RESEARCH PROPOSAL
RHODES UNIVERSITY
FACULTY OF EDUCATION

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Provisional Title:

Investigating Grade 6 learners changing mathematical procedural fluency and learning dispositions through participation in after school mathematics clubs.

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Supervisors	:	Dr Debbie Stott & Prof Mellony Graven
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ABSTRACT

A wide range of research locally points to intermediate phase learners having extremely weak basic number sense resulting in the dominance of inefficient strategies for calculations with the four operations, irrespective of the number range. Following informal conversations with teachers in Uitenhage, five of them expressed an interest in running after school mathematics clubs based on the South African Numeracy Chair (SANC) project model. The SANC project team ran workshops in April, May and June 2016 with the five teachers in which teachers were provided with key resources for use in their clubs. Fifteen club sessions ran across the 2nd and 3rd terms.

These clubs form the empirical field for this research which aims to investigate the nature of learners' evolving mathematical proficiency and teachers' experiences of working with learners in the club space. The unit of analysis in this study is both the learners in the clubs and the teacher facilitators experiences of working with learners in those clubs.

A social constructivist perspective of learning guides this study. Kilpatrick et al.'s (2001) strands of mathematical proficiency provide the conceptual frame with a particular focus on conceptual understanding, procedural fluency and productive disposition. The work of Carr and Claxton supplements the notion of productive learning dispositions and across these frameworks indicators of shifting learning dispositions will be derived. A mixed method approach to data collection will be used. Quantitative data will be drawn from learner's scores on pre and post assessments on four basic operations. Qualitative narratives will be drawn from learner progression data, learner dispositional questionnaires as well as teacher questionnaires and one-to-one teacher interviews.

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RESEARCH CONTEXT

South Africa is significantly underperforming in mathematics education. The condition of mathematics education in South Africa has often been described as being in crisis (Fleisch, 2008). Currently learners are unable to move their thinking sufficiently forward from concrete counting to abstract thinking (Graven and Stott, 2016). Both international and regional comparative studies SACMEQ II (Moloi and Strauss, 2013) indicate that our learners are not competent in computing and manipulating numbers and general mathematics concepts.

Many reasons have been given for this situation including poor quality of mathematics teaching, teacher knowledge, language, opportunities to learn, teaching time, home resources, and learner dispositions (Carnoy et al., 2011; Hoadley, 2012; Spaull, 2013; Reddy, 2006; Heyd-Mezuyanim and Graven, 2015). The report on 2012 – 2014 ANA results reveals that in the Eastern Cape province the sixth graders achieved below 40% and so it is with Uitenhage District respectively (DBE, 2014 p.89) The 2012 to 2014 ANA results for the Uitenhage are shown in the graph below.

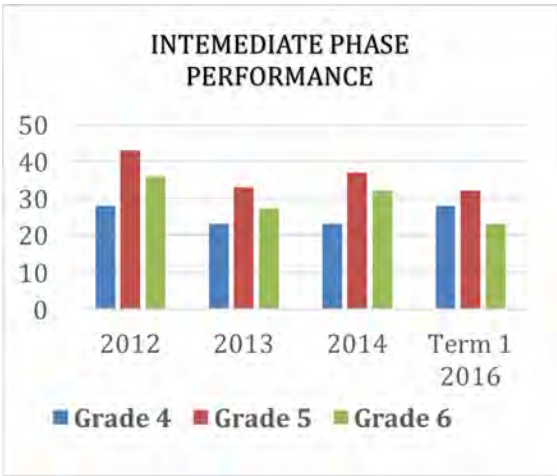

Figure 1: Uitenhage district ANA 2013 – 2014 learner results & 2016 (Term 1) learner performance

The Problem

Poor performance worsens in Grade 6 (DBE, 2014 p.92), as illustrated in the graph above. Learners are promoted up the grades without having the content and foundational proficiencies of the preceding grades, resulting in a large cognitive backlog and learning dispositions that inhibit more complex learning (Schollar, 2008, p.5, Carnoy, Chisholm and Addy, 2011). In my experience this is mostly apparent when grade six learners still use tally marks, circles and modelling to calculate 1 to 3-digit operations (DBE, ANA diagnostic report 2014).

