THE NEED FOR RELEVANT INITIAL TEACHER EDUCATION FOR PRIMARY MATHEMATICS: EVIDENCE FROM THE PRIMARY TEACHER EDUCATION PROJECT IN SOUTH AFRICA

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ABSTRACT

Recently, initial teacher education for primary mathematics teachers has drawn much attention worldwide due to its importance and contribution to childhood development. In South Africa, in response to a quest for relevant and quality primary mathematics teachers, the Primary Teacher Education (PrimTEd) pro ject has been established as a collaboration between all higher education institutions (HEIs). Different workstreams in PrimTEd are mandated to develop sets of commonly agreed standards, materials and assessments of knowledge for teaching primary mathematics. A common assessment in mathematics was deemed necessary to allow each HEI to reflect on their student intake, and design of their Bachelor of Education programmes (B.Eds). The assessment workstream constructed an online test of 90 minutes, consisting of 50 items on different mathematics concepts pertaining to foundation and intermediate phase school mathematics for teaching. The authors, analysed the performance of the 2017 pilot testing with first year students (n = 317) from two universities, and the 2018 national assessment (n = 1 117), where students from seven higher education institutions participated. The results from the 2017 pilot ($\bar{x}$=45.89%,SD= 14.8*) and 2018 national assessment (*$\bar{x}$=48.46%,SD= 16.8*) reveal similar patterns of performance. As the test was set at the level of mathematics at which the students are expected to teach, it is concerning that the majority of students (71%) were not able to obtain more than 60%. This brings into question the assumptions made about the mathematics skills and competencies that entrants into the B.Ed programme bring with them into tertiary education. It is recommended that the lower than expected starting point, should be taking into account, when reflecting on the relevance of the preparation of primary mathematics teacher education for quality teachers of primary mathematics in South Africa.*

Keywords: Primary mathematics education; PrimTEd project; assessment; initial teacher education; relevance; South Africa

INTRODUCTION

International and national benchmarking studies conducted in South Africa (such as Trends in International Mathematics and Science Study (TIMSS), Southern Africa Consortium for Monitoring Education Quality (SACMEQ), the Annual National Assessments (ANA) and the National Senior Certificate (NSC) exams) show that despite many years of mathematics development programmes aimed at redressing the devastating effects of the past, there is little evidence to prove we have made enough progress at the level of the learner (Pournara, Hodgen, Adler & Pillay, 2015).

The poor performance of South African learners in assessment of mathematics is primarily attributed to teacher quality which is a key determinant of learner achievement (Deacon, 2012). This is not a new observation. It is two decades since the President's Education Initiative was undertaken and Taylor and Vinjevold (1999) reported the quality of teaching and learning (and hence the quality of learning outcomes) is significantly constrained by teachers' poor conceptual knowledge of the subjects they teach. Taylor and Vinjevold (1999) referred to low levels of conceptual knowledge, and teachers' poor grasp of their subjects. This is a serious and consistent concern as, while not a sufficient condition for excellent teaching, 'disciplinary knowledge… is the foundation on which all other types of knowledge needed for effective pedagogy rest" (Taylor, 2018). Such concerns have been raised in relation to both the quality of teachers already teaching in the school system and the quality of initial teacher education.

Evidence of low levels of mathematics knowledge of practising teachers has been drawn from SAQMEC data of Grade 6 teachers. Venkat and Spaull (2015) found that 79% of South African Grade 6 mathematics teachers (*n* = 401, SAQMEC 2007) were classified as having content knowledge levels below Grade 6 (using 60% as a benchmark for mastery at a Grade level). Taylor and Taylor (2013) drew on the same SAQMEC data to show that the many Grade 6 teachers do not have a firm grasp of additive relations (addition & subtraction) and multiplicative reasoning (multiplication & division). For the latter, particular weaknesses with regard to rational numbers (encompassing fractions, ratio and proportion) were evident.

Evidence of low levels of mathematics knowledge at the initial teacher education level, has been at a more general and small-scale level. Taylor (2018) refers to a 2010 Council on Higher Education report which described the state of the initial teacher education (ITE) sector as far from healthy.

