early learning measurement tools

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ELOM-R (v1) TECHNICAL MANUAL 1

The Development of the Language and Mathematics ELOM-R (v1) Assessments

1ST EDITION 2025

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This Technical Manual accompanies the tablet-based ELOM-R Direct Assessment Manual (v1), as well as the ELOM-R (v1) Technical Manual 2: Language Assessment and the ELOM-R (v1) Technical Manual 3: Mathematics Assessment.

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ACRONYMS

BASAT	Basic Skills Assessment Tool
CTT	Classical Test Theory
CTOPP	Comprehensive Test of Phonological Processing
EAP CDS	East-Asia Pacific Early Child Development Scales
EF	Executive Functioning
EFA	Exploratory Factor Analysis
EGRA	Early Grade Reading Assessment
IDELA	International Development and Early Learning Assessment
ITC	International Test Commission
JSAIS	Junior South African Intelligence Scale
GCS	Grover-Counter Scale
KABC	Kaufman Assessment Battery for Children
MAIN	Multilingual Assessment for Narratives
MODEL	Measure Development and Early Learning
NWR	Nonword Repetition
PA	Phonological awareness
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
RAN	Rapid Automatized Naming
SETT	School-readiness Evaluation by Trained Testers
TBK-R	Test of Basic Concepts Knowledge-Revised
TIMSS	International Mathematics and Science Study
WELA	Wordworks Early Literacy Assessment
WISC IV	Wechsler Intelligence Scale for Children
ZAMCAT	Zambian Child Achievement Test

INTRODUCTION

The ELOM-R (v1) tools assess the Language and Mathematics skills that are central to children's readiness to learn when they enter Grade 1. ELOM-R (v1) is a successor to the widely used ELOM 4&5 Years Assessment tool designed to measure the development of children in early learning programmes prior to Grade R, the Reception year in South Africa.

THE ELOM-R (v1) TECHNICAL MANUALS ARE IN THREE PARTS:

1. **ELOM-R (v1) Technical Manual 1: Development of ELOM-R Language and Mathematics Assessments** *(this Manual)*
2. **ELOM-R (v1) Technical Manual 2: Language (v1) Assessment (second phase Language)**
3. **ELOM-R (v1) Technical Manual 3: Mathematics Assessment (second phase Mathematics)**

Norms and expected standards of performance for children to be On Track for Grade 1 are included in Manuals 2 and 3. All are available on the DataDrive2030 website.

INTRODUCTION

PURPOSE:

The ELOM-R Mathematics and Language (v1) Assessments are primarily intended for use in research studies, surveys, and evaluations of mathematics and literacy and language interventions designed to enable readiness for Grade 1. They are, therefore, appropriate for the assessment and description of groups of children and are not as diagnostic tests of individual child school readiness.

The two assessments are closely aligned with the skills and knowledge expected of children who have completed the Grade R curriculum.

They, therefore, permit users to identify the levels of knowledge and skill at which groups of children are functioning toward the end of the Grade R year. The two tools may, therefore, be regarded as summative assessments. Unless there is a good reason, such as addressing a specific research question, they should be administered close to the end of the Grade R year or early in Grade 1.

When used at a population level (e.g. a random sample of Grade R classes in an Education District) the tools enable users to a) look back at the Grade R year and make recommendations for attention to areas of weakness that show up in the findings that may benefit subsequent cohorts, and b) look forward to Grade 1 by drawing attention to areas in which populations of children require particular support in the early phases of that Grade.

Findings can then be used to inform strategies for enhancing the preschool, Grade R and Grade 1 curricula, quality and training. They can, therefore, be used in population surveys to estimate the proportion of children who are on Track for Grade 1 in each learning area, similar to the assessment of pre-Grade R children in the Thrive By Five series
(see https://thrivebyfive.co.za).

Like the ELOM 4&5 Assessment tool, the ELOM-R (v1) tools are direct individual assessments of children's abilities designed for administration by trained assessors using standard test kits. Test performance is captured on tablets and records are uploaded to a server for analysis. This practice standardises administration for each language group and minimises measurement error.

At the time of publication, ELOM-R Mathematics and Language (v1) assessments have been standardised in eight of South Africa's official languages: isiZulu, isiXhosa, Sepedi, Sesotho, Setswana, Tshivenda, English and Afrikaans. Others will be added over time.

It is important to note that as is common practice with measures of this nature, their improvement is ongoing. In particular, and while they are suitable for use, ELOM-R Language (v1) assessment norms must be regarded as provisional. Further required psychometric analysis is underway.The results will be published in the next edition of the ELOM-R Language Assessment Technical Manual.

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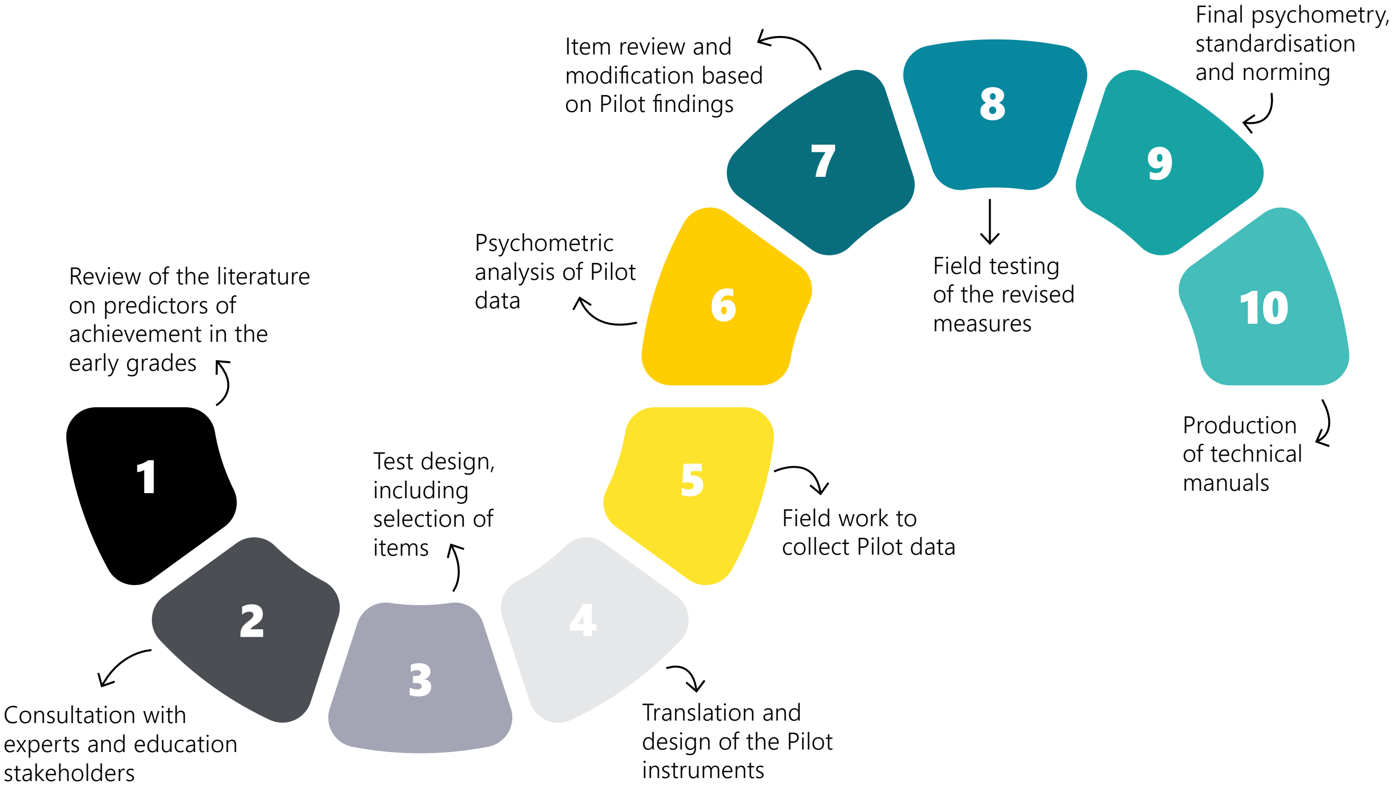
BACKGROUND:

The development of the ELOM-R (v1) tools commenced in 2018, and the Pilot instruments were tested in 2019. Data collection necessary for final psychometry and norming was interrupted in 2020 by the COVID-19 pandemic, which prevented access to schools. Data collection for finalisation was only possible in 2023 and 2024.

Unlike the development of a new measure for a culturally homogenous population, the goal was a standardised test that fairly assesses children from a range of ethnolinguistic backgrounds. The process is particularly complex (Hambleton 2001[1]). We are aware of no other measure that has been designed from the start with so many language groups in mind.

AS IS TYPICAL, BOTH TESTS WERE DEVELOPED IN **10 STEPS**:



This document covers steps 1 to 7, providing the background to the conceptualisation and development of each skill area. It concludes with a summary of the Pilot study undertaken to refine the instruments.

Steps 8-10 are described in the **ELOM-R Language and Mathematics (v1) Technical Manuals.**

[1]Hambleton, R. K. (2001). The next generation of the ITC test translation and adaptation guidelines. *European Journal of Psychological Assessment*, 17(3), 164-172. **http://dx.doi.org.ezproxy.uct.ac.za/10.1027//1015-5759.17.3.164**

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ASSESSING EQUIVALENCE AND BIAS IN MEASURES FOR A DIVERSE SOCIETY:

The design and development of both ELOM-R (v1) tools is informed by recent International Test Commission (ITC) Guidelines for the development, translation and adaptation of tests in culturally diverse populations (International Test Commission, 2017[2]; 2019[3]). As the ITC (2019) states:

"These guidelines are designed to inform test developers, psychometricians, and test users of the considerations that should be made to help ensure test fairness and score comparability to support meaningful inferences in culturally and linguistically diverse contexts. They augment existing ITC guidelines and other professional guidelines (or standards)..." (p. 302).

Given that the ELOM-R (v1) tools are intended to be a fair test of children's ability regardless of their cultural and linguistic backgrounds, the 2017 ITC Guidelines listed in Table 1 were followed (see also Hernández, 2020[4]). While all Guidelines are important, those particularly relevant to the ELOM-R (v1) tools process are listed.