Teachers often complain that they are not able to complete and cover the prescribed curriculum due to the challenges aforementioned. It is imperative that these learners are not pushed through to the next grade with these content gaps and backlogs in mathematics without any intervention in place.

Additionally, interventions aimed at improving learner attainment by Department of Basic Education (DBE) and the Eastern Cape Provincial office in the form of lecturing style workshops provide the participants with little or no time for a hands on approach to engaging with shared activities.

The South African Numeracy Chair project (SANCP)

The SANCP at Rhodes University is one of two national numeracy chairs in South Africa who are tasked with addressing this problem. Their aim is to research sustainable ways to improve the quality of teaching of in-service mathematics teachers at primary level and improve learner performance as a result of quality teaching and learning (Graven, 2011). There is a growing research community of both full time and part time doctoral and masters' students emanating from these projects over the last five years.

One of the key objectives of the SANC project is to support the progress of learners from inefficient, constrained methods to more fluent and flexible methods through after school club activities. This push towards increasingly efficient methods of calculating is the central aspect of the SANCP's Pushing for Progression (PfP) teacher development programme.

The Pushing for Progression (PfP) teacher development programme

The PfP programme is a 15-week programme (see appendix 5 for the timeline) which aims to provide support for teachers to run weekly after school maths clubs in their schools. The programme aims to develop learner sense making in numbers, shifting learner mathematical fluency and dispositions from being passive learners to becoming active participants (South African Numeracy Chair Project, 2016).

The nature of the after school maths clubs

The after school clubs set up as part of the PfP aim to support participating teachers to progress their club learners from concrete to more efficient methods of calculation by offering activities in a more actively engaged and informal environment. As learners participate in the club activities they are encouraged to talk about their thinking, share their ideas and strategies while solving mathematical problems. Furthermore, through clubs, learners spend more time working on mathematics as they spend an hour in the clubs and at home using their take home books.

Clubs and the PfP teacher development programme in my district

As a way of addressing the aforementioned challenges, as a district official, I wanted to explore if maths clubs could be a productive space to progress learners' mathematical proficiency when clubs are run by teachers rather than by SANCP team members. In this role, I argued for running the PfP programme in five of the schools in my district. I presented the rationale to my colleagues in the Department and ran an information workshop for the principals and teachers in five schools

where teachers showed interest and wanted to know more about how the clubs could work in their schools. All stakeholders expressed interest and willingness to participate in the programme.

Thus, the SANC project offered this PfP programme to my district and ran workshops in April, May and June 2016 with the five schools. These workshops focused on the use of focused activities and games to develop mathematical proficiency and positive learner learning dispositions. Teachers were provided with an overview of club aims and pedagogical principles, key resources, mathematics fluency games and sets of take home learner workbooks for use in their clubs.

Following the first workshop, teachers began running these clubs once a week for an hour each session after school. Fifteen club sessions took place at each school across the 2nd and 3rd terms. The teachers invited interested learners from the bottom half of the performance spectrum to attend (learners attaining below 30% in Mathematics). SANCP sought parental permission for learners to participate in the clubs and for their progress to be recorded and provided teachers with assessment activities as part of their broader data collection activities for the PfP programme. Although the clubs ran independently and prior to my research learner progression and teacher experiences in these clubs are the focus for my research.

Rationale, significance and potential value of the research

As mentioned earlier research locally points to intermediate phase learners having extremely weak basic number sense resulting in the dominance of inefficient, one to one counting based strategies for calculations with the four operations. The result is an absence in flexibility and fluency with both numbers and operations (SANCP, 2016). The diagnostic reports produced after the administration of grade 6 ANA 2013 to 2014 also point to errors and misconceptions that tend to dominate learners' computations for the four operations. The authors attribute such errors to the use of either tallies, repeated addition based strategies or incorrectly applied procedures (DBE Report on the ANA 2014, 2015).

The PfP programme is specifically aimed at developing such flexibility and fluency in cub learners. Given that the PfP programme has now expanded across 4 provinces, it becomes essential to research whether learners can progress mathematically in clubs when the clubs are run by teachers and not by the SANCP team. My research aims to explore whether participation in these clubs can promote shifts in learner disposition, their procedural fluency and conceptual understanding or if these shifts are only evident when clubs are run by the SANCP members.