In 2014, the Initial Teacher Education Research Project (ITERP) investigated the nature and quality of initial teacher education programmes offered by the Higher Education Institutions (HEIs) and the extent to which these programmes meeting the needs of the South African schooling system. ITERP considered intermediate phase (IP) courses in five HEIs on the content taught and the instruments for assessing the practice teaching in the mathematics education course. It reported that in four out of the five institutions, the mathematical work in their courses focus mainly on the mathematics content that South African learners deal with in the Intermediate Phase (Grades 4 to 6) and Senior Phase (Grades 7 to 9), but mostly at a much deeper level than expected at school and with a specific focus on the specialised content knowledge required by teachers (Bowie, 2014). Lecturers at the five universities reported very low mathematics knowledge by the students entering the B.Ed. programme referring to student teachers mostly only managing mathematics content at the Intermediate Phase level (4-6) (Bowie & Reed, 2016).

The key finding emerging from ITERP was that the quality of ITE in South Africa was questionable in relation to mathematics and language courses. But student teachers in ITE programmes researched through ITERP were not assessed on their mathematics knowledge. A mathematics subject and pedagogical knowledge test was administered to a very small sample (n= 30) of newly qualified teachers. Their mathematics was described as “downright poor” (where there was a mean of 56% on mathematics test set at Grade 4-7 level). Deacon (2012) called for the establishment of benchmarks – to diagnose what mathematics and English the students entering the Bachelor of Education programmes possess.

In this paper we contribute to addressing Deacon’s (2012) call to establish benchmarks in order to diagnose the mathematics that students entering B.Ed programmes possess. We report on a common assessment of the ‘mathematical knowledge for teaching’ amongst prospective teachers (students) entering undergraduate programmes in education at South Africa’s universities. These students enter four-year Bachelor of Education (B.Ed.) programmes with the view to become primary school teachers, at either Foundation phase (Grades R-3) or Intermediate Phase (Grades 4-7) levels. The common assessment was developed and administered as part of the Primary Teacher Education (PrimTEd) project. PrimTEd was launched in 2016 in South Africa to study the present state of mathematics education in primary teacher training and seek ways to encourage collaboration across institution for agreement on a set of common core standards for mathematics and language/literacy.

CONCEPTUAL FRAMEWORK

Since Shulman’s (1986) seminal work there has been much research on exactly what knowledge teachers require to be excellent teachers of mathematics, and how to prepare them for this role. It is now generally recognised that ‘more mathematics’ is not sufficient for good teaching of mathematics, and that what is required is specialised content knowledge (SCK) as well as pedagogical content knowledge (PCK)**.**

In relation to mathematics the concept of ‘mathematical knowledge for teaching’ has arisen (see for example Thanheiser, Browning, Moss, Watanabe & Garza-Kling (2010) which built on the framework by Hill, Ball and Shilling (2008) which drew on Shulman’s (1986) framework). Thanheiser et al (2010) used ‘mathematical knowledge for teaching’ (MKfT) framework when discussing different types of knowledge, they want their preservice teachers to develop in order to teach mathematics in schools.

‘Mathematical knowledge for teaching’ has also been used in the South African context by Kazima, Pillay and Adler (2008) when they investigated case studies on teaching mathematics topics by reputably successful, qualified and experienced secondary school mathematics teachers. The purpose was to learn from the selected sample of teachers, the mathematical demands of teaching the different topics and in the ways that they had chosen, and through this to further the understanding of the mathematical work of teaching.

In this paper we adopt the concept of ‘mathematical knowledge for teaching’ (MKfT) as the knowledge teachers require to teach primary mathematics well. In this regard, we adapt the description offered by Hart (2010) for what such knowledge entails to our South African context. Primary teachers must have deep knowledge of:

(1) the mathematical topics at the primary school level that includes a robust understanding of why particular concepts and procedures within each topic make sense mathematically;[1]
(2) the future use and further development of this content in previous and subsequent grade levels;
(3) appropriate representations, suitable classroom contexts, alternate approaches and methods (such as might be used by children in solving problems);
(4) interconnections and interdependence among the content and topics, as well as how a new concept can be built upon other existing ideas; and
(5) when the mathematical ideas are developmentally appropriate for children to learn.