TABLE 1. RELEVANT ITC (2017) GUIDELINES FOR THE DESIGN OF THE ELOM-R (v1) TOOLS

ITC GUIDELINES
TD-1 (4). *"Ensure that the translation and adaptation processes consider linguistic, psychological, and cultural differences in the intended populations through the choice of experts with relevant expertise."* (p. 106)
TD-2 (5). *"Use appropriate translation designs and procedures to maximize the suitability of the test adaptation in the intended populations" (p. 108). The key questions in this regard posed by the Commission are: "Is the language of the translated item of comparable difficulty and commonality with respect to the words in the item in the source language version?" and "Does the translation introduce changes in the text (omissions, substitutions, or additions) that might influence the difficulty of the test item in the two language versions?"* (p. 109)
TD-3 (6). *"Provide evidence that the test instructions and item content have similar meaning for all intended populations."* (p. 109)
TD-4 (7). *"Provide evidence that the item formats, rating scales, scoring categories, test conventions, modes of administration, and other procedures are suitable for all intended populations."* (p. 110)
TD-5 (8). *"Collect pilot data on the adapted test to enable item analysis, reliability assessment and small-scale validity studies so that any necessary revisions to the adapted test can be made."* (p. 111)

[2]International Test Commission. (2017). ITC Guidelines for Translating and Adapting Tests (Second edition). **www.InTestCom.org.**

[3]International Test Commission (2019). ITC guidelines for the large-scale assessment of linguistically and culturally diverse populations. *International Journal of Testing,* 19(4), 301–336. **https://doi.org/10.1080/15305058.2019.1631024**

[4]Hernández, A., Hidalgo, M. D., Hambleton, R. K., & Gómez Benito, J. (2020). International Test Commission guidelines for test adaptation: *A criterion checklist Psicothema, 2020, vol. 32(3), 390-398. doi: 10.7334/psicothema2019.306*

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RELEVANT CONFIRMATION GUIDELINES:

C-1 (9). *"Select sample with characteristics that are relevant for the intended use of the test and of sufficient size and relevance for the empirical analyses."* (p. 112)

C-2 (10). *"Provide relevant statistical evidence about the construct equivalence, method equivalence, and item equivalence for all intended populations."* (p. 114)

C-3 (11). *"Provide evidence supporting the norms, reliability and validity of the adapted version of the test in the intended populations."* (p. 119)

C-4 (12). *"Use an appropriate equating design and data analysis procedures when linking score scales from different language versions of a test."* (p. 119).

RELEVANT ADMINISTRATION GUIDELINES:

A-1 (13). *"Prepare administration materials and instructions to minimize any culture- and language-related problems that are caused by administration procedures and response modes that can affect the validity of the inferences drawn from the scores"* (p. 121).

A-2 (14). Specify testing conditions that should be followed closely in all populations of interest. (p. 122).

EQUIPMENT

Both the ELOM-R (v1) tools have accompanying test kits and digitised standardised administration manuals in all South African official languages (except South African Sign Language). Information is available on the DataDrive2030 website **here.** ELOM-R Technical Manuals for the Mathematics and Language (v1) Assessments provide standard scores and norms interpreting children's scores relative to the standardisation population.

All ELOM-R (v1) assessors (who administer the tools) must be **trained** and certified as competent prior to assessing children. They are also screened on the Child Protection, National Sex Offenders, and Criminal Record Registers.

CONTENT VALIDITY

Content validity involves the *"systematic examination of the test content to determine whether it covers a representative sample of the behaviour domain to be measured"* (Anastasi, 1968[5]). This legendary authority in the field notes that the objective of the assessment must be specified and that all relevant aspects of the domains to be measured must be included. In the case of the ELOM-R, and as will be elaborated below, the Curriculum Assessment Policy Statements (CAPS) for the Reception Year of the Foundation Phase were central to the selection of areas to be measured and, hence, the content of the items.

[5]Anastasi, A. (1968). Psychological Testing. London: Collier-MacMillan.

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SELECTION OF ITEMS

At the time of its development in 2018-2019, and prior to piloting, the brief for the research team was to produce two instruments that could be administered on the same day within a short timeframe. Given the age of the children and as field logistics require both to be administered on one day, each test should require no more than 45 minutes of administration time for the average 6- to 7-year-old.

As noted by one of our peer reviewers, a rule of thumb is to develop twice as many items as needed, as a proportion of at least a third will be discarded after the pilot testing. While more items were piloted than needed, this 'rule' could not be followed as the number of items in each test was restricted by time constraints and the age of the children in the pilot stage whose attention span is limited and would tire if the test had more items than they could reasonably manage. One also has an ethical concern about not having a testing burden that is too much for a young child to manage.

That said, we recognise that the constraints faced placed limits on optimal test design and development. As will be evident in the ELOM-R (v1) Language Technical Manual, more items are needed for the ELOM-R Language (v1) Assessment in particular. At the time of writing, these are being investigated, and revisions will be provided in the next edition of the Language assessment.

AS NOTED ABOVE, SKILLS MEASURED IN BOTH TOOLS ARE ALIGNED WITH THE GRADE R CAPS *(SEE APPENDIX 1 FOR PILOT ITEMS):*

- The Pilot Mathematics tool included 19 items (18 remain in the current tool) designed to assess CAPS areas: number sense and operations; shape and space; patterning; and sorting and grouping.

- The Pilot Language Assessment tool consisted of 13 items (eight remain in the current tool) designed to assess: short-term and working memory ; CAPS areas: Listening and speaking (vocabulary and oral language); Reading and Phonics (phonemic awareness and the underpinning auditory, visual and spatial perception required for reading); Writing and handwriting (Drawing and emergent writing skills; underpinning perceptual and motor skills; spatial and visual awareness); and Understanding of Print (book and word concepts).

Item selection was also informed by research on predictors of Foundation Phase learning outcomes. This included knowledge of the cognitive skills necessary for performing the mathematical operations included in the test, as well as the competencies underpinning phonetic awareness, comprehension and other aspects of the language skills covered in the Grade R CAPS.

Finally, extensive individual consultations and focus groups with stakeholders in the education system, as well as with language and mathematics education researchers, were held to explore views on the key competencies children should acquire prior to entering Grade 1, and thereby contribute to the content validity of the measures. Those consulted included provincial Grade R coordinators, curriculum specialists with Grade R/1 subject matter expertise in language and mathematics, Foundation Phase educators, Foundation Phase African language specialists, and South African scholars with expertise in linguistics and African languages, as well as language and mathematics education.

To the extent possible, items for the ELOM-R (v1) tools were sourced from existing measures. A scan, including normed South African tests, was undertaken. The focus was primarily on instruments used in the Southern and Eastern African Region and in low- and middle-income countries *(see Appendix 1)*.

A brief overview of relevant literature that informed the development of the two domains of the ELOM-R (v1) tools follows.

[6]These items were removed from subsequent versions of the test. A separate measure of executive functioning has been developed.

INTRODUCTION

LITERATURE REVIEW: PREDICTORS COMMON TO BOTH LANGUAGE AND MATHEMATICS ABILITIES IN THE FOUNDATION PHASE

Proficiency in emergent literacy and language, emergent mathematics, problem-solving skills, self-regulation, approach to learning, interpersonal skills, and confidence, all contribute to early school performance (e.g. Cadima et al., 2015[7]; McClelland, Morrison, and Holmes, 2000[8]). Children who have mastered the skills that underlie language and mathematics abilities in the preschool phase are more likely to adjust well to the Foundation Phase and perform better than children with lower levels of foundational skills in each area (Gathercole et al., 2004)[9].

Socioeconomic status is a significant influence on children's skill development in these areas, regardless of where it is measured globally. A social gradient is evident in both developed (e.g. Duncan et al, 2010[10]) and in low- and middle-income countries (Boyden et al., 2018[11]), including South Africa, where only 33% of children enrolled in the lowest early learning programme fee quintile are on track for Grade R, compared to 81% of those in fee level five. There is only one large sample South African study that reports predictors of Foundation Phase achievement in mathematics and reading (Robinson and Hanekom,1994[12]). Children were assessed on the Junior South African Individual Scale (JSAIS) (only standardised on white English and Afrikaans-speaking children) and the Aptitude Test for School Beginners (ASB) (standardised on nine South African language groups).

JSAIS subtests that best-predicted Grade 1 reading scores were: a) Ready knowledge[13], b) Number and Quantity concepts, c) Digits span, and d) Word Association. In the case of Grade 1 mathematics, most variance was explained by a) Ready knowledge and b) Number and Quantity concepts, with c) Digits, d) Block Design, e) Word Association, f) Picture Puzzles, and g) Visual Memory also being significant contributors. Common to both reading and mathematics were Ready knowledge, Number and Quantity concepts, Digits, and Word Association.

On the ASB, the best predictor of Grade 1 reading was the numerical scale (like the association between JSAIS Number and Quantity concepts and Grade 1 reading), while in the case of mathematics, the spatial, numerical and gestalt scales were predictive. For both JSAIS and ASB, a strong relationship exists between numerical tests and reading ability. As will be evident in Appendix 1, the Pilot ELOM-R (v1) tool items drew upon these findings. Given the limited research in South Africa, the remainder of this section relies on studies conducted in the Global North, with the United States in particular.

[7]Cadima, J., Doumen, S., Verschueren, K., & Buyse, E. (2015). Child engagement in the transition to school: Contributions of self-regulation, teacher–child relationships and classroom climate. *Early Childhood Research Quarterly,* 32, 1-12.

[8]McLelland, M.M., Morrison, F.J. & Holmes, D.L. (2000). Children at risk for early academic problems: The role of learning-related social skills. *Early Childhood Research Quarterly,* 15, 307–329.

[9]Gathercole, S. E., Pickering, S. J., Knight, C., & Stegmann, Z. (2004). Working memory skills and educational attainment: Evidence from national curriculum assessments at 7 and 14 years of age. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition, 18*(1), 1-16.

[10]Duncan, G. J., Ziol-Guest, K. M., & Kalil, A. (2010). Early-childhood poverty and adult attainment, behavior and health. Child Development, 81(1), 306–325.

[11]Boyden, J, Dawes, A. & Tredoux, C.G. (2018). Improving children's chances: Using evidence from four low and middle-income countries to set priorities for the SDGs. In Verma, S. and Petersen, A. (Eds.) *Sustainable Development Goals: Using Developmental Science to Improve Young Lives Globally.* Springer. **https://link.springer.com/chapter/10.1007/978-3-319-96592-5_14**

[12]Robinson, M. & J.D.M. Hanekom (1994). The use of the Junior South African Scales (JSAIS) and the Aptitude Tests for School Beginners (ASB) for the evaluation of school readiness at the school entrance phase. In van Eeden, R., Robinson, M. & Posthumus, A.B., *Studies on South African individual intelligence scales.* Pretoria: Human Sciences Research Council.

[13]According to the JSAIS Manual, *ready knowledge* measures social reasoning skills and general knowledge (i.e. long-term memory).

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EXECUTIVE FUNCTIONING (EF)

EF is a well-established predictor of early-grade performance in both reading and mathematics domains. Fitzpatrick et al. (2014, p. 25[14]) note that as they reach school age: *"executive function skills can help children hold information or instructions in mind during classroom activities, focus on task-relevant stimuli during problem-solving tasks, and resist internal or external distractions."*

CORE ELEMENTS OF EF INCLUDE:

Working memory: the ability to retain and manipulate information over short periods as when holding information in memory while working on a mental arithmetic problem or decoding text.

Inhibitory control: suppression of dominant action tendencies in favour of more goal-appropriate behaviour when solving a problem. (e.g. Blair and Ursache, 2013[15]).

Cognitive flexibility: the ability to switch from one set of rules for solving a problem to another– known as *"set-shifting."* The shape and colour games of the Dimensional Change Card Sort (DCCS) used in the ELOM 4&5 assessment test this ability (Frye, Zelazo, and Palfai, 1995; Zelatzo, 2006[16]).

Since the pilot phase, a measure of executive functioning (EF) has been excluded from the ELOM-R Mathematics or Language (v1) Assessments. A separate instrument, (ELOM-R Executive Function), is in development.

