the normal textbooks teachers are using. Various excerpts of articles and book chapters as readings for teachers are provided. | The toolkits are for teachers and subject advisors and the accompanying activities are for learners covering grades 7 to 12. The readings are for teachers. | www.uwc.ac.za/education/projects/LEDIMTALI |



Schäfer | Secondary School Mathematics

| Materials/ Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability/ Weblinks |
|---------------------|---------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------|
| VITALmaths | Video clips on interesting mathematical ideas (over 50) | Teachers and learners Senior primary and secondary phases | www.vitalmaths.com |
| Teacher Handbook | A resources book: exploring concepts with cubes | Teachers and learners Senior primary and secondary phases | www.ru.ac.za/mathsedchair |



Olivier | Secondary School Mathematics

| Course Name | Course Description/ Objective | Target Audience | Duration | Accreditation Status (SACE) | Availability/ Weblinks |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------------------------------------|
| Mathematics Skills Upgrade programme (2010 -2015) | Two Mathematics Modules with integrated use of technology that focus on FET Maths content | In-service Mathematics Educators | 6 months per module Semi-distance model 8 contact days per module | SAQA accredited | Contact Prof Olivier: werner.olivier2@mandela.ac.za |
| Technology Pedagogy and Content Knowledge (TPACK) Professional Development Programme | A series of Short Learning Programmes (SLP) for establishing professional learning networks focusing on content, pedagogy and technology for the classroom | In-service Mathematics Educators | Eight SLP's over a period of 2-years. Each SLP consists of themed mathematics curriculum content with integrated demonstrations of training in the use of offline ICT in the Mathematics classroom. CAPS aligned digital T&L resource distribution accompanies the delivery of the TPACK programme | SAQA accredited | Contact Prof Olivier: werner.olivier2@mandela.ac.za |
| Tablet & TouchTutor® Assisted Peer Support Programme (TAPS) | School based after-hours support programme with Tablets and TouchTutor® digital package. Comprises guided self-directed learning programme facilitated by teachers | Mathematics learners with potential | One afternoon per week for 90-120 minutes over 20 weeks with 24/7 access to TouchTutor® installed on Tablets | - | Contact Prof Olivier: werner.olivier2@mandela.ac.za |
| Tablet & TouchTutor® Assisted Incubation Programme (ISP) | Centralized Saturday incubation programme with Tablets and TouchTutor® digital package | Selected top mathematics learners from under-resourced schools | 18 Saturday programme with 130 minutes facilitation by top tutor + a self-directed learning programme with Tablets on a 24/7 basis | - | Contact Prof Olivier: werner.olivier2@mandela.ac.za |

| Materials/Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability/ Weblinks |
|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------|
| TouchTutor® Mathematics Support Package for Tablets, Mobile Phones and Laptops | Interactive Digital CAPS Maths content and T&L support material which covers the complete curriculum: Video & animated power point lessons, self-assessment with feedback, calculator videos, Multi-language support, Math examination revision and GeoGebra applets | Grades 8-12 mathematics teachers and learners | Contact Prof Olivier: werner.olivier2@mandela.ac.za |
| TouchTutor® Quiz Mathematics Support Package for Android Tablets and Mobile Phones | Interactive Digital Maths Exam Revision, self assessment and language support material which covers the complete CAPS curriculum: self-assessment with scoring and feedback, past exam papers and memos, multi-language concept explanation support | Grades 8-12 mathematics teachers and learners | Freely available for all mathematics learners in South Africa via Google Playstore |
| TouchTutor® Resource Centres in Project schools | TouchTutor® Mathematics support package on tablets or desktop PC's with accompanying learner guides for self-directed learning available as resource centres in project schools for the benefit of learners without tablets | Grade 8-12 mathematics learners | Contact Prof Olivier: werner.olivier2@mandela.ac.za |