We concur with Kazima, Pillay and Adler (2008) that “mathematics for teaching needs to be understood as shaped by the particular topic being taught, as well as by how teachers select to introduce and approach the ideas and concepts they are teaching” (p. 283).
We draw from Ball, Thames and Phelps (2008) to illustrate that MKfT in primary school is not trivial. While a prospective teacher may have learnt how to follow a formal long division algorithm (and so obtain the correct solution), they may never have understood this and may therefore be unable to infuse this with meaning for a child. They are unlikely to know that there are two models for division: a quotative and partitive model (where 18 ÷ 3 can either be 18 shared into 3 equal groups or 18 partitioned into groups of 3).

Taylor (2018) offers another illustrative example which that MKfT in primary school is not trivial, when he cites this example from Hill, Shilling and Ball (2008):

1. Which of these three methods will work for multiplying ANY two whole numbers? Explain why.

A.	B.	C.
35	35	35
x 25	x 25	x 25
125	175	25
+750	+700	100
875	875	150
		+600
		875

We have explained the concept of MKfT in primary school, and illustrated that this is not trivial. The task of universities is to develop MKfT amongst prospective teachers, which is also not trivial. To develop their MKfT prospective teachers first require knowledge of the content (know *how* to do the mathematics themselves) and then they need to know *why* these make sense, how to represent them using multiple *representations*, how the particular aspect of content *connects* to other topics and grades, and at what *stage* children are ready to learn this content.

[1] These topics include counting and cardinality, operations and algebraic thinking, number and operations in base ten, number and operations in fractions, measurement and data, and geometry (topics as described in the Curriculum and Assessment Policy Standards).

THE PRIMTED PROJECT

The Primary Teacher Education (PrimTEd) Project is a component of the Department of Higher Education and Training (DHET)'s (TLDCIP) program and as such is under the overall authority of the DHET's Director-General. The PrimTEd Project is managed by the Chief Directorate for Teaching and Learning Development, located in the University Education branch of the DHET. PrimTEd is a collaborative initiative bringing together all the Higher Education Institutions in South Africa, to work together on key common standards, materials and assessment approaches for how to prepare teachers in initial teacher education to be better prepared for the teaching of mathematics and language/literacy in the primary school.

The PrimTEd Assessment workstream has been established as a coordinating body to bring together the assessment efforts of various workstreams constituted under the broad PrimTEd project. The workstreams include a focus on Mathematics (with 'Number & algebra', 'Measurement & geometry' and 'Mathematical thinking' workstreams), as well as a work stream on language & literacy, and work integrated learning (WIL). This is all further supported by a Knowledge Management workstream. The content workstreams are intended to design and share standards, materials, assessment tools and research relating to their focal areas. The assessments formulated by the assessment workstream are not intended for progression and certification purposes as 'assessment of learning' for progression and certification purposes remain the responsibility of each HEI. It is expected that standards and materials, templates and exemplar assessment tasks will be made available to the PrimTEd community by the content-specific workstreams, as well as in Work Integrated Learning (Venkat, Bowie & Alex, 2017).

The assessment workstream of the PrimTEd project began its work in 2016 with academic staff from four universities (of which two were historically disadvantaged, and one was rural) collaborating on the formulation of the items for the mathematics assessment. In 2017 the test was administered to first year Primary B.Ed. students in selected institutions and then it was modified and in 2018, students from seven HEIs wrote the test.

METHODOLOGY

This paper reports on part of the PrimTEd study by the assessment workstream on the mathematics assessment. The research question addressed is: What evidence can be drawn from the PrimTEd mathematics test data for 2018 to benchmark some of the mathematics students entering the B. Ed in South African know?

The overall design of mathematics assessment component of PrimTEd draws on design-based research which is systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation. Design-based research is based on collaboration among researchers and practitioners in real-world setting, and leading to contextually-sensitive design principles and theories (drawn from Wang and Haffanin, 2005 as reported by Fonseca, Maseko and Roberts, 2018).

The purpose of the broader PrimTEd research is to improve B.Ed. programme impact through obtaining feedback on student teacher attainment at the first and fourth years of their degree programme. The results from these assessments are intended to allow programme designers and lecturers to reflect on and improve their B.Ed. programmes over time and have some sense of their own students' performance compared to a national data set (Fonseca, Maseko & Roberts, 2018). In this paper we focus only on the first year students.