THEORETICAL AND CONCEPTUAL FOCUS

Here I present the theoretical and conceptual perspectives that frame this study and provide a review of literature that frames this study from a conceptual point of view.

The club design as conceptualised by SANCP purposefully aims to develop both individual learner mathematical proficiency and more participatory practices in the club context (Stott, 2016). It is for this reason that the Vygotskian view of social constructivist learning fits well as the theoretical frame for this study.

Vygotsky (1978) conceptualised development as the transformation of socially shared activities into internalised processes in his "general genetic law of cultural development" arguing that higher mental functioning appears first on the social level and then on the individual level. Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people ... and then inside the child… All the higher [mental] functions originate as actual relations between human individuals" (Vygotsky, 1978, p.57).

Thus, from a social constructivist perspective, learning is an active process in which the social environment and context plays an important role. From this perspective, learning is mediated by other people who interact with the learner and use mediatory tools to facilitate the learning process. These tools are "psychological" (Vygotsky, 1978, p. 53) in nature, in that they are used to express thinking, and include language, signs, symbols, texts and mnemonic techniques.

The clubs are designed to help develop learner proficiency by focusing on the acquisition of individual learner mathematical proficiency through engagement with other club participants (including the facilitator) and the activities offered in the club. In other words, possible learning (in this case mathematical proficiency) could be mediated by the club facilitator, the club activities and other club participants. I now turn to review the concepts relevant for this research.

Mathematical proficiency

Kilpatrick et al. (2001) define mathematical proficiency as five interwoven strands but for the purpose of this study I focus just on the two strands of procedural fluency and conceptual understanding. *Conceptual understanding* is the comprehension of mathematical concepts, operations, and relations and the ability to use multiple representations, estimating, making connections and links and understanding properties of number systems (i.e. number sense). *Procedural fluency* is skill in carrying out procedures flexibly, accurately, efficiently, and appropriately and the ability to solve a problem without referring to tables and other aids, using efficient ways to add, subtract, multiply and divide mentally and on paper, understanding when it is appropriate to use procedures or not.

Procedural fluency is specially needed to support conceptual understanding and meaning of numbers (Kilpatrick et.al 2001, p.121). The activities promoted in the clubs aim to develop conceptual understanding alongside procedural fluency. Thus in this study, these two concepts are key to understanding the nature of learner progress in mathematical proficiency.

Number sense

A child with number sense has the ability to work flexibly with numbers, observe patterns and relationships and make connections to what they already know, to make generalisations about patterns and processes (NMAP, 2008, p.27). Number sense also includes developing a positive attitude and confidence (Anghileri, 2006). Bobis et al. (2006) agree and refer to number sense as an organised conceptual framework of number information that enables the learner to understand numbers and number relationships and solve mathematical problems.

At its core the PfP programme states that a number sense approach can be useful to develop the relationship between procedural fluency and conceptual understanding. Again, many of the activities offered aim to develop number sense in learners.

Learner progression in mathematical proficiency

Teacher awareness of learner progress, starts when the teacher identifies the level where the learner is operating. This awareness extends to the various levels through which learners must progress in order for foundational numeracy proficiency to be sufficiently in place in the IP grades. The teachers need to understand how to move learners from the more concrete to more abstract levels, along a progression trajectory. (Askew, Venkat, and Mathews, 2012).

In essence progressing in mathematical proficiency means that learners' sense making and conceptual understanding is linked to the learner's ability to work independently, actively, have that zeal to try, believe that they can do maths and talk about their mathematical thinking. The assessments offered as part of the PfP programme which were carried out prior to learner participation in the club activities and again after the 15-week club intervention, will enable the teachers to establish the levels that learners are operating at and will aid them in planning activities to push them forward.

Learning dispositions

The clubs also aim to develop learner learning dispositions. Part of the approach to running the club, is the establishment of a club ethos (SANC project, 2016, p.12) which is more informal and relaxed. This ethos enables learners to have fun while learning, make mistakes, enjoy maths, talk about it, engage actively, and make sense of mathematics while building their confidence in doing and engaging with mathematics.