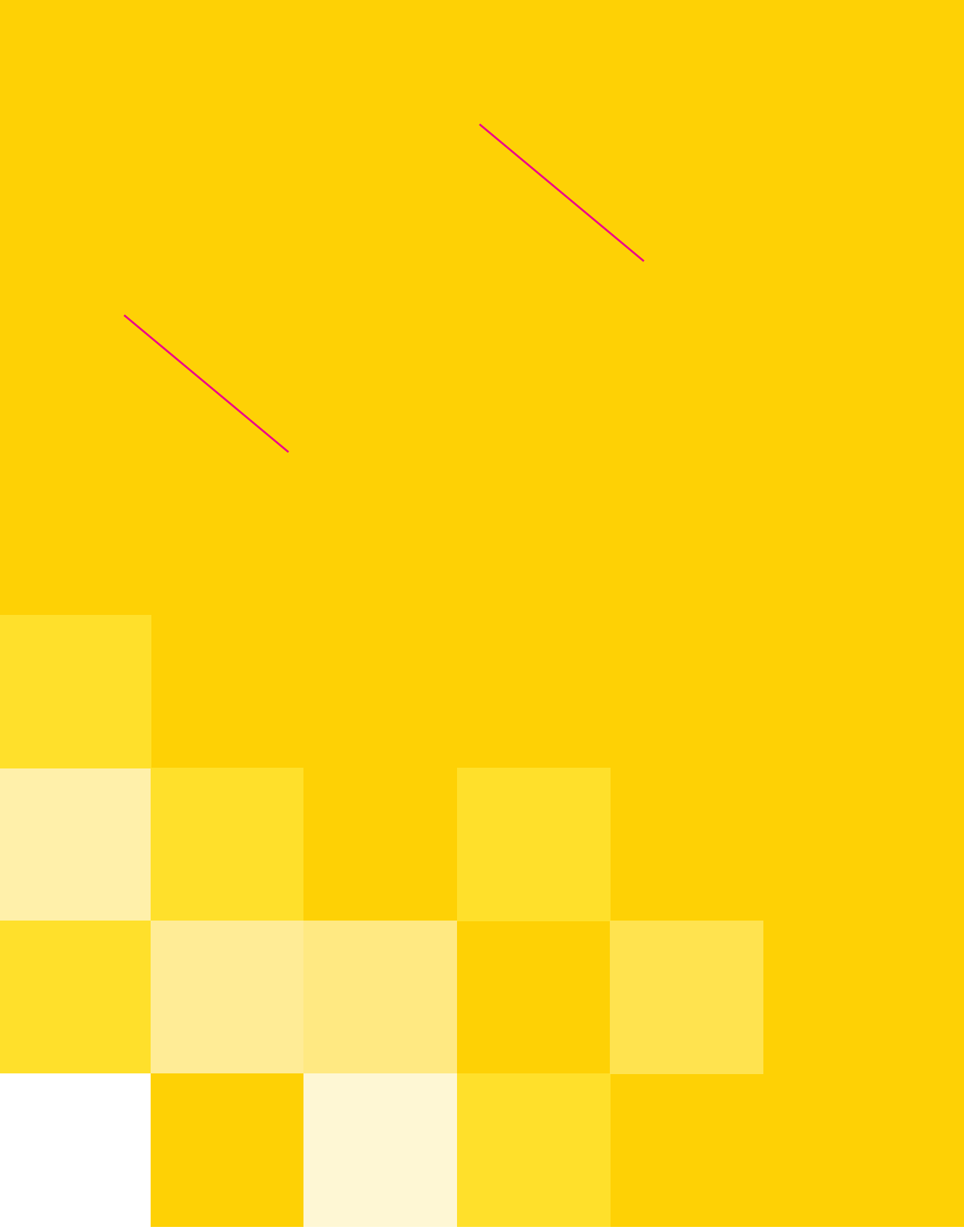
| Course Name | Course Description/ Objective | Target Audience | Duration | Accreditation Status (SACE) | Availability / Weblinks |
|------------------|--------------------------------------------------|------------------------------------------------------------------|-------------------------------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NICLE | Research-informed numeracy development programme | Grade 3 and 4 Teachers. FP & IP subject advisors | 5 years (2011 to 2015) | - | www.ru.ac.za/sanc/teacherdevelopment/niclegr3-42011-2015/ |
| Early Number Fun | Research-informed numeracy development programme | Grade 3 and 4 Teachers. FP & IP subject advisors | 10 sessions over 18 months (2016/7) | - | www.ru.ac.za/sanc/teacherdevelopment/earlynumberfungrader2016-2017/ |
| eNICLE | Research-informed numeracy development programme | Grade 1 and 2 Teachers FP subject advisors Cluster leaders | 10 sessions over 18 months (2017/8) | - | www.ru.ac.za/sanc/teacherdevelopment/eniclegr1-2/ |