Design of the PrimTEd mathematics test

The test items were constructed by the team members of the PrimTEd assessment workstream after a rigorous consideration of what and how the test items to be constructed. Experts from four different Higher Education Institutions (HEIs), who had experience in mathematics education and particularly in primary mathematics education took part in the test design, and development of the assessment framework. The test was constructed as an online test of 90 minutes consisting of 50 items. The Cronbach Alpha for the pilot test in 2017 was 0.84 and for national test in 2018 was 0.86.

The content areas included were whole numbers and operations; rational numbers and operations; geometry; patterns, functions and algebra and measurement. The weighting of each content for the test was 24%, 38%, 8%, 16% and 14% respectively. These content areas were chosen from the Curriculum and Assessment Policy statement (CAPS) document for the mathematics curriculum of foundation and intermediate phases schooling in South Africa.

The test items were mainly from two cognitive categories, lower and higher cognitive demands. As reported by Fonseca, Maseko, & Roberts (2018) the items were classified as either lower or higher cognitive demand, applying the Stein, Grover and Henningsen (1996) framework on tasks. While 'lower cognitive demand' items were considered to be routine procedures; the 'higher cognitive demand' items involved moves between representations; required insight; connected across topic areas; and/or had no obvious procedure or starting point (Venkat, Bowie & Alex, 2017).

Fonseca, Maseko, and Roberts (2018) provide two illustrative examples of the kind of items included in the PrimTEd test:

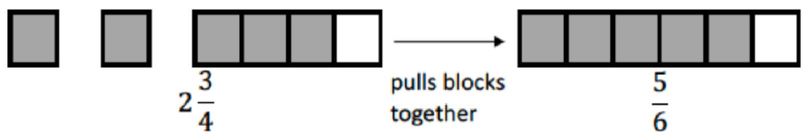
Exemplar item 1: Rational number, low cognitive demand
0,7 is a decimal fraction.
Write 0,7 as a common fraction.

Exemplar item 2: Rational number, high cognitive demand
A farmer's cost for milk production is R3,12 for each litre. What are his production costs for 2,5 litres of milk?
The calculation you need, to get the correct answer is:

A. 3,12 × 2,5
B. 3,12 - 2,5
C. 2,5 ÷ 3,12
D. 3,12 ÷ 2,5
Further exemplar items include the different ways to multiply (exemplar item 3) provided by Taylor (as reported above). This item would be classified as 'whole number, high cognitive demand' in the PrimTEd assessment. Taylor (2018)'s example from SACMEQ of an 'item requiring knowledge of arithmetic operations', is also a good illustration of the kind of item included in PrimTEd:

Exemplar item 4: Whole number, low cognitive demand
Solve: 10 × 2 + (6 – 4) ÷ 2 =
The test included some items which related to mathematical pedagogy. Such questions were specifically phrased to solicit analysis of a learner's work or of a common error in mathematics.

Exemplar item 5: Mathematical pedagogy
Linda says that $2\frac{3}{4} = \frac{5}{6}$ and she uses the figure below to show why she says so.



*Choose the BEST explanation of the key fault in Linda's **reasoning**.*

A) *She doesn't know how to represent fractions*
B) *She is using different units to represent the whole part and the proper fractions in $2\frac{3}{4}$*
C) *She doesn't know what a mixed number is.*
D) *She doesn't know that $2\frac{3}{4}$ is not $\frac{5}{6}$ but is actually $\frac{11}{4}$*

The pilot administration of the assessment in 2017, resulted in some changes to the assessment items for the test instrument used in 2018. These changes were proposed by members of the PrimTEd mathematics workstreams (number sense, mathematical thinking and geometry& measurement) in their review of the pilot instrument; as well as by members of the assessment workstream when reflecting on the facility and discrimination indices for each item using the pilot item response data. In particular, the following changes were made:

The geometry and measurement items in the 2017 pilot were reviewed and more higher cognitive demand questions were included in this topic.

Several of the pedagogy questions were not answered correctly be any students in the 2017 pilot. These items were reviewed and in some cases replaced and in other cases reworded for clarity.