Chicoine (2004) refers to learner dispositions as a state of mind that creates inclination to think or act. Increased willingness to verbalise/discuss and engage mathematically, trying without fear of being wrong coupled with learner confidence, love for mathematics and sense making relates to productive learners' dispositions (Claxton and Carr, 2000). Claxton and Carr refer to these as aspects of enjoyment/excitement/playfulness, reciprocity, resilience and steady effort.

Although I acknowledge that Kilpatrick et al. (2001) refer to five strands of proficiency, for the purposes of this study I use the term mathematical proficiency to encompass the *three* strands I have discussed above, namely *conceptual understanding, procedural fluency* and *productive disposition*. This will be apparent in my research questions.

RESEARCH GOAL AND QUESTIONS

The overarching goal for this research is to investigate if the clubs can be a productive learning space for learners when the clubs are run by Uitenhage teachers. Therefore, this research aims to explore two main aspects: the nature of learners' changing mathematical proficiency (specifically conceptual understanding, procedural fluency and learning dispositions) as a result of participation in after school clubs and how these might evolve through club participation; and teachers' experiences of working with learners in a club space. The unit of analysis in this study is therefore both the learners (in terms of changing mathematical proficiency) in the clubs and the teacher facilitators experiences of working with learners in those clubs.

The research questions are:

1. What changes were evident in learners mathematically proficiency through club participation?
2. What are teachers' experiences of learners' changing mathematical proficiency as a result of participating in the clubs?
3. What are teachers' experiences of working with learners in the club space?

RESEARCH DESIGN

Methodological Orientation

Working from an interpretive paradigm, this research is a multi-site case study using five after school maths clubs. Below, I discuss general case study research then that of a multi-case study and briefly explain why I have chosen this design. Yin (2009) states that a case study approach is an approach to qualitative research that "investigates a contemporary phenomenon in depth and within its real life context". Denscombe (2010) characterises case study research as emphasizing a number of different aspects including depth of study rather than breadth of study,

the particular / specific rather the general, natural settings rather than artificial situation and the use of more than one research method (p. 54).

A number of these characteristics are important for my study. The case study will allow me to investigate in depth the phenomenon of shifts in learner's mathematically proficiency and learning dispositions while they participate in after school clubs and portray, analyse and interpret the complexity and uniqueness of these real learners and the situation within the real life context of the clubs. I will be exploring learners in five specific clubs which are operating in a natural learning situation.

Yin (2009) states that the same study may contain more than a single case. As I am using five clubs, my design will use what he calls the multiple-case design variant. Bishop (2010) defines a multi-site study as a ''contemporary phenomenon that is common to two or more real-world" (p.587) settings and can reveal "within-site patterns and cross-site synthesis" (p.589). The research design in a multi-site case study is the same across all sites and all sites are studied using the same key research questions, with the same data collection, analysis and reporting approaches. This is valid for the five clubs in this study. Yin (2009) states that analytic conclusions arising from two or more cases "will be more powerful than those coming from a single case" (p.61). The logic followed in selecting multiple cases is replication of results and not sampling (Yin, 2009). That is, multiple cases make stronger claims possible by replicating emerging patterns among the different cases studied.

Consequently, the multi-site case study would also increase to some extent broader applicability of the findings and enable the use of the comparison to support my conclusions, thus strengthening the case for external validity (Stott, 2014 p.107). All schools are in previously disadvantaged townships and the medium of instruction[1] is English except for the one school in Rosedale which is Afrikaans. I wish to maximize diversity as much as possible and for the schools to be "as like the population of interest as possible" (Firestone, 1993 p.20).

According to Cohen et al. (2000), my case is a 'non-probability sample' as I targeted a particular set of schools with full knowledge that they do not represent the wider population; they rather represent themselves. Moreover, my case is of the 'convenience' sampling type which is known as accidental or opportunity sampling which involves choosing the nearest individuals to serve as respondents (Denscombe, 2010, p.102).

[1] Medium of instruction: Language of Learning and Teaching (LoLT), mathematics in grade 6 is taught in the LoLT of that particular school.

Research field

Uitenhage District is among the 23 districts of the Eastern Cape in South Africa. Kwa Nobuhle, Kwa Langa and Rosedale are previously disadvantaged townships of the semi-rural Uitenhage district. These three townships comprise of two ethnic groups mainly Black and Coloured.