[14]Fitzpatrick, C., McKinnon, D., Blair, C., & Willoughby, M. (2014). Do preschool executive function skills explain the school readiness gap between advantaged and disadvantaged children? Learning and Instruction, 30, 25–31. **http://dx.doi.org/10.1016/j.learninstruc.2013.11.003.**

[15]Blair, C., & Ursache, A. (2013). A bidirectional model of executive functions and self-regulation. In K. Vohs, & R. Baumeister (Eds.), Handbook of self-regulation: Research, theory and applications (pp.300-320). New York: The Guildford Press.

[16]Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. Cognitive Development, 10(4), 483–527; Zelazo, D.P. (2006). The Dimensional Change Card Sort (DCCS): a method of assessing executive function in children. Nature. Protocols 1, 297–301.

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SOCIAL-EMOTIONAL FUNCTIONING (SEF)

It is noteworthy that the Thrive by Five 2021 cross-sectional survey of children aged between 50 and 59 months found that SEF was strongly associated with children's ELOM 4&5 Years Assessment tool performance when controlling for other likely influences (Tredoux et al., 2024[17]).

The findings of longitudinal studies on the influence of early SEF on later school performance in areas such as language and mathematics are mixed. SEF is increasingly recognised as important both for adapting to formal schooling and in enabling academic achievement (Collie et al., 2019[18]; Alzahrani & Alodwani, 2019[19]; Arnold et al., 2012[20]; McClelland et al., 2006[21]). However, preschool SEF has historically been found to be less strongly predictive of early grade school performance as cognitive skills (La Paro & Pianta, 2000[22]; Duncan et al 2007[23]). More recently, Ricciardi et al. (2021[24]) used a large longitudinal dataset to find an association between SEF in four-year-olds and Grade 5 performance.

However, like earlier studies, the effects were smaller than for cognitive predictors. The limited evidence in this field may be due to the poor availability of sound measures and limited attention to this domain. The situation is evolving as current research seeks to design more robust measures for these investigations (Campbell et al., 2016[25]).

At this point in our knowledge, one can be confident in asserting that cognitive skills are more strongly predictive of school achievement than children's social-emotional functioning, (although this domain does have an influence). A separate measure, available as part of the ELOM suite of tools, can be used by teachers and caregivers to rate young children's **social and emotional functioning.**

[17]Tredoux, C., Dawes, A., Mattes, F. et al. Are South African children on track for early learning? Findings from the South African Thrive By Five Index 2021 Survey. *Child Indicators Research,* 17, 601–636 (2024). **https://doi.org/10.1007/s12187-023-10093-3**

[18]Collie, R. J., Martin, A. J., Nassar, N., & Roberts, C. L. (2019). Social and emotional behavioral profiles in kindergarten: A population-based latent profile analysis of links to socio-educational characteristics and later achievement. *Journal of Educational Psychology, 111(1),* 170–187. **https://doi.org/10.1037/edu0000262**

[19]Alzahrani, M., Alharbi, M., & Alodwani, A. (2019). The effect of social-emotional competence on children's academic achievement and behavioral development. *International Education Studies, 12(12)*, 141-149. **doi:10.5539/ies.v12n12p141**

[20]Arnold, D. H., Kupersmidt, J. B., Voegler-Lee, M. E., & Marshall, N. A. (2012). The association between preschool children's social functioning and their emergent academic skills. Early childhood research quarterly, 27(3), 376-386

[21]McClelland, M. M., Acock, A. C., & Morrison, F. J. (2006). The impact of kindergarten learning-related skills on academic trajectories at the end of elementary school. *Early Childhood Research Quarterly, 21(4),* 471-490

[22]La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. Review of Educational Research, 70(4), 443-484.

[23]Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology,* 43, 1428-1446

[24]Ricciardi, C., Manfra, L., Hartman, S., Bleiker, C., Dineheart, L., & Winsler, A. (2021). School readiness skills at age four predict academic achievement through 5th grade. *Early Childhood Research Quarterly,* 57, 110–120. **https://doi.org/10.1016/j.ecresq.2021.05.006**

[25]Campbell, S. B., Denham, S. A., Howarth, G. Z., Jones, S. M., Whittaker, J. V., Williford, A. P., ... & Darling-Churchill, K. (2016). Commentary on the review of measures of early childhood social and emotional development: Conceptualization, critique, and recommendations. Journal of Applied Developmental Psychology, 45, 19-41. **https://doi.org/10.1016/j.appdev.2016.01.008**

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PREDICTORS SPECIFIC TO NUMERACY AND MATHEMATICS ABILITIES IN THE FOUNDATION AND PRIMARY PHASES

Early mathematics skills, such as counting, number knowledge, estimation and measurement, are the strongest predictors of later overall academic achievement - more so than early reading skills (Duncan et al., 2007). The effect is evident through to adolescence (Watts et al., 2014)[26]. Foundational domains for mathematics learning include the ability to name symbols used to represent numerosity (numerals) and discriminate between two quantities as represented by sets of numerals. These domains also include the ability to detect number patterns, perform operations such as addition and subtraction, and apply these skills to real-life situations, which are generally assessed through word problems (Geary, 2011)[27].

FIVE KEY ABILITIES IN PRESCHOOLERS ARE ASSOCIATED WITH SCHOOL PERFORMANCE IN FOUNDATION PHASE MATHEMATICS PERFORMANCE (e.g. GELMAN & GALLISTEL, 1978[28]):

1. KNOWLEDGE OF THE COUNTING WORD SEQUENCE;
2. AN UNDERSTANDING OF THE ONE-TO-ONE CORRESPONDENCE BETWEEN EACH OBJECT AND NUMBER WORD;
3. KNOWLEDGE THAT THE LAST NUMBER WORD IN THE COUNT IS THE CARDINAL VALUE OF THE SET (i.e. NUMEROSITY);
4. KNOWLEDGE THAT OBJECTS CAN BE COUNTED IN ANY ORDER; AND,
5. AN UNDERSTANDING THAT ANY COLLECTION OF OBJECTS CAN BE COUNTED.

Related, subitising, is the ability to recognise quantities quickly and accurately without counting, Kindergarten (Grade R) children's subitising abilities are strongly associated with primary school performance in mathematics (e.g. Hannula-Sormunen, 2015[29]; Kroesbergen et al., 2009[30]). Two subitising items were included in the ELOM-R Mathematics (v1) Pilot Assessment, one requiring subitising to five, and the other to 10. Many children struggled with subitising to 10, and this item was dropped, and subitising to five (five trials) was retained.

Number sense and *number operations* are the primary focus of Grade R mathematics and form the bulk of items in the ELOM-R Mathematics (v1) *Assessment. Shape and space, patterning, measurement* and *data handling* are also covered in the Grade R curriculum. The ELOM-R Mathematics (v1) Assessment includes items to assess these areas.

[26]Watts, T. W., Duncan, G. J., Siegler, R. S., & Davis-Kean, P. E. (2014). What's past is prologue: Relations between early mathematics knowledge and high school achievement. *Educational Researcher,* 43(7), 352-360.

[27]Geary, D. C. (2011). Cognitive predictors of achievement growth in mathematics: A 5-year longitudinal study. *Developmental Psychology,* 47(6), 1539–1552.

[28]Gelman, R. & Gallistel, C. (1978). *The Child's Understanding of Number.* Cambridge, Mass., Harvard University Press.

[29]Hannula-Sormunen, M. M., Lehtinen, E., & Räsänen, P. (2015). Preschool Children's Spontaneous Focusing on Numerosity, Subitizing, and Counting Skills as Predictors of their Mathematical Performance 7 Years Later at School. Mathematical Thinking and Learning, 17(2-3), 155-177.

[30]Kroesbergen, E. H., Van Luit, J. E. H., Van Lieshout, E. C. D. M., Van Loosbroek, E., & Van de Rijt, B. A. M. (2009). Individual differences in early numeracy: The role of executive functions and subitizing. *Journal of Psychoeducational Assessment*, 27(3), 226-236.

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Number sense and number operations are the primary focus of Grade R mathematics and form the bulk of items in the ELOM-R Mathematics (v1) Assessment. *Shape and space, patterning, measurement* and *data handling* are also covered in the Grade R curriculum. The ELOM-R Mathematics (v1) Assessment includes items to assess these areas.

Spatial skills appear to be foundational to these aspects of early mathematics ability (Clements & Sarama, 2014[31]; Mix & Cheng, 2011[32]). For example, children's early spatial skills predict performance on numerical arithmetic tasks at age 8 (Gunderson et al., 2012[33]). The use of measurement vocabulary relating to size in the early years is predictive of later spatial problem-solving tasks (Pruden et al., 2011)[34]. Le Fevre et al. (2010) report that symbolic mapping, calculation, and pattern knowledge predict mathematic ability in first grade low-income children (USA).

In a longitudinal study, Nguyen et al. (2016[35]) found that four domains of mathematical knowledge in pre-schoolers (counting and cardinality, patterning, geometry, and measurement skills), predicted mathematics ability in Grade 5. While all mathematics skill areas were predictive, numeracy and counting skills had the strongest effects.

ELOM-R Mathematics (v1) Assessment items selected for piloting (and post-pilot revision) are noted in the discussion of the Pilot work below.

[31]Clements, D. H., & Sarama, J. (2014). Developing young children's mathematical thinking and understanding. In *The Routledge International Handbook of Young Children's Thinking and Understanding* (pp. 331-344). Routledge.

[32]Mix, K. S. & Cheng, Y. L. 2011. The relation between space and math: developmental and educational implications. *Advances in Child Development and Behavior,* Vol. 42, pp. 197–243.

[33]Gunderson, E. A., Ramirez, G., Beilock, S. L. & Levine, S. C. 2012. The relation between spatial skill and early number knowledge: the role of the linear number line. *Developmental Psychology,* 48, (5), 1229–41.

[34]Pruden, S. M., Levine, S. C. & Huttenlocher, J. 2011. Children's spatial thinking: Does talk about the spatial world matter? *Developmental Science,* 14(6), 1417–30

[35]Nguyen, T., Watts, T. W., Duncan, G. J., Clements, D. H., Sarama, J. S., Wolfe, C., & Spitler, M. E. (2016). Which preschool mathematics competencies are most predictive of fifth grade achievement? Early Childhood Research Quarterly, 36, 550–560. **https://doi.org/10.1016/j.ecresq.2016.02.003**

INTRODUCTION

PREDICTORS SPECIFIC TO LITERACY AND LANGUAGE ABILITIES IN THE FOUNDATION AND PRIMARY PHASES

GRADE R LANGUAGE LEARNING HAS THREE FOCUS AREAS:

1. ORAL LANGUAGE SKILLS,
2. DECODING SKILLS NEEDED FOR EARLY READING AND
3. VISUAL MOTOR INTEGRATION AND FINE MOTOR COORDINATION SKILLS NEEDED FOR WRITING.

The National Early Literacy Panel (2008[36]) of the USA reported that children's *print knowledge, phonological processing and oral language* are all independent predictors of later language skill development. The South African curriculum follows systematic phonics (or balanced approach) to early reading, which is suited to local language orthography and the general lack of print experience in most learners entering school[37].