Some of the whole number and rational number questions were reworded for clarity.

As a result, the two assessments (pilot in 2017 and test in 2018) are similar (in that they have anchor items which are used in both tests), but are not identical (as the test instrument was refined based on the pilot data). Annual comparisons between the two assessments therefore cannot be interpreted to mean a decline or increase in attainment amongst the participating students. Nevertheless, percentage scores for each year; and the relative attainment by decile, topic and cognitive demand have been included in this paper. In reading these results, the pilot data from 2017 is simply suggestive of generally poor attainment. The more robust empirical data source is the larger-scale and more refined test attainment (which was refined after piloting) and administered in 2018.

ADMINISTRATION OF THE PRIMTED TEST

The 2017 test was piloted in the first semester with first year Bachelor of Education students in two universities with 317 students. The one university was an urban comprehensive university and the other an urban university of technology. The two institutions were selected conveniently, as their B.Ed. programme coordinators were willing and able to administer the assessments with the first year students.

The 2018 test was written in the first semester of 2018 with a student participation of 1,117 from seven[2] Higher Education Institutions. Once again the selection of participating universities was convenient – with the mathematics education colleagues across these institutions being willing to administer these assessments with their students. The seven institutions included 4 traditional universities, 2 universities of technology and 1 comprehensive university. These were located across four provinces (Gauteng, Free State, Eastern Cape and Western Cape) and included 3 historically disadvantaged institutions. The assessment drew on mathematics content at the Grade 4 - 7 level of the South African curriculum assessment policy statements.

In both years, the students were the first year registered students for Foundation or Intermediate Phase Bachelor of Education (B.Ed.) degree programmes. In both tests – the 2017 pilot test and the 2018 test – were administered as an online test monitored by the lecturers at the respective intuitions and the data were captured and analysed at a national central level. The test was a total of 50 marks and then it was converted to a percentage

[2] In total 9 universities participated in this assessment in 2018 with first year students. However, one of the institutions was unable to complete the assessment due to server capacity problems (due to errors on the PrimTEd administration side). Another institution opted to write the test in a pen and paper format. At the time of writing, this institutions data had not been submitted for inclusion in the PrimTEd national data set.

Firstly, the test was analysed using descriptive statistics for overall attainment across all the items. Following Venkat and Spaull (2015) a benchmark for 'mastery' of the mathematics content in the test was set at 60%. This was considered a reasonable expectation for students (who had completed Grade 12 with a university exemption) and intended to teach primary school mathematics. It was expected that by fourth year level their attainment on such or similar assessment ought to be significantly higher that then first year benchmark.

Secondly the test results were analysed in relation to the assessment framework which was used to code each item. The assessment framework attended to the CAPS content area or topic, and the cognitive demand level. The assessment framework was collaboratively developed involving the participating members of the PrimTEd assessment workstream (spanning across 8 Higher Education Institutions).

ETHICS

The PrimTEd assessment workstream followed an ethical process requiring voluntary, informed consent for educational research with University of Johannesburg's protocol number of 2017-072. For more detail in this process see Fonseca et al. (2018).

FINDINGS

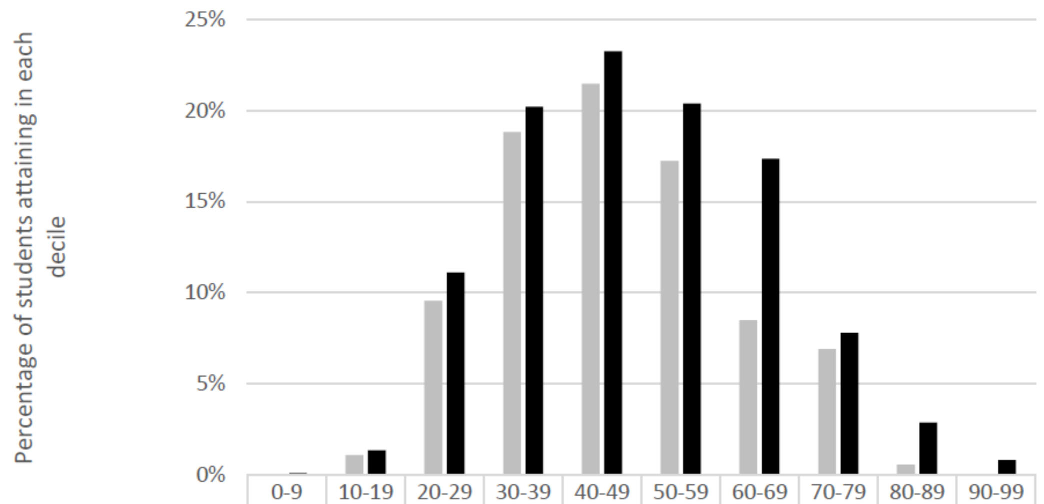
The following table give an overall idea on the performance of the student teachers in the mathematics assessment in the years 2017 and 2018.