The five sampled schools are among the 128 primary schools of the Uitenhage Districts that are not immune from the findings on the context above. All club sites in Kwa Nobuhle are less than a kilometre apart which makes it easier for me to access them. The same applies to the other two sites as they are not far from each other and my work place is central to all of them. The five after school maths clubs are situated in these five schools (sites) and they will act as the empirical field of my multi-site study.

Five teachers from these schools who facilitated the clubs are enthusiastic lead teachers, elected by other teachers in their cluster due to their experience and expertise in mathematics and have shown interest in running the clubs.

Each of the five grade 6 teachers ran clubs in their respective schools with 12 learners each resulting in a total sample of 60 learners with respect to learner data collection. The learners were selected from a broader pool of low attaining learners who showed interest in participating in the clubs.

Data collection methods

Although both *qualitative* and *quantitative* methods of data collection will be used (making this a mixed method study), the majority of the data generated will be qualitative. A mixed method study is characterised by research questions or data collection methods that draw “inferences using both qualitative and quantitative approaches or methods in a single study” (Tashakkori & Cresswell, 2007). Ross and Onwuegbuzie (2012) cite five purposes for integrating quantitative and qualitative approaches in a mixed method approach, namely:

- triangulation (i.e., comparing results from quantitative data with qualitative findings to assess levels of convergence)
- complementarity (i.e., seeking elaboration, illustration, enhancement, and clarification of the findings from one method with results from the other method)
- initiation (i.e., identifying paradox and contradiction stemming from the quantitative and qualitative findings)
- development (i.e., using the findings from one method to help inform the other method)
- expansion (i.e., expanding the breadth and range of a study by using multiple methods for different study phases). (p. 89).

For my study, a mixed methods approach will provide a means of *triangulating* data collected by the participating teachers from the PfP programme, as well *as initiation and development* where the results from one method will highlight cases of interest to generate questions for another method. I have indicated that the theoretical framing for this study is a social constructivist one; it is thus important to ensure that the methods used to collect data will give me access to both individual learner progression (learning / internalisation) and the social aspects of the clubs.

As mentioned previously, some data will be collected exclusively for this research study (e.g. teacher questionnaires and interviews), while other data has already been collected by the participating teachers which is also collated by SANC project team as part of monitoring the effects of their broader PfP development programme. As part of my study I will request permission the teachers to access and draw on the data already collected for use in this study. The different methods used in this study are shown in Figure 1 below and I will indicate the type of data generated as I discuss each data collection method in the section that follows.