| Materials/Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability/ Weblinks |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| After School Maths Clubs "Pushing for Progression" Programme | Materials for starting and running after school clubs | NGOs, schools, DoE District officials, Provincial officials | www.ru.ac.za/sanc/mathclubs/pushingforprogressionprogramme/ |
| Family Math Story-time program | Provision of story books and take-home math games for engaging learners in the home. 3 sessions on how to use these resources for dialogic reading and developing learner agency and mathematics talk. Grade R parents, learners and their teachers | NGOs, schools, DoE District officials, Provincial officials, families | www.ru.ac.za/sanc/resources/families/ |
| Number Talks | This initiative cuts across the NICLE (Grade 3 &4) and eNICLE (Grade 1 & 2) programmes and are an integral aspect of the Pushing for Progression programme. Number Talks are 5 to 15-minute conversations around problems that learners solve mentally, which encourage sense-making. We have promoted them to be used as mental starters in mathematics lessons. | NGOs, schools, DoE District officials, Provincial officials | www.ru.ac.za/sanc/resources/numbertalks/ |
| Family Maths fun day community events | Activities for parents and learners to do together – families move from math station to station participating in different activities. Take home games are shared for use at home. | NGOs, schools, DoE District officials, Provincial officials, families | www.ru.ac.za/sanc/resources/families/ |
| Diagnostic Assessments and Teaching Support Materials | Tests and teaching materials being developed in collaboration with Wits Chair team and DBE | Grade 3 teachers and learners | Testlet and 2-week teaching model; 6 clusters of skills in focus across the year. These will become available through the Department of Education. |
| Independent learner resources (homework drive for Gr 3-4 learners) | Provision of 'write-in' booklets to learners to work on at their own pace to support development of basic numeracy fluency and increasingly efficient calculation strategies | Gr 3-4 teachers and learners | A series of 5 booklets in English, Afrikaans, isiXhosa and Setswana. www.ru.ac.za/sanc/resources/homeworkdrive/ |
| Community maths buzz local press activities | Provision of single or double page spreads of mathematical activities with parent guidance for publication in local press. These could be freely shared in other local forums to stimulate broader community participation in mathematics | Local community | A series of 31 mathematical activities for use by parents and resources in the local press. www.ru.ac.za/sanc/resources/communitymathsbuzz/ |
| STEAM Camps | Aimed at Grade 4 and 5 club learners and their maths club leaders, the camps have a dual focus on taking maths out of the classroom and into the real world and connecting mathematics to home, science and environmental awareness / issues. Camp activities are interactive, hands-on and focused on joint problem solving with the intention of encouraging the participating learners and leaders to view mathematics a way of thinking and being creative in everyday life and seeing possible future career opportunities in the STEM field. | Local community | STEAM camp model and resources, freely available |



| Course Name | Course Description/ Objective | Target Audience | Duration | Accreditation Status (SACE) | Availability / Weblinks |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lesson Starters Project - Structuring Number Starters | Improving early number sense: resources and activities. | Grades R-3 teachers and learners | 3 workshops with in-class observations & coaching | Not currently, but interest from GDE | www.wits.ac.za/wits-maths-connect/wits-maths-connect-primary/structuring-number-starters/ |
| Primary Mathematics for Teaching Course | Improving primary teachers' maths knowledge for teaching | Primary teachers | 10-day & 20 day course versions trialed | Interest in SACE accreditation | Materials being collated. Contact Prof Venkat (hamsa.venkatakrishnan@wits.ac.za) |
| Coaching for Development Course for Primary Mathematics Subject Advisors | Supporting primary maths teaching through building constructive maths-focused conversations | Foundation and Intermediate Phase Maths Subject Advisers | 16 days across 2 years | - | Course in process. Contact Prof Venkat (hamsa.venkatakrishnan@wits.ac.za) |
| Diagnostic Assessments and Teaching Support Materials | Tests and teaching materials being developed in collaboration with Rhodes Chair team and DBE | Grade 3 teachers and learners | 2-week testlet and teaching model; 6 clusters of skills in focus across the year | - | Materials being shared with DBE for further trialing. Supplementary Wits G1-3 Diagnostic Assessment materials available at - (TBC) |

| Materials/Tools | Mathematics Topic/ Content/ Description | Target Audience | Availability/ Weblinks |
|-----------------------------------------------|-------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Multiplicative reasoning materials | Booklets with assessments, and lesson plans | Grade 1-3 and 4-7 | https://www.wits.ac.za/wits-maths-connect/wits-maths-connect-primary/multiplicative-reasoning/ |
| Structuring Number Starters Project Materials | Tasks and resources, and supporting video clips | Grades R-3 | https://www.wits.ac.za/wits-maths-connect/wits-maths-connect-primary/structuring-number-starters/ |
| Wits Maths Circles booklet | Tasks and activities for supporting primary maths teaching and learning | Grades R-7 | https://www.wits.ac.za/media/wits-university/faculties-and-schools/humanities/wits-school-of-education/research-entities/maths-connect/documents/mag.compressed.pdf |



This booklet was commissioned by FirstRand Foundation and developed by CASME