Table 1: Overall performance in 2017 and 2018 (mean percentage)

	HEIs	*n*	Mean (%)	SD
Pilot (2017)	2	317	45.89	14.84
National (2018)	7	1117	48.46	16.18

Table 1 shows that in 2017, two institutions participated in the pilot study with the student participation of 317 first year students. The mean percentage of the overall performance was 45,89% (SD = 14,84). When the adapted test was administered in 2018, the mean percentage of the overall performance was found to be 48,46 % (SD = 14,84). As both tests were set at the level of mathematics at which the students are expected to teach, it is concerning that the majority of students were not able to obtain more than 60%.

The following figures give an overall idea on the performance of the first year student teachers in the years 2017 and 2018.

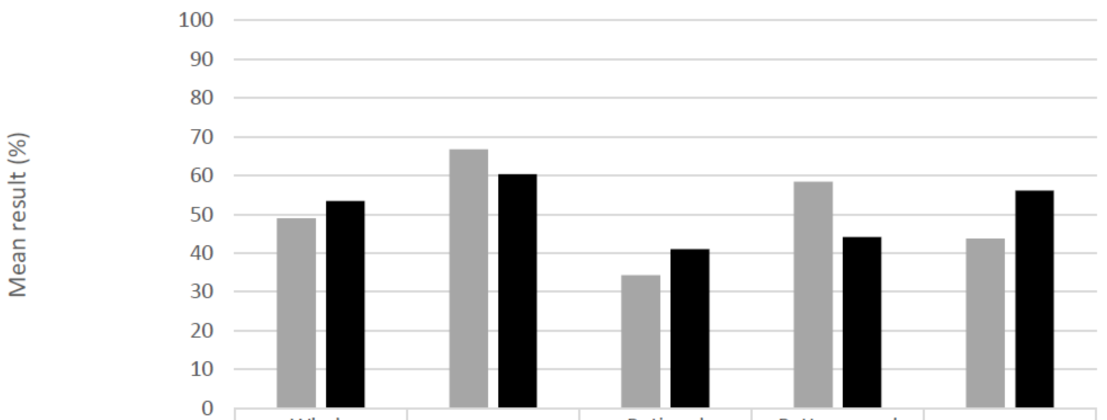


	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
2017 pilot (n = 377)	0%	1%	10%	19%	21%	17%	8%	7%	1%	0%
2018 test (n = 1117)	0%	1%	11%	20%	23%	20%	17%	8%	3%	1%

Figure 1: Distribution of attainment per decile in 2017 pilot and 2018 test

Figures 1 indicates that most of the students entering the B.Ed. program in 2017 (8 in every 10) and also in 2018 (7 in every 10) were not meeting the 60% 'mastery level' of mathematical knowledge (assessed at Grade 4 - 7 level). The 2018 test showed a distribution which was slightly to the right of the 2017 pilot distribution, which as consistent with the higher mean; and understandable in relation to the improved test instrument design.

Focusing the more robust empirical data from 2018, the first year ITE students participating in PrimTEd in 2018 show poor mathematical knowledge for teaching (MKfT). The majority of the first year students (71%) do not meet the minimum benchmark of 60% for knowledge of the mathematics content at primary school level. This has implications for the design and intensity of mathematics courses in the B.Ed. programme.
The following figure shows the relative performance by topic in the years 2017 and 2018.