The South African National Literacy Strategy and Plan[38] points out that phonics may not be the most effective strategy for teaching reading in African languages because of the diverse phonemic and orthographic systems, including the use of tonal sounds in some languages. In addition, and in contrast to English, African languages spoken in South Africa have a simple syllabic structure (words are built from syllables rather than individual sounds[39]). Wilsenach (2019, p. 1) stresses the importance of phonological awareness (PA) skills as readers need these *"in order to grasp the alphabetic principle (i.e. that letters on a page correspond to sounds in a language). Poor PA skills lead to poor decoding skills, which in turn affect reading automaticity and fluency, ultimately causing poor comprehension skills."*

EMERGENT EARLY CHILDHOOD ABILITIES SKILLS THAT HAVE BEEN IDENTIFIED AS STRONG PREDICTORS OF LATER LANGUAGE SKILL ACHIEVEMENT INCLUDE:

1. A large vocabulary (e.g. Sénéchal, et al., 2006[40]).
2. Demonstrating phonological awareness (e.g. Sodoro et al., 2002[41]).
3. Oral language - being capable of explanatory talk (e.g. Catts et al., 2015[42]).
4. Demonstrating some letter identification before age five (e.g. The National Early Literacy Panel, 2008).
5. Understanding narrative and stories (e.g. O'Carroll & Hickman, 2012[43]).
6. Understanding writing functions (e.g. Strickland & Riley-Ayers, 2006[44]).

[36]National Early Literacy Panel (NELP) (2008). Developing early literacy: Report of the National Early Literacy Panel. Washington, DC, National Institute for Literacy. **http://lincs.ed.gov/publications/pdf/NELPReport09.pdf**

[37]Pretorius E (2019). Still falling at the first hurdle. Examining early grade reading in South Africa. In Spaull, N. & Jansen, J.D. (Eds.), South African Schooling: The Enigma of Inequality, A Study of the Present Situation and Future Possibilities (pp. 147-168). Springer Nature.

[38]Department of Basic Education (2023) South African National Literacy Strategy and Plan 2024 – 2030. Pretoria.

[39]In transparent orthographies, each grapheme (the written form of a sound) typically represents a single phoneme, and the spelling of words is predictable based on their pronunciation. English has an opaque orthography.

[40]Sénéchal, M., Ouellette, G., & Rodney, D. (2006). The misunderstood giant: On the predictive role of early vocabulary in future reading. In D. Dickinson, & S.B. Neuman (Vol. Eds.). *Handbook of Early Literacy Research*, Vol. 2 (pp 173-184). New York, NY: Guilford Press

[41]Sodoro, J., Allinder, R. M., & Rankin-Erickson, J. L. (2002). *Assessment of phonological awareness: Review of methods and tools. Educational Psychology Review*, 14, 223-260.

[42]Catts, H. W., Herrera, S., Nielsen, D. C., & Bridges, M. S. (2015). Early prediction of reading comprehension within the simple view framework. Reading and Writing, 28, 1407-1425.

[43]O'Carroll, S. & Hickman, R. (2012). Narrowing the literacy gap: *Strengthening language and literacy development between birth and six years for children in South Africa*. Wordworks: Cape Town.

[44]Strickland D, Riley-Ayers S (2006) Early literacy policy and practice preschool years. National Institute for Early Education Research at Rutgers, Policy Brief **http://www.readingrockets.org/article/early-literacy-policy-and-practice-preschool-years.**

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Vocabulary, phonological awareness, phonological memory and oral language are essential for comprehension and are strongly predictive of later reading comprehension (Papadimitriou & Vlachos, 2014[45]; Roth, et al., 2002[46]; Matafwali, 2010[47]).

A recent study of Grade 1 learners in the Western Cape identified poor receptive and expressive language as early literacy barriers in disadvantaged children (Wildschut et al., 2016[48]). The US National Early Literacy Panel (NELP) (2008[49]) noted that these abilities accounted for a considerable amount of variance in subsequent reading skills.

FINALLY, DUBECK AND GOVE (2015[50]) PROVIDE A USEFUL SUMMARY OF THE KEY READILY MEASURABLE EARLY LITERACY AND LANGUAGE SKILLS ASSOCIATED WITH SUCCESSFUL LANGUAGE ACQUISITION THAT CONTRIBUTE TO READING ACHIEVEMENT:

PHONOLOGICAL AWARENESS
(sound identification, sound discrimination, & syllable segmentation)

PRINT KNOWLEDGE

ORTHOGRAPHIC KNOWLEDGE

All are included in the **ELOM-R Language (v1) Assessment tool.**

[45]Papadimitriou, A. M. & Vlachos, F, M. (2014). Which specific skills developing during preschool years predict the reading performance in the first and second grade of primary school? Early Child Development and Care 184(11), 1706-1722.

[46]Roth, F. P., Speece, D. L., & Cooper, D. H. (2002). A longitudinal analysis of the connection between oral language and early reading. The Journal of Educational Research, 95(5), 259-272. DOI: 10.1080/00220670209596600

[47]Matafwali, B. (2010) The role of oral language in the acquisition of early language skills: A case of Zambian languages and English. Unpublished PhD, University of Zambia.

[48]Wildschut, Z., Moodley, T. & Aronstam, S., (2016), The baseline assessment of Grade 1 learners' literacy skills in a socio-economically disadvantaged school setting, South African Journal of Childhood Education 6(1), a340. **http://dx.doi.org/10.4102/sajce.v6i1.340**

[49]National Early Literacy Panel (NELP). 2008. Developing early literacy: Report of the National Early Literacy Panel. Washington, DC, National Institute for Literacy. **http://lincs.ed.gov/publications/pdf/NELPReport09.pdf**

[50]M.M. Dubeck, A. Gove (2015) The early grade reading assessment (EGRA): Its theoretical foundation, purpose, and limitations. International Journal of Educational Development, 40, 315–322316

INTRODUCTION

PHONOLOGICAL AWARENESS

Phonological awareness (PA) is one of the most researched early literacy skills and has consistently been found to predict the acquisition of later word-reading skills in every language in which it has been studied. Awareness of individual sounds (phonemes) is particularly necessary for successful literacy acquisition (Castles & Coltheart, 2004[51]).

South African researcher Wilsenach (2019, p.1[52]) defines PA as *"a sensitivity to the sounds and sound structure of a particular language (and) plays a key role in reading development across languages, regardless of the phonological structure, the orthography and the writing system of the language in which a child learns to read (emphasis ours)".* Note the stress we have placed on regardless of the language.

She goes on to note that PA: *"facilitates an individual's ability to distinguish, analyse and manipulate the sound units that constitute words – an ability that is critically important when learning to read as it allows beginning readers to associate sound units of varying 'grain sizes' (i.e. phonemes ….) with graphemes and ensures the formation of stable phoneme-grapheme correspondence"* (p.1).

Wilsenach (2019) and Diemer et al. (2015[53]) both note that the role of PA skills in the South African Southern Bantu language group is under-researched. Seeking to address this gap, Wilsenach investigated the relationship between phoneme awareness, syllable awareness and reading in Grade 3 North Sotho speakers. She found that these children were significantly better at identifying syllables rather than phonemes. The same findings have been made by Diemer et al. for isiXhosa-speaking Grade 3 children.

What is perhaps most important, however, is that PA was more strongly predictive of reading abilities at Grade 3 than knowledge of syllables. This indicates how important it is to enhance phonetic awareness in children speaking North Sotho as well as other languages. In accordance with these findings and the importance of PA in the South African Literacy Policy and Plan, a measure of PA is included in the ELOM-R Language (v1) assessment for all languages.

THE CHALLENGE OF DESIGNING TESTS OF PHONOLOGICAL AWARENESS IN A MULTI-LINGUAL SOCIETY

A major challenge for developing phonological awareness tests in our multilingual South African context is to establish the cross-group equivalence of the measure.

Milfont and Fischer (2015[54]) note that when a test is adapted for use from the original language (in this case English), it is necessary to establish the functional equivalence (Peña, 2007[55]) of the test items in the new language (in this case each of the local languages for which the test has been adapted). Functional equivalence refers to ensuring as far as possible that the instructions given by the assessor and the task required of the child by each test item are understood in the same way by children speaking any of the languages for which the test is designed. If this is not the case, then the performance of affected children will be disadvantaged, and they will not be able to demonstrate their actual ability.

[51]Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition*, 91, 77-111.

[52]Wilsenach, C. (2019). Phonological awareness and reading in Northern Sotho – Understanding the contribution of phonemes and syllables in Grade 3 reading attainment. *South African Journal of Childhood Education,* 9(1), 10 pages. doi:**https://doi.org/10.4102/sajce.v9i1.647**

[53]Diemer, M., van der Merwe, K., & de Vos, M. (2015). The development of phonological awareness literacy measures for isiXhosa. *Southern African Linguistics and Applied Language Studies*, 33(3), 325–341. **https://doi.org/10.2989/16073614.2015.1108769.**

[54]Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research*, 3(1), 111-130.

[55]Peña, E. D. (2007). Lost in translation: Methodological considerations in cross-cultural research. Child Development, 78(4), 1255-1264.

INTRODUCTION

It is challenging to design equivalent and fair tests of phonological awareness and other language abilities across the different language families in South Africa.

While there is debate on this matter, Probert (2019[56]) states that the Southern Bantu language group are agglutinating languages and have different morphologies to English – the reference language used in the development of the ELOM-R Language (v1) Assessment. In these languages, morphemes (prefixes, and suffixes) are added to noun and verb roots to change grammar and convey specific meaning. Probert observes that: *"The morphological word refers to the piece of speech which behaves as a unit of pronunciation as well as meaning in context"* (p.2). (emphasis ours).

In isiXhosa, for example, *"the morphological word coincides with the orthographic word, but ... in Setswana, the morphological word is represented by several orthographic words in that blank spaces are placed between the morphemes that make up the word..."* (p.2).

Furthermore, Probert notes that words in the Southern Bantu languages tend to be *"much longer than what would be said to constitute a word in English"* (p.2).

In the ELOM-R Language (v1) Assessment, we measure PA using an item that tests the child's discrimination of initial sounds of words presented by the assessor. Phoneme deletion tasks also test for PA (and working memory), and the pilot version of the test drew on Rosner's Phonological Awareness Test (Rosner, 1993[57]) to construct deletion tasks for all languages. The test administrator says a word and the child is instructed to repeat it, omitting the final syllable. However, the pilot revealed a floor effect and highly positively skewed score distributions on this item for all languages with 85% of the scores being zero. It was clearly too difficult for the pilot sample (including in English), and the instructions were not well understood. This item was, therefore, dropped from the standardised version of the ELOM-R Language (v1) Assessment.

For all languages covered in the ELOM-R (v1) tools, a further issue in assessing PA and other early literacy abilities is that children's performance will be influenced by the way these skills are taught in the Grade R year. This is likely to favour children learning in English. As Pretorius and Spaull (2016[58]) note, much of the current instruction used in South African classrooms is borrowed from the teaching of early reading in English, and they assert that this is not necessarily the best way to teach early reading in African languages. The same may apply to instruction in literacy and language in early learning programmes and Grade R, and this is likely to affect performance on PA test items as well as other skills.

Current research indicates that in contrast to English, PA does not necessarily develop early in African language speakers. This could be due to the languages themselves, the measures used to test PA in the Southern Bantu languages, and the quality and form of instruction in preschool years and early grades.

Further discussion of this interesting topic is beyond the scope of this contribution.

The views of experts were considered in the design of the PA domains of the ELOM-R Language (v1) Assessment. Indeed, it provides an opportunity for researching PA across languages and in longitudinal studies, investigating the extent to which it predicts later reading ability. This will be helpful in establishing whether the ELOM-R (v1) has criterion validity – which is yet to be tested.