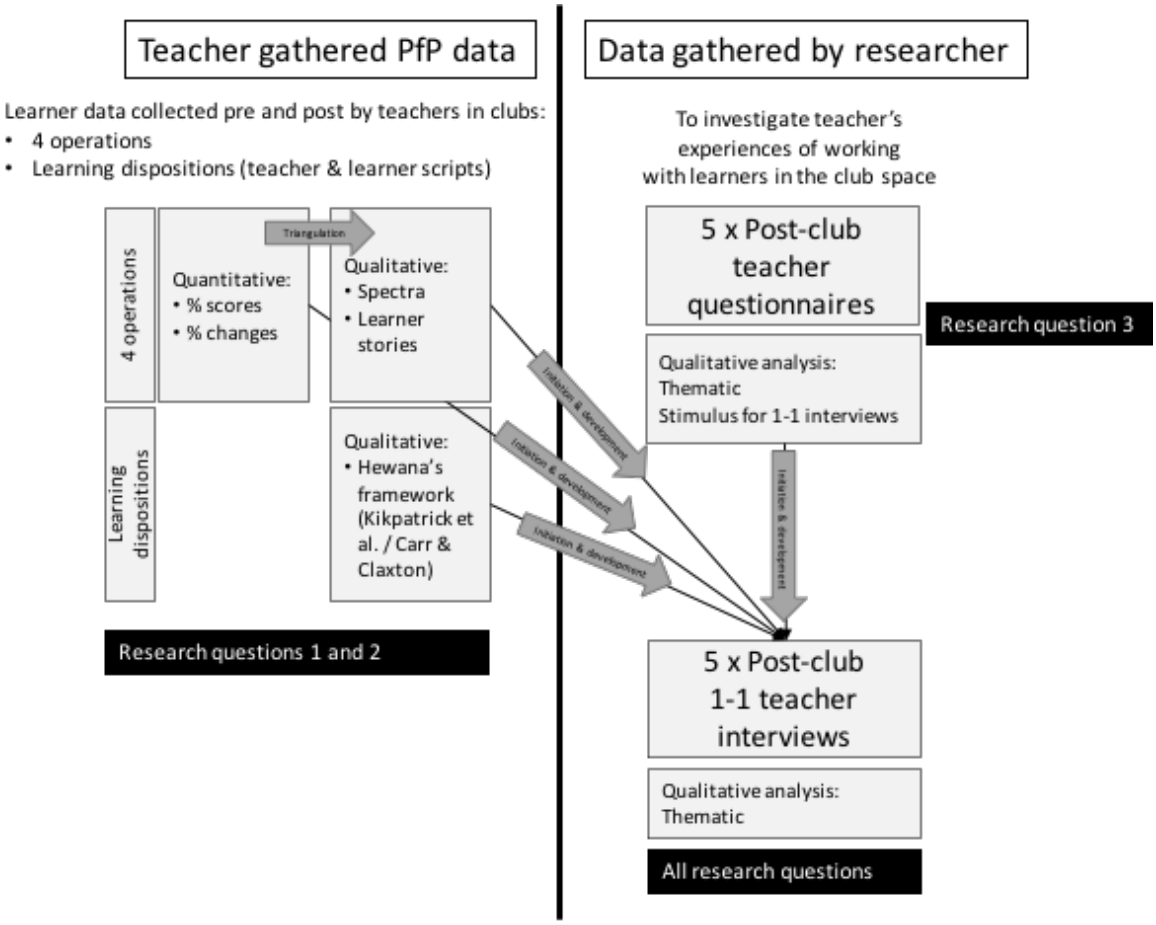

Figure 1: Summary of data collection methods for this study

PfP programme data collection instruments

Permission will be sought from participating teachers and learners' parents to draw on this data. The data will be accessed from each individual teacher. This data collected by the participating teachers, after further analysis, will enable me to address research questions one and two.

4 operations assessment

The PfP uses an instrument with 5 sums for each operation ranging from 1-digit to 3 by 2-digits (see appendix one). This is used to assess *learner* progression in mathematical proficiency. In the first club session learners completed the assessment before they began to participate in club activities. The assessments and an assessment schedule (see appendix two) were used by the teachers to profile each learner according to a progression spectrum shown below (figures 2 and 3) and to guide individual learning experiences for the club participants. The same instrument was used after 15 weeks of learner participation in clubs as a post-assessment to determine whether individual learners progressed.

<table>
<tr><th>Constrained methods</th><th>Less constrained</th><th>Semi fluent methods</th><th>Flexible fluency</th></tr>
<tr><td rowspan="2">Inefficient (I)
Use of fingers, tally marks, circles, drawings of any kind</td><td colspan="2">Somewhere in between (IE)</td><td rowspan="2">Efficient (E)
Use of known addition and subtraction facts, appropriate use of algorithms for 2 or more digits' problem</td></tr>
<tr><td>Breaking of numbers into place values using some kind of expanded notation</td><td>Another strategy such as splitting, working with friendly numbers</td></tr>
</table>

Figure 2: Addition and subtraction spectrum

<table>
<tr><th>Constrained methods</th><th>Less constrained</th><th>Semi fluent methods</th><th>Flexible fluency</th></tr>
<tr><td rowspan="2">Inefficient (I)
Use of fingers, tally marks, circles, drawings of any kind</td><td colspan="2">Somewhere in between (IE)</td><td rowspan="2">Efficient (E)
Strategies using known multiplication and division facts, appropriate use of algorithms for 2 or more digits</td></tr>
<tr><td>Skip counting and repeated addition</td><td>Arrays, breaking down of numbers into expanded notation</td></tr>
</table>

Figure 3: Multiplication and division spectrum

Learner scores on both the pre and post assessment as well as the percentage change on progression across spectrums will produce quantitative data for this study. Individual cases will also be noted for discussion in the teacher one-to-one interviews.