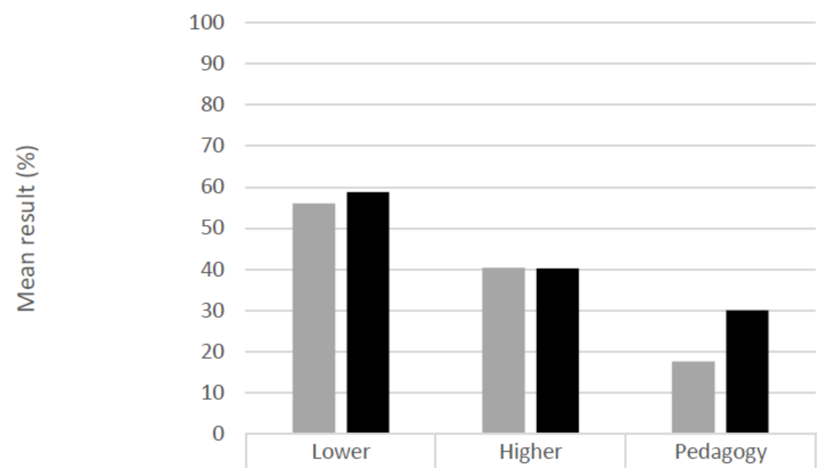
	Whole numbers	Geometry	Rational numbers	Patterns and algebra	Measurement
2017 pilot (n = 377)	48,94	66,8	34,28	58,4	43,8
2018 test (n = 1117)	53,47	60,42	41,09	44,21	56,15

Figure 2: Comparison of relative performance by topic in the years 2017 and 2018

The students were tested on the different topics in the Continuous and Assessment Policy Statement (CAPS) of the foundation phase and intermediate phase of the South African school curriculum. The content areas included were whole numbers and operations; rational numbers and operations; geometry; patterns, functions and algebra and measurement. The comparison is done to check the trends in performance of the intakes of 2017 and 2018 in the similar tests. The performance pattern shows that the worst performed topic in both the years was rational numbers (weighting in the 2018 test =38%). This finding coheres with the finding by Taylor and Taylor (2013) where particular weaknesses were identified with regard to rational numbers (encompassing fractions, ratio and proportion) when testing Grade 6 practicing teachers.

Both years' students seemed to perform relatively well in geometry. It is assumed that the performance can be related to the comparatively lower cognitive demand items and the relatively low number of geometry items in the test. The lower attainment in 2018 is to be expected, as the geometry items were reviewed from the pilot and increased in their complexity.

It is evident from Figure 3 that the items on pedagogy was the worst performing items in both years.



	Lower	Higher	Pedagogy
2017 pilot (n = 377)	56,01	40,32	17,54
2018 test (n = 1117)	58,77	40,2	30,02

Figure 3: Relative performance by cognitive demand level for 2017 pilot and 2018 test

It is assumed that since the students are in first year level, they might not have been exposed to the methods of teaching yet as the test was conducted in the first semester. The higher mean result of pedagogy items in the 2018 test is likely a result in the change in test design, and pedagogy items in the pilot which were replaced and re-worded for the 2018 test. It is also noted that – as would be expected – the lower cognitive level items were answered more successfully that the higher cognitive demand items.

DISCUSSION

The performance of the students in 2018 gives a clear indication that our student intake in Bachelor of Education programmes across 7 universities, shows poor mathematical

knowledge for teaching (MKfT) in the primary school. Similar results were obtained in the 2017 pilot of a similar mathematics test, across 2 universities. This finding aligns with the similarly poor attainment in mathematics tests written by practicing teachers - from the previous small scale study conducted by ITERP (n = 30) for newly qualified Intermediate Phase (Grades 4-7) teachers, and the SAQMEC (n = 409) for Grade 6 practicing teachers. The low percentages in higher cognitive demand levels also talks of the knowledge the students bring with them to the teacher education program. This can be attributed to the vicious cycle of their own learning when they were at schools. It has been noted by the International Mathematics Union (2014) that in South Africa at the school level, mathematics achievement is inadequate, with a low number of students going on to university with an adequate mathematical background, over the last 20 years.
The low attainment in most of the content areas portrayed in the topic-wise analysis also gives a serious concern on the what mathematical knowledge do student teachers have when they enter the program. Particular attention is required for rational numbers (as a result of multiplicative reasoning, involving common or decimal fractions). Hence teacher trainers need to know to exploit time and resources wisely to render quality teaching and learning to happen in these programs.