[56]Probert, T.N. (2019). A comparison of the early reading strategies of isiXhosa and Setswana first language learners. *South African Journal of Childhood Education* 9(1), a643. **https://doi.org/10.4102/ sajce.v9i1.643**

[57]Rosner, J. (1993). Helping Children Overcome Learning Difficulties, 3rd Ed. New York: Walker and Company.

[58]Pretorius, E. J., & Spaull, N. (2016/09//). Exploring relationships between oral reading fluency and reading comprehension amongst English second language readers in South Africa. *Reading and Writing*, 29(7), 1449-1471. doi: **https://doi.org/10.1007/s11145-016-9645-9**

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PRINT KNOWLEDGE

This area involves understanding the orthographic system of a written language. Print concepts include book orientation, directionality (e.g., left to right; top to bottom), a purpose for reading, as well as letter recognition and knowledge of letter names and their corresponding sounds. Letter knowledge has been consistently shown to be a strong predictor of early reading.

Letter identification is the strongest predictor among reading readiness skills of later literacy achievements, such as decoding, spelling, and reading comprehension skills (Scarborough, 1998[59]; Lonigan, et al., 2008[60]; Schatschneider et al., 2004[61]; Wagner et al., 1994[62]; National Early Literacy Panel, 2008[63]).

ORTHOGRAPHIC KNOWLEDGE

Understanding words in their written form includes the knowledge that certain sequences of letters compose words that represent spoken sounds. In the earliest phase, children have to learn that speech can be turned into print or that letters represent speech sounds in the language. They can memorise text, associate meaning with pictures and environmental print, and identify words by their unique shapes.

In the emergent stage, children notice the phonological features of spoken words (e.g., word length) and book handling, In the second phase, partial alphabetic, students now understand the alphabetic principle, meaning they use some of the word's letters (i.e. symbols) to cue corresponding sounds, and this, in conjunction with memory for that word's initial unit of sound, allows them to "read" the word. Learners in this phase can give the names and sounds of some letters, recognise a few words, and match spoken to written words. They learn to combine picture cues with initial sounds or syllables to read new words and are developing a sight-word vocabulary (i.e. words read automatically). Grade R CAPS assess emergent orthographic knowledge and more limited aspects of the partial alphabetic phase. The next alphabetic phase is marked by an ability to learn new words using several strategies.

Finally, the Measurement of Early Learning Quality and Outcomes (MELQO) team note that specific skills – including alphabet knowledge and phonological awareness – not only correlate with later language skills but maintain their predictive power even when the role of other variables, such as age, IQ or socio-economic status were accounted for and may therefore be useful as assessment items in contexts where children's experiences prior to school entry vary greatly[64].

[59]Scarborough, H. 1998. Predicting the future achievement of second graders with reading disabilities: contribution of phonemic awareness, verbal memory, rapid naming, and IQ. Annals of Dyslexia, 48, 115–36.

[60]Lonigan, C. J., Schatschneider, C., Westberg, L. & NELP (2008). Identification of children's skills and abilities linked to later outcomes in reading, writing, and spelling. Developing early literacy: Report of the National Early Literacy Panel. Washington, DC, National Institute for Literacy, pp. 55–106.

[61]Schatschneider, C., Fletcher, J. M., Francis, D. J., Carlson, C. D. & Foorman, B. R. (2004). Kindergarten prediction of reading skills: a longitudinal comparative analysis. Journal of Educational Psychology, 96(,2), 265–82.

[62]Wagner RK, Torgesen JK, & Rashotte CA. (1999). CTOPP: Comprehensive test of phonological processing. Austin, Texas: Pro-Ed.

[63]National Early Literacy Panel (NELP) (2008). Developing early literacy: Report of the National Early Literacy Panel. Washington, DC, National Institute for Literacy. **http://lincs.ed.gov/publications/pdf/NELPReport09.pdf**

[64]UNESCO, UNICEF, Brookings Institution and the World Bank (2017) Overview measuring early learning quality and outcomes. Accessible at **https://www.brookings.edu/research/overview-measuring-early-learning-quality-and-outcomes/**

INTRODUCTION

PERCEPTUAL-MOTOR SKILLS IN EARLY LITERACY AND LANGUAGE

A study of socioeconomically disadvantaged Grade 1 learners in the Western Cape has identified difficulties in perceptual-motor skills as barriers to acquisition of literacy and language skills (Wildschut, 2016[65]). Their acquisition in the Foundation Phase is strongly underpinned by perceptual-motor skills including spatial awareness and orientation and auditory, visual and temporal sensory awareness (Excell and Linington, 2011[66])

[65]Wildschut, Z., Moodley, T. & Aronstam, S. (2016), The baseline assessment of Grade 1 learners' literacy skills in a socio-economically disadvantaged school setting, South African Journal of Childhood Education 6(1),1-9.

[66]Excell, L & Linington, V. (2011) Move to literacy: fanning emergent literacy in early childhood education in a pedagogy of play. South African Journal of Childhood Education, 1 (2) 27 – 45.

THE ELOM-R (v1) PILOT

The primary purpose of the Pilot was to examine how children from different socio-economic backgrounds (based on school quintiles) and languages responded to each pilot test item so that adjustments to the measure could be made prior to collecting data for psychometric analysis, standardisation and norming (see the ELOM-R (v1) Technical Manuals 2 and 3). Pilot item analyses were also used to investigate the functional equivalence of each item, that is, whether or not the instructions in the different languages elicited the same behaviour in children from different language groups and SES backgrounds (also considering qualitative information from assessors).

As noted above, in both the design of the Pilot measures and all subsequent psychometric procedures, we followed the *ITC Guidelines* for test adaptation across cultures.

ITEM TRANSLATION AND ADAPTATION

Item translation and adaptation followed ITC Guidelines TD-1 (4), TD-2 (5), TD-3 (6), TD-4 (7), and TD-5 (8) (see Table 1 above). All items were double translated from the original English into Afrikaans, Ndebele, isiXhosa, Sepedi, Sesotho, Setswana, Siswati, Tshivenda,

Xitsonga, and isiZulu following accepted procedures (ITC Guidelines on Translating and Adapting Tests, 2018[67]; Hambleton, 2002[68]; Milfont & Fischer, 2015[69]; Pena, 2007[70]).

Ensuring the ELOM-R Language (v1) Assessment was as equivalent as possible across different languages was a particular challenge given variations in the morphology and grammar of the African tongues. Language experts provided significant assistance in this process, as well as in formulating certain items.

FOR EXAMPLE:

1. Pilot ELOM-R Language (v1) Assessment test item *nonword repetition:* Sesotho, Nguni, Afrikaans, Xitsonga and Tshivenda versions were developed with equivalent numbers of syllables in each nonword. For example, the first nonword in isiXhosa is *"luki"* and in Tshivenda it is *"dupa"*,
2. Pilot ELOM-R Language (v1) Assessment test item *beginning sounds:* initial letters common to all languages were used (verbs for the agglutinating African languages); for example, the first word presented in English is *"mother";* in isiXhosa it is *"mamela"*,
3. Pilot ELOM-R Language (v1) Assessment test item *Letter sounds:* frequently occurring randomised (lowercase) letters were used in the letter recognition charts for all languages,
4. Pilot ELOM-R Language (v1) Assessment test item *Drawing and emergent writing* require the child to write two words. As far as possible these were standardised across languages.

PILOT SAMPLE

The pilot sample was neither nationally nor provincially representative. This is not required for a pilot study of this nature. Seventy-five (75) public school Grade R classes were selected from across all provinces to cover the eight languages. Four children per school were randomly selected for assessment.

[67]International Test Commission. (2016). *The ITC Guidelines for Translating and Adapting Tests* (Second edition). **[www.InTestCom.org]**

[68]Hambleton, R.K. (2002). Adapting Achievement Tests into Multiple Languages for International Assessments. In National Research Council, *Methodological Advances in Cross-National Surveys of Educational Achievement* (pp. 58-79). Washington, DC: The National Academies Press.

[69]Milfont, T. L., & Fischer, R. (2015). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research,* 3(1), 111-130.

[70]Pena, E. D. (2007). Lost in translation: Methodological considerations in cross-cultural research. *Child Development,* 78, 1255-1264.

THE ELOM-R (v1) PILOT

After data cleaning, the sample consisted of **532** children {52% female (n = 278); 48% male (n = 254}}; mean age = 72.66 months (SD = 4.67) (Age Range: 63 - 85 months). Table 2 displays the number of children per school quintile in each language used for analyses.

TABLE 2. PILOT PSYCHOMETRY SAMPLE.

	QUINTILE 1	QUINTILE 2	QUINTILE 3	QUINTILE 4	QUINTILE 5	TOTAL
Afrikaans	0	17	8	30	10	65
English	0	0	4	24	39	67
isiNdebele	7	0	18	0	0	25
isiXhosa	19	15	25	0	0	59
isiZulu	16	0	43	8	0	67
Sepedi	39	16	16	0	0	71
Sesotho	31	5	11	8	0	55
Setswana	0	22	24	13	0	59
Siswati	8	8	8	0	0	24
Tshivenda	8	8	0	0	0	16
Xitsonga	8	16	0	0	0	24
TOTAL	**136**	**107**	**157**	**83**	**49**	**532**

As is inevitable given the highly skewed socio-economic gradient resulting from the Apartheid era, far higher proportions of Africans than Afrikaans or English language speakers make up the lower socio-economic strata.

Language and socio-economic status (SES), based on school quintile, were therefore confounded in the Pilot. It is essential to appreciate, therefore, that the influence of SES cannot be separated from language when these are compared on the various items.

We chose not to classify children using 'race' categories as we do not agree with this practice and there is no rationale for doing so.

As is appropriate for a pilot, the sample size in each language was not large enough to finalise psychometric analyses. As indicated above, the primary purpose was to enable decisions on a final item set for administration to a large enough sample for standardisation and norming in the next phase.

PILOT PROCEDURE

Prospective assessors attended a five-day training. The criterion for acceptance as an assessor was to achieve an *85% score correspondence* with a video of a demonstration administration (a form of inter-rater reliability).

THE ELOM-R (v1) PILOT

The Pilot ELOM-R (v1) tools were administered individually to Grade R children in the third term of the school year. Test administration was counter-balanced for the majority of languages (not Sepedi and Ndebele – an error in the Pilot process) with the majority of children (60%; n = 321) tested on ELOM-R Language (v1) first, while the remaining 40% (n = 211) were tested on ELOM-R Mathematics (v1) first.

Data was collected on password-protected tablets and uploaded to a secure server for analysis.

PILOT PSYCHOMETRIC ANALYSIS SUMMARY

The goal of the analysis was to generate a set of items suitable for inclusion in the next iteration of the instrument, to be administered to a larger and more representative sample of Grade 1 learners of sufficient size.

THE FOLLOWING STEPS WERE UNDERTAKEN IN THE ANALYSIS OF PILOT DATA:

1. Data cleaning and finalisation of the dataset for analysis.
2. Descriptive statistics: final sample characteristics; item administration time by test language for both the ELOM-R Language and Mathematics (v1) Assessments,
3. Re-scaling items: item total scores were rescaled to facilitate the generation of total scores and the application of any general linear models.
4. Exploration of Test Order effects using rescaled item total scores.
5. Mean total scores for each test were compared to determine the order. Histograms were constructed for each item to establish possible Floor and Ceiling effects.
6. Item difficulty investigations were conducted on each set of ELOM-R Language and Mathematics (v1) Assessment test items, using the proportions of children succeeding on each trial.
7. Exploratory Factor Analysis (EFA) was conducted to determine factor structure, generate unidimensional subscales, and to further inform judgement of items.
8. Reliability: Item-rest correlations and Cronbach’s alpha were computed on each sub-scale.