CONCLUSION

So, what evidence can be drawn from the PrimTEd mathematics test data for 2018 to benchmark some of what mathematics students entering the education degree programmes in South African know?

The majority (7 in every ten) first year ITE students in 2018, across 7 South African universities, show poor mathematical knowledge for teaching (MKfT). The low benchmark of MKfT for prospective teachers entering the B.Ed. programmes has implications for the design of these programmes. Sufficient time is required for teachers to be able to develop deep understanding of the mathematics content. They need time and intensive instructional support to know *how* to do the primary school mathematics themselves, to know *why* these processes make sense, to know how to represent these solutions using multiple *representations*, to know how the particular aspect of content *connects* to other topics and grades, and to know at what *stage* children are ready to learn this content.

The PrimTEd mathematics test has provided a common assessment instrument which is at least showing some of the mathematics that student teachers bring with them into the B.Ed. programmes. A mean result of above 45%, at least shows that the instrument is not suffering from floor effects. However, considering that the items were pitched at the level of Grade 4-7 mathematics, with a minority of items relating to mathematics pedagogy; that the majority of prospective teachers are not able to reach a minimum benchmark of 60% is concerning.

This finding is perhaps not surprising, given that small scale evidence suggested similar results for newly qualified teachers, and practicing teachers at Grade 6 level. What is new is that this dire situation is now evident amongst first year entrants into Bachelor of Education programmes.

What is not known from this evidence, is the extent to which the Bachelor for Education programmes are able to work with students with this low level of MKfT, so that by the time they exit the 4-year programme they have made substantial improvements in their MKfT. The data from Fonseca et al., (2018), drawn from only one institution, shows that there were very small gains, when comparing fourth year students to first years. It is not yet known the extent to which this finding is more prevalent across other institutions.

This suggests several possible responses by HEIs. First, HEIs could reflect on their entrance criteria, and the extent to which their intake is sufficiently proficient in primary level mathematics to be able to benefit from a degree designed to support MKfT at primary school. Secondly, the extent to which – with the evidence of poor MKfT at the first year – the B.Eds. programmes are appropriately pitched to work with students, at the mathematics level which they have bene diagnosed to have. Do the B.Eds. programmes take these low attainment results into account, and provide enough mathematics (both quantity and quality) of mathematics engagement to have shifted the prospective teachers enough? By the end of B.Eds. programmes do newly qualified teachers know:

- *how* to do the primary school mathematics themselves,
- *why* processes make sense,
- how to represent these solutions using multiple *representations*,
- how the particular aspect of content *connects* to other topics and grades, and
- at what *stage* children are ready to learn this content?

In Bowie's report (2014), on the ITERP Project, it was noted that although the sampled institutions had some strong aspects in their courses, to improve the quality of "IP/SP mathematics tasks for teachers" institutions need to pursue on working cooperatively. Our findings from this initial data about the MKfT primary mathematics amongst first year B.Ed. students, make it clear that the low student performance calls for HEIs need to collaborate to redesign the curriculum of the ITE programs for its relevance. The work of the broader PrimTEd project is a step in the right direction. Much remains to be done to research and improve mathematics learning in Initial Teacher Education programmes for primary school teachers.

ACKNOWLEDGEMENTS

This publication has been developed through the Teaching and Learning Development Capacity Improvement Programme (TLDCIP) which is being implemented through a partnership between the Department of Higher Education and Training and the European Union. The authors acknowledge and thank all of the ITE institutions and colleagues in mathematics who have contributed and continue to contribute to the PrimTEd assessment workstream.

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To cite this article:

Alex, J. & Roberts, N. (2019) 'The need for relevant initial teacher education for primary mathematics: Evidence from the Primary Teacher Education project in South Africa' in Govender, N., Mudaly, R., Mthetwa, T. & Singh-Pillay, A. (eds) *Book of Proceedings, 27th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE)*, University of KwaZulu-Natal, Durban, South Africa, 15-17 January 2019.