To have adequate sample sizes for pilot psychometry, as some language samples were too small for the purpose, language groupings were constructed following consultation with language experts:

1. English and Afrikaans group (Germanic languages);
2. Nguni group (Zulu, Xhosa, Siswati, Ndebele, Xitsonga[71]); and
3. Sotho group (Sesotho, Setswana, Sepedi, Tshivenda).

CRITERIA FOR ITEM RETENTION

1. The item had no significant floor or ceiling effects.
2. The item contributed to test reliability.
3. The item contributed to a factor in at least two language groups; if not, the item was retained if essential for capturing information relevant to CAPS.

[71]Xitsonga is regarded by some as a sub-group of the Nguni languages.

THE ELOM-R (v1) PILOT

4. The item measured a CAPS priority, or if not, there is evidence that it predicts either mathematics or language performance in the Foundation Phase.
5. The item was feasible to administer at scale within the South African context, or problems observed in the Pilot can be addressed.

If items recommended for retention contained trials that were clearly too challenging, judgment was used to exclude such trials.

ELOM-R MATHEMATICS (v1): PILOT PSYCHOMETRIC FINDINGS SUMMARY

The Pilot Mathematics Assessment consisted of nineteen (19) items which followed CAPS content and were designed to assess:

1. NUMBER SENSE AND OPERATIONS
2. SHAPE AND SPACE
3. PATTERNING
4. SORTING AND GROUPING

The three language groups specified above were used for psychometric analyses.

The score distribution for the item *Counting Forwards* was bimodal. We observed that many African language speakers were unclear about the instruction, and whether they should count in the vernacular. The item has been retained with modified instructions.

Scoring errors were evident for the item Count with *1:1 correspondence*.
Both have been retained for the final ELOM-R Mathematics (v1) tool following adjustment of the instructions.

TWO FACTORS WERE SUPPORTED BY EXPLORATORY FACTOR ANALYSIS (EFA) IN ALL THREE LANGUAGE GROUPS:

1. **Factor 1:** CAPS Number sense and operations items (count backwards, count from a given number, skip counting in twos, number recognition and order, missing number, subitise to 5, knowledge of ordinal numbers, show a collection without counting). Cronbach's Alpha (standardised values) were acceptable for this purpose: English and Afrikaans =. 814; Nguni group = .816; Sotho group = .779.

2. **Factor 2:** a mix of CAPS Number Sense and Operations, Shape and Space Skills (Patterns, Functions and Algebra) items: Solving Addition and Subtraction Problems, Solving Sharing and Grouping Problems, Copy Shape from Models, 2-Dimensional Shapes, Pattern Extension, Find the Missing Item, Sort the Objects. Cronbach's Alpha (standardised values) were acceptable for this purpose in the Nguni group (.764) but not in the case of the Sesotho (.638) and English and Afrikaans (.662) groups.

ELOM-R Mathematics (v1) Pilot items (and sources) recommended for inclusion or removal following the pilot are included in Appendix 2.

THE ELOM-R (v1) PILOT

ELOM-R LANGUAGE (v1): PILOT PSYCHOMETRIC FINDINGS SUMMARY

The Pilot ELOM-R Language (v1) Assessment consisted of thirteen (13) items designed to assess:

1. SHORT-TERM AND WORKING MEMORY;[72]
2. EMERGENT LITERACY AND LANGUAGE;
3. CONCEPTS ABOUT PRINT.

On Exploratory Factor Analysis (EFA), two factors that made theoretical sense in each of the three language groups were evident:

1. **Factor 1:** CAPS writing skills items (Writing Name and Writing Words). Cronbach's alpha (standardised values) ranged from .826 (English and Afrikaans) to .884 (Nguni group) and .809 (Sotho group). All groups had good reliability.

2. **Factor 2:** CAPS Listening and Speaking items plus book concepts items[73]. Cronbach's alpha (standardised values) ranged from .734 (English and Afrikaans) to .728 (Nguni group) (both acceptable) and .651 (Sotho group) (poor reliability).

ELOM-R Language (v1) Items (and sources) recommended for inclusion or removal following the pilot are included in Appendix 2. Those retained were included in the final psychometric analyses leading to standardisation and norming (see the ELOM-R (v1) Technical Manual 2: Language).

The final steps in psychometry and norming of both tests are reported in the ELOM-R (v1) Technical Manual 2: Language Assessment and ELOM-R (v1) Technical Manual 3: Mathematics Assessment.

[72]These items were removed from subsequent versions of the test. A separate measure of executive functioning has been developed.

[73]This factor included one short term memory item and three executive functioning items since removed from the test.

APPENDIX 1: PILOT MEASURES

APPENDIX 1 TABLE 1. ELOM-R MATHEMATICS (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: NUMBER SENSE AND OPERATIONS **SKILLS:** EARLY NUMBER SKILLS; CONCEPTUAL REASONING ABILITY	**1. NUMBER SENSE AND OPERATIONS:** COUNTING FORWARDS Task: Child counts in ones to 20 No time limit and no stop rule. One Trial	ELOM, ZAMCAT, MODEL, IDELA (among others). Herbst (Herbst, & Huysamen, 2000[74])
	2. NUMBER SENSE AND OPERATIONS: COUNTING BACKWARDS Task: Child counts backwards in ones from 10. No time limit and no stop rule. One Trial	Wright et al. (2006[75]).
	3. NUMBER SENSE AND OPERATIONS: COUNT ON FROM A GIVEN NUMBER Task: Assessor requests child to count on from a given number (from 5 onwards and from 9 onwards). No time limit and no stop rule. Two trials	Wright et al. (2006).
	4. NUMBER SENSE AND OPERATIONS: SKIP COUNTING IN TWOS Task: Assessor requests child to count in twos to 10 and to 20. No time limit. Stop if the child reaches 6. Two trials	Wright et al (2006).
	5. NUMBER SENSE AND OPERATIONS: COUNT WITH ONE-TO-ONE CORRESPONDENCE Task: Assessor requests child to count the (20) counters placed on the table. No time limit and no stop rule. One Trial	Wright et al. (2006), Gelman & Gallistel (1986[76]).
	6. NUMBER SENSE AND OPERATIONS: NUMBER ORDER Task: Assessor places number cards (0 to 10) randomly arranged before the child; child is required to place the cards in the correct order from 0-10. No time limit and no stop rule. One Trial	Wright et al. (2006).
	7. NUMBER SENSE AND OPERATIONS: WHAT IS THE MISSING NUMBER? Task: Assessor places a number card before the child; child is asked to a) identify the number and b) say which number comes before and c) after the number presented. No time limit and no stop rule. Two Trials.	EAP CDS, ASB Numeracy, Wright et al. (2006)

[74]Herbst, I., & Huysamen, G. K. (2000). The construction and validation of developmental scales for environmentally disadvantaged preschool children. South African Journal of Psychology, 30(3), 19-26.

[75]Wright, R. J., Martland, J., & Stafford, A. K. (2006). Early numeracy: Assessment for teaching and intervention. Sage.

[76]Gelman, R. and Gallistel, C.R. (1986). The child's understanding of number. Cambridge, MA: Harvard University Press.

APPENDIX 1: PILOT MEASURES

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CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: NUMBER SENSE AND OPERATIONS **SKILLS:** EARLY NUMBER SKILLS; CONCEPTUAL REASONING ABILITY	**8. NUMBER SENSE AND OPERATIONS:** CHILD SUBITISES TO 6 Task: For each trial, the assessor's tablet flashes a card with dots on it for 2 seconds; the assessor and asks the child to say how many dots they see. Cards have 1-5 dots in different arrays. No time limit and no stop rule. Eight trials (3 second interval between trials).	Wright et al. (2006).
	9. NUMBER SENSE AND OPERATIONS: CHILD SUBITISES TO 10 Task: For each trial, the assessor's tablet flashes a card with dots on it for 2 seconds; the assessor and asks the child to say how many dots they see. Cards have 8 to 10 dots in different arrays. No time limit and no stop rule. Eight trials (3 second interval between trials).	Wright et al. (2006).
	10. NUMBER SENSE AND OPERATIONS: POSITION IN A ROW Task: Assessor shows a picture of children in a running race. Child is asked which child is first, last, second, third, fourth and fifth. No time limit and no stop rule. Six trials.	Similar tasks in EAP CDS and ASB Numeracy[77]
	11. NUMBER SENSE AND OPERATIONS: COMPARE TWO COLLECTIONS OF OBJECTS. Task: Assessor places groups of 5 and 9 counters before the child. Child is asked which has more and fewer, how she knows; child is then asked to make the groups equal in number. No time limit and no stop rule. Six trials.	IDELA, MODEL, EAP CDS, ASB numerical (using pictures), TAYARI (using counters), Cognitive Development Assessment (CDA[78]) Quantities Sub-scale.
	12: NUMBER SENSE AND OPERATIONS: SHOW A COLLECTION WITHOUT COUNTING Task: Assessor shows the child a string of beads and asks the child to show a specified number of beads without counting.No time limit and no stop rule. Five trials.	Rekenrek (Frykholm, 2008[79]).
	13: NUMBER SENSE AND OPERATIONS: SOLVING ADDITION AND SUBTRACTION PROBLEMS Task: Assessor asks 6 questions to assess counting ability (using counters if necessary). No time limit and no stop rule. Six trials.	Herbst, EAP CDS, IDELA, TAYARI, ASPECTS , Wright et al. (2006).
	14: NUMBER SENSE AND OPERATIONS: SOLVING SHARING AND GROUPING PROBLEMS Task: Using counters, assessor asks three questions for the child to demonstrate sharing and grouping. No time limit and no stop rule. Three trials	Herbst Evaluation Scale, EAP CDS, IDELA, TAYARI , ASPECTS

[77]Oliver, N. M. & Swart, D. J. (1988) Aptitude Tests for School Beginners (ASB). Pretoria: Institute for Psychological and Edumetric Research Human Sciences Research Council

[78]Cueto, S., Leon, J., Guerrero, G., & Muñoz, I. (2009). Psychometric characteristics of cognitive development and achievement instruments in Round 2 of Young Lives. Young Lives Technical Note 15

[79]Frykholm, J. (2008). Learning to Think Mathematically with the Rekenrek: A Resource for Teachers, A Tool for Young Children. The Math Learning Center, Salem, Oregon. Cloudbreak Publishing, Colorado

APPENDIX 1: PILOT MEASURES

APPENDIX 1 TABLE 1. ELOM-R MATHEMATICS (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: SHAPE AND SPACE **SKILLS:** RECOGNISES THE ATTRIBUTES OF DIFFERENT SHAPES, COPIES A CONSTRUCTION FROM A DESIGN	**15: SPACE AND SHAPE:** COPY SHAPES FROM MODELS Task: Child uses counters to construct shapes. Three trials 1) copy assessor's construction (aeroplane); 2) copy assessor's construction from memory (man); copy image presented to the child (church). Time limits: trial 2 = 120 seconds; trial 3 = 130 seconds. Stop rule: if the child cannot complete trial 1 (aeroplane) discontinue the item.	Grover Counter Scales[81], School-readiness Evaluation by Trained Testers (SETT) (Developed by the HSRC), Herbst.
	16: SPACE AND SHAPE: TWO DIMENSIONAL SHAPES Task: Child us asked to a) name shapes presented on a card depicting triangles, squares, rectangles, and circles of different sizes; answer questions about the properties of these shapes. No time limit and no stop rule. Eleven trials.	IDELA, EAP CDS, TAYARI
CAPS: PATTERNS, FUNCTIONS AND ALGEBRA **SKILLS:** PERCEPTUAL SKILLS DEMONSTRATED BY COPYING AND EXTENDING PATTERNS BASED ON THE UNDERLYING LOGIC	**17: PATTERN EXTENSION** Task: A pattern strip (with multi-coloured disc counters arranged in a particular order). The child uses counters to complete the pattern in the correct sequence. There are three trials. No time limit and no stop rule	Similar items in EAP CDS, ASB spatial and gestalt sub-scales
	18: PATTERN COMPLETION: FIND THE MISSING ITEM Task: The child is shown a series of stimuli (symbols) that form a logical, linear pattern. One stimulus is missing. The child is required to complete the series by choosing the correct symbol from an array of options.No time limit and no stop rule. Six trials.	Based on the KABC ii. Pattern Reasoning subscale (Kaufman & Kaufman, 2004[82]; Mitchell, 2015[83])
CAPS: DATA HANDLING SKILLS **SKILLS:** ABILITY TO SORT OBJECTS BASED ON THEIR PROPERTIES	**19: SORTING AND GROUPING:** SORT THE OBJECTS Task: Child is asked to group triangles, squares and circles by 1) shape; 2) size and 3) colour. No time limit and no stop rule. Three trials.	IDELA, ELOM, ASB perception, ASB reasoning, EAP CDS, Herbst.

[80]https://www.cem.org/aspects

[81]Grover, V. M. (2000). Revised Manual for the Grover Counter Scale of Cognitive Development. Pretoria: Unit for assessment Research and Technology, Human Sciences Research Council.

[82]Kaufman, A. S., & Kaufman, N. L. (2004). Kaufman Assessment Battery for Children: Second Edition (KABC-II). Minnesota, MN: AGS Publishing.

[83]Mitchell, J.M. (2015). Psychometric evaluation of the Kaufman Assessment Battery for Children, Second Edition (KABC-II) in rural South Africa. MA Thesis, University of Stellenbosch

APPENDIX 1: PILOT MEASURES

APPENDIX 1 TABLE 2. ELOM-R LANGUAGE (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
UNDERLYING COGNITIVE SKILL: SHORT TERM AND AUDITORY MEMORY	1: DIGITS FORWARD Assessor states a number series (e.g. 6…1…3). Child is required to repeat the series in the same order (6…1…3). Stop if the child cannot pass two practice trials. Five trials.	WISC-IV[84] TAYARI[85] MODEL[86] Early Grade Reading Study (EGRS) (Schaefer & Kotze 2019[87], Taylor et al., 2017[88])
UNDERLYING COGNITIVE SKILL: WORKING AND AUDITORY MEMORY	2: DIGITS BACKWARD Assessor states a number series (e.g. 5…7…2). Child is required to repeat the series in reverse order (2…7…5). Stop if the child cannot pass two practice trials. Four Trials	
SKILL: ABILITY TO RELATE ORTHOGRAPHIC AND PHONOLOGICAL REPRESENTATIONS USING WORKING MEMORY; PREDICTIVE OF EARLY GRADE READING FLUENCY	3: **OBJECT NAMING:** RAPID AUTOMATISED NAMING (RAN) Task: A set of 6 objects is shown to the child. Child is shown a chart with four rows in which these objects are randomly presented (some are repeated to make up 9 per row). Child is required to name as many objects as possible in 60 seconds. Stop at 60 seconds. One trial.	Early Grade Reading Study (EGRS), RAN[89], ZAMCAT[90]
UNDERLYING COGNITIVE SKILL: SHORT TERM AND WORKING MEMORY	4: NON-WORD REPETITION Assessor presents 20 increasingly challenging 'nonsense' words one by one. Child is required to repeat each 'nonsense' word. Stop if the child fails 3 consecutive items. 20 Trials.	English adapted from Nonword Repetition (NWR): Comprehensive Test of Phonological Processing (CTOPP). Wagner, Torgesen & Rashotte (1999[91]).

[84]Wechsler, D. (2003). Wechsler intelligence scale for children-WISC-IV. Psychological Corporation

[85]https://learningportal.iiep.unesco.org/en/library/impact-evaluation-of-tayari-school-readiness-program-in-kenya-endline-report

[86]http://ecdmeasure.org/about-melqo/what-is-melqo/

[87]Schaefer, M., & Kotzé, J. (2019). Early reading skills related to Grade 1 English Second Language literacy in rural South African schools. South African Journal of Childhood Education, 9(1), 1-13.

[88]Taylor, S., Cilliers, J., Prinsloo, C. Fleisch, B. & Reddy, V. (2017). The early grade reading study: Impact evaluation after two years of interventions technical report. Pretoria: Department of Basic Education.

[89]Denckla, M. B., and Rudel, R. G. (1976). Rapid "automatized" naming (R.A.N): dyslexia differentiated from other learning disabilities. Neuropsychologia 14, 471–479. doi: 10.1016/0028-3932(76)90075-0

[90]Fink, G., Matafwali, B., Moucheraud, C., & Zuilkowsk, S.S. (2012). The Zambian Early Childhood Development Project 2010 Assessment Final Report. Center on the Developing Child at Harvard University. Retrieved from http://www.poverty-action.org/study/zambian-early-childhood-development-project

[91]Wagner RK, Torgesen JK, & Rashotte CA. (1999). CTOPP: Comprehensive test of phonological processing. Austin, Texas: Pro-Ed.

APPENDIX 1: PILOT MEASURES

APPENDIX 1 TABLE 2. ELOM-R LANGUAGE (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: LISTENING AND SPEAKING **SKILL:** VOCABULARY AND ORAL LANGUAGE	**5: PRODUCTIVE VOCABULARY** Task: Child is required to name 36 objects presented in pictures (Three sets of pictures). Stop after 8 consecutive errors in a set. 36 Trials.	Wilsenach & Schaefer (2022[92]) receptive vocabulary test. Adapted with permission.
	12: LISTENING COMPREHENSION Task: Child is shown 6 pictures that illustrate a story. The assessor tells the story. Child is required to answer 10 questions about the story. No time limit and no stop rule. Ten Trials.	MODEL, IDELA[93], TAYARI, BASAT Multilingual Assessment for Narratives (MAIN) (Gagarina, et al., 2019[94])
CAPS: DEVELOP PHONEMIC AWARENESS, LETTER AND WORD RECOGNITION AND THE UNDERPINNING AUDITORY, VISUAL AND SPATIAL PERCEPTION REQUIRED FOR READING	**6: BEGINNING SOUNDS** Task: Child has to say the initial sound of the object or action depicted in each of 8 pictures No time limit and no stop rule. Eight Trials.	TAYARI, MODEL, ELOM (4&5), BASAT, EGRA[96]
	7: PHONEME DELETION Task: Assessor says a word. Child is instructed to repeat the word but omit the final syllable. Stop after 3 consecutive errors. Ten Trials	Rosner test of Auditory Analysis, The Phonological Awareness Test (Rosner, 1993[97]). Also measures working memory.
	8: LETTER SOUNDS Task: Assessor shows letter cards to the child and asks the child to say which sound each letter makes (12 letters presented in turn). No time limit and no stop rule. 12 Trials	MODEL, IDELA, EGRA, BASAT, TAYARI, TBCK_R[98].

[91]Wagner RK, Torgesen JK, & Rashotte CA. (1999). CTOPP: Comprehensive test of phonological processing. Austin, Texas: Pro-Ed.

[92]Wilsenach, C., & Schaefer, M. (2022). Development and initial validation of productive vocabulary tests for isiZulu, Siswati and English in South Africa. Language Testing, 39(4), 567-592

[93]Pisani, L., Borisova, I., & Dowd, A. J. (2015). International Development and Early Learning Assessment Technical Working Paper. Retrieved from **http://resourcecentre.savethechildren.se/sites/default/files/documents/idela_technical_working_paper_v3_nodraft.pdf**

[94]Mwanza-Kabaghe, S., Mubanga, E., Matafwali, B., Kasonde-Ngandu, S. & Bus, A.G. (2015). Zambian Preschools: A Boost for Early Literacy? English Linguistics Research, 4(4), **http://dx.doi.org/10.5430/elr.v4n4p1**

[95]Gagarina, N., Klop, D. Kunnari, S., Tantele, K., Välimaa,T., Bohnacker, U., & Walters, J., (2019). MAIN: Multilingual Assessment Instrument for Narratives Revised English Version. ZAS Papers in Linguistics 62.

[96]Dubeck, M. M., & Gove, A. (2015). The early grade reading assessment (EGRA): Its theoretical foundation, purpose, and limitations. International Journal of Educational Development, 40, 315-322.

[97]Rosner, J. (1993). Helping Children Overcome Learning Difficulties, 3rd Ed. New York: Walker and Company.

[98]Test of Basic Concept Knowledge **www.basicconcepts.co.za**

APPENDIX 1: PILOT MEASURES

APPENDIX 1 TABLE 2. ELOM-R LANGUAGE (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: DEVELOP WRITING AND HANDWRITING SKILLS WITH A FOCUS ON THE UNDERPINNING PERCEPTUAL MOTOR SKILLS PARTICULARLY SPATIAL AND VISUAL AWARENESS	**9: DRAWING AND EMERGENT WRITING** Task: Child required to copy pictures of a triangle, a rectangle and a vertical diamond. No time limit and no stop rule. Three Trials	IDELA, MODEL, ZAMCAT, Beery Buktenica Test of Visual Motor Integration[99]. EAP CDS[100]
	10: DRAWING AND EMERGENT WRITING Task: Child is asked to write her / his name. No time limit and no stop rule. One Trial.	EAP CDS, TBCK-R, BASAT, Wordworks Early Literacy Assessment (WELA)[101]
	11: DRAWING AND EMERGENT WRITING Task: Child is shown a picture of a cat and asked to write the word CAT. Child is shown a picture of a butterfly and asked to write the word BUTTERFLY. (Words vary according to languages). Time limit 120 seconds for each word. Two Trials.	WELA
CAPS: UNDERSTANDING OF PRINT **SKILLS:** UNDERSTANDING THE ORTHOGRAPHIC SYSTEM AND WRITTEN LANGUGE	**13: BOOK CONCEPT ORIENTATION AND WORD CONCEPT** Task: Child is shown a picture book and asked 9 questions that assess awareness of print and book concept. No time limit and no stop rule. Nine Trials.	Task adapted from Clay (2017[102]).

[99]Beery, K. E., Buktenica, N. A. & Beery, N. A. (2010). Beery-Buktenica Developmental Test of Visual-Motor Integration. 6th Edition. Pearson.

[100]Rao, N., Sun, J., Ng, M., Becher, Y., Lee, D., Zhang, L. & Lau, C. (2014). East-Asia Pacific Early Child Development Scales. Hong Kong: Faculty of Education, the University of Hong Kong.

[101]O' Carroll, S.; Twiss, A. & Setton, S. (2017) Early Literacy Assessment Kit: Grade R and Grade One. Cape Town: Wordworks

[102]Clay, M. M (2017) Concepts about Print, Second Edition: What Has a Child Learned about the Way We Print Language? Heinemann.

APPENDIX 2: RECOMMENDATIONS FOR ITEMS

APPENDIX 1 TABLE 2. ELOM-R LANGUAGE (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: NUMBER SENSE AND OPERATIONS **SKILLS:** EARLY NUMBER SKILLS; CONCEPTUAL REASONING ABILITY	1: Counting forwards to 20	**Retain:** Adjust assessor instruction so that children are not cued to count in vernacular. *"Let's count. See how far you can count."* (It is very unlikely that children will skip count, so this is a good resolution). Stop the child at 20 Then use language that child counted in for subsequent items **Reasons:** Due to language issues this item shows a bimodal distribution. The adjustment should address this and as this is a basic number competence. It should be retained.
	2: Counting backwards from 10	**Retain:** **Reason:** Bimodal distribution (children either do very well or poorly). Must be retained as it is a CAPS requirement.
	3: Counting on from 5 and from 9	**Retain:** But ensure that assessors say the numbers in the language in which the child counted to allow for counting in English or vernacular – a training emphasis is needed. **Reasons:** Good distribution and CAPS related.
	4: Skip counting in twos to 10 and to 20	**Retain with modification:** Exclude 2nd trial As for item 1, ensure use of number names in language child has selected for counting. **Reasons:** Highly positively skewed distribution indicating that most children cannot do the second trial. It is proposed that only the first trial is retained as that is the Grade R requirement.
	5: Count with 1:1 correspondence	**Retain:** **Reasons:** Key CAPS requirement
	6: Number order	**Retain with modification:** impose a time limit of 2 minutes. **Reason:** CAPS requirement. The average time for this item was 1 minute 26 seconds (standard deviation 47 secs); we recommend 2 minutes to reduce administration time.
	7: Identify missing numbers Learners are able to recognise the numbers but are not familiar with 'before' and 'after' most of them guessed the answers for those questions	**Retain:** **Reasons:** good spread in item total scores. Important number skill.
	8: Subitise to 5 (cards displayed on tablet for 2 seconds)	**Retain:** **Reasons:** a good spread in item total scores. Key mathematics skill.

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CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: NUMBER SENSE AND OPERATIONS **SKILLS:** EARLY NUMBER SKILLS; CONCEPTUAL REASONING ABILITY	9: Subitise to 10 (cards displayed on tablet for 2 seconds)	<u>**Discard:**</u> **Reasons**: highly positively skewed distribution indicting that this item is too difficult for children
	10: Position in a row (knowledge of ordinal numbers)	<u>**Retain:**</u> **Reasons:** highly satisfactory distribution
	11: Compare two collections of objects.	<u>**Retain but modify administration**</u> to provide counters in the same colour **Reasons:** despite scoring challenges in the pilot this is a standard and important number skill.
	12: Show a collection without counting	<u>**Retain:**</u> **Reasons:** normal distribution and important competence.
	13: Solving addition and subtraction problems	<u>**Retain but modify.**</u> To shorten this item and increase fairness, we recommend discarding trials 4 and 5 (these are the most cognitively demanding). **Reasons:** Floor effect. Highly positively skewed distribution indicating a poor item with most children not succeeding. However, solving word subtraction and addition problems is a key CAPS requirement in Grade R CAPS requirement.
	14: Solving sharing and grouping problems	<u>**Retain:**</u> **Reasons:** Floor effect. Highly positively skewed distribution with children performing very poorly. Despite this, because sharing and grouping problems are a Grade R CAPS requirement, we recommend retention.
CAPS: SHAPE AND SPACE **SKILLS:** RECOGNISES THE ATTRIBUTES OF DIFFERENT SHAPES; COPIES A CONSTRUCTION FROM A DESIGN.	15: Copy shapes from models	<u>**Retain with some modification**</u> The scoring needs to be reassessed to give greater range on the third trial. Scoring should also be automatised to reduce error. **Reasons:** distribution is slightly skewed but not unsatisfactory. The item tests child ability to copy a shape from a model and a picture. As well as assessing CAPS shape and space the standardized item assesses underpinning cognitive capacities.
	16: Name two dimensional shapes	<u>**Retain with modification:**</u> by removing the counting requirement. **Reasons:** As counting was only programmed for English there is a great deal of missing data. However, in the interests of shortening administration time and numerous counting items, a focus on the recognition of the attributes of shapes as the key shape and space skill is deemed sufficient.

APPENDIX 2: RECOMMENDATIONS FOR ITEMS

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CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: PATTERNS, FUNCTIONS AND ALGEBRA **SKILLS:** PERCEPTUAL SKILLS DEMONSTRATED BY COPYING AND EXTENDING PATTERNS BASED ON THE UNDERLYING LOGIC	17: Pattern extension	**Retain with modification:** adjust to include two full pattern repeats.ww Adjust scoring on tablet so that the assessor ticks which shapes were selected for each space to reduce scoring error. **Reasons:** Floor effect. Positively skewed distribution with children performing poorly indicating that the item is difficult for the majority. However, pattern extension is an important CAPS area and should be retained. Including two full pattern repetitions would be easier for children.
	18: Pattern completion	**Retain with modification:** reduce number of trials to the following 1, 2 and 6 **Reasons:** Item 18 is negatively skewed indicating that most find the item difficult. However, pattern recognition is important in CAPS and more than one item is needed to measure this construct. To reduce difficulty and time of administration we propose the deletion of the more difficult trials.
CAPS: DATA HANDLING SKILLS **SKILLS:** ABILITY TO SORT OBJECTS BASED ON THEIR PROPERTIES	19: Sort objects	**Retain but move** from after patterning to before shape and space to avoid response set for patterning. **Reasons:** Though the distribution is positively skewed and therefore quite difficult for most, it is the only data handling item, key to CAPS; the ability to sort in different ways is also an indication of cognitive flexibility, an important element of executive functioning associated with mathematics ability.
ESTIMATED TOTAL ELOM-R V.1MATHEMATICS ADMINISTRATION TIME FOR RECOMMENDED ITEMS		30-40 minutes

APPENDIX 2: RECOMMENDATIONS FOR ITEMS

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CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
UNDERLYING COGNITIVE SKILL: SHORT TERM AND AUDITORY MEMORY	1: Digits Forward	Retain: **Reasons:** Good score distribution. Widely used indicator of short-term memory, good spread in item total scores.
UNDERLYING COGNITIVE SKILL: WORKING AND AUDITORY MEMORY	2: Digits Backward	Discard: **Reasons:** Floor effect. Highly skewed distribution, which is indicative of a poor item. Difficulty level too great for inclusion.
SKILL: ABILITY TO RELATE ORTHOGRAPHIC AND PHONOLOGICAL REPRESENTATIONS USING WORKING MEMORY; PREDICTIVE OF EARLY GRADE READING FLUENCY	3: Rapid Automatised Naming (RAN)	Discard **Reasons:** The Tangerine application was programmed to only time the whole item (including assessor instruction) and we do not know how quickly children managed in different languages. As well as being uncertain as to how the item performs across languages there are questions of the value of RAN as a population measure. Language experts and literature indicate that it is mostly used as an individual diagnostic of children who might have dyslexia. Additionally, while RAN is a good predictor of later reading fluency especially in African languages, evidence is mixed as to whether poor RAN can be remediated through teaching practice.
CAPS: UNDERLYING COGNITIVE SKILL: SHORT TERM AND WORKING MEMORY	4: Non-Word Repetition (Standard Audio presentation in each language)	**Retain with modifications.** Reduce to first 14 trials. Ensure that the recordings are at the same pace with the same interval between words across languages to improve standardisation. **Reasons:** Good score distribution. While there are slight differences in number of syllables in non-words across languages (with agglutinating languages having one more syllable than the others), on average there is a significant drop in performance after trial 14. Reducing the number will also shorten administration time.
CAPS: LISTENING AND SPEAKING **SKILL:** VOCABULARY AND ORAL LANGUAGE	5: Productive Vocabulary	**Retain with modification** to include more difficult words. Note any retained words where assessors have noted problems with image recognition (e.g. the mat/carpet) **Reasons:** Ceiling Effect. Highly skewed distribution indicates that the item is too easy and will require modification. Vocabulary is a key content focus.
	12: Listening Comprehension (Standard Audio presentation in each language)	**Retain with minor translation modification** with 'meat 'as an alternative to the word 'sausage' as it is not familiar in some vernacular languages, **Reasons:** Although distribution is negatively skewed (a ceiling effect is not evident), comprehension is a key CAPS area, and it will be important to explore Quintile / language differences in future ELOM-R V.1tools rounds with representative samples.

APPENDIX 2: RECOMMENDATIONS FOR ITEMS

APPENDIX 1 TABLE 2. ELOM-R LANGUAGE (v1) PILOT ITEMS		
CAPS CONTENT AREA OR SKILL	**ITEM**	**ITEM SOURCE/ OTHER MEASURES ASSESSING SIMILAR SKILLS**
CAPS: DEVELOP PHONEMIC AWARENESS, LETTER AND WORD RECOGNITION AND THE UNDERPINNING AUDITORY, VISUAL AND SPATIAL PERCEPTION REQUIRED FOR READING	6: Beginning Sounds	Retain **Reasons:** Bimodal score distribution suggesting that children tend to either score low or high on the item (likely to be attributable to five of the Pilot African languages). However, this is an essential literacy skill
	7: Phoneme Deletion	Discard: **Reasons:** Floor Effect. The item has a highly positively skewed distribution and is too difficult. Difficult to administer- instructions not understood.
	8: Letter Sounds	Retain: **Reasons:** Distribution positively skewed (attributable to performance of children in certain languages), but this is not sufficient for exclusion. Letter sounds are a key domain of the CAPS.
CAPS: DEVELOP WRITING AND HANDWRITING SKILLS WITH A FOCUS ON THE UNDERPINNING PERCEPTUAL MOTOR SKILLS PARTICULARLY SPATIAL AND VISUAL AWARENESS	9: Copy Pictures of Triangle, Rectangle, Vertical Diamond	Retain: **Reasons:** good score distribution
	10: Write Name	Retain **Reasons:** Although the item is negatively skewed, with 62% of children achieving the maximum score, it is a CAPS requirement and builds confidence prior to Item 11.
	11: Write words for e.g. Cat and Butterfly Easy item to administer. Learners understand the instructions however they are not able to write.	Retain **Reasons:** The item is positively skewed but provides for range/stretch even though this is a Grade 1 level skill
CAPS: UNDERSTANDING OF PRINT **SKILLS:** UNDERSTANDING THE ORTHOGRAPHIC SYSTEM AND WRITTEN LANGUAGE	13: Book Concept, Orientation, and Word Concept	Retain **Reasons:** the item has a sound distribution. It is a useful measure of familiarity with books and print and helpful systemic indicator
ESTIMATED TOTAL ELOM-R LANGUAGE (v1) ADMINISTRATION TIME OF RECOMMENDED ITEMS		15-20 Minutes