Learner dispositions: Teacher checklist

The second instrument utilised by the PfP programme is a disposition questionnaire (see appendix three) which explores how the *teachers* view the learners in their clubs from a dispositional perspective. The teacher was able to select 8 dispositional descriptors from a list of from 23 dispositions to describe each learner. The checklist was completed twice during the period of the PfP programme: once before the club participation began and after the 15th club session. From a research point of view these will be used to explore if there are changes in the learners' dispositions over the period of participation in the club programme. These checklists will be analysed according to themes categorised suggested by Hewana (2014. p.44). These

checklists will form part of the qualitative data and teachers will be asked to elaborate on individual learner cases during the one-on-one interviews.

Learner dispositions: Learner questionnaire

Each *learner* completed a learner questionnaire with five items (see Appendix Four) developed by the SANCP (Graven, Hewana & Stott, 2013) twice during participation in the PfP programme. This explores learners' dispositional changes; how the learner feels about mathematics, how s/he compares him/herself with the weakest or strongest learners in mathematics, how s/he defines mathematics and what s/he does when s/he does not know an answer in maths class. Learners' responses will be transcribed. This data may be quantified, although shifts in learner's dispositions will also be told in the narrative form.

Data collection for the specific purposes of this research study

Pre interview teacher questionaire

The aim of the questionnaire is to enable the teachers to reflect on their experiences of working with learners in the club space as this space and practices are different to their daily classroom environment and routine, thus interrogating some of the more social aspects of the clubs. Data will be used to address research question three and to inform questions asked in the teacher one-to-one interviews. At this stage I anticipate asking questions such as these:

What are your experiences of:

- Working with the idea of baselineing assessment?
- Working with a focus on progression in the 4 operations?
- Working with the club culture and ethos?
- Working with small groups of learners?
- Using card and dice games as activities?

Teacher interviews

These interviews will qualitatively investigate *all* the research questions with the aim of collecting deep, rich data. Analysis of the data collected using the methods described above will be a stimulus to inform the questions asked for the teacher interviews as shown in Figure 1 above. The interviews will allow me to ask the teachers to elaborate and give more details of learner progression and their own experiences.

One–to–one semi structured interviews will be conducted with the five grade 6 teachers who facilitated the clubs. I will audio record all interviews and use my journal to take notes on teacher learning experiences in facilitating the clubs. Since "interviewing people is a natural way of interacting with people than making them fill out questionnaires or do a test" (Kelly, 2006 p.297) A semi-structured interview schedule will be designed before the interviews are conducted using

the analysis of the SANCP data and the pre-interview teacher questionnaire. The interview questions on the interview schedule will thus address all the research questions developed for this study.

Data analysis

Learner progression in mathematical proficiency

I will draw on methods used by SANCP team over the last five years (Stott, 2014), to analyse this data. I anticipate using both qualitative and quantitative data analysis methods as follows:

Firstly, I will quantitatively analyse the four operations pre and post assessments by counting the total number of correct answers for each of the 60 learners (club participants) to arrive at a score that is $\left(\frac{x}{20}\right)$ for each test. Then I will compare the pre and post test scores. The aim is to check whether is there any change between the two by looking at percentage changes.

Secondly, I will look at the progression across the two spectra detailed above by comparing both the pre and post *scripts* of each individual learner looking at the percentage of learners who have moved from inefficient strategies to somewhere in between and to efficient strategies. Qualitative analysis will take place based on the methods used by the learners as evident on both pre and post-tests spectra.

As a result of this analysis, learner cases will be highlighted which will be useful to discuss with the teachers in the 1-1 interviews.

Learner dispositions

I will analyse the data from both dispositional instruments using a framework drawn from Hewana's (2013) combination of indicators of a productive disposition from Kilpatrick et al. (2001) and Carr and Claxton's (2002) as shown in table 1 below.

Kilpatrick et al.'s (2001) indicators of a productive disposition	**Carr & Claxton's (2002) 3 dimensions of disposition**
Tendency to see sense in maths	Links to 'resourcefulness' – conceptual/explorative understanding
Perceive it as both useful and worthwhile	Not connected – no equivalent in Carr and Claxton's three dimensions
Believe steady effort pays off	Links to resilience
See oneself as effective and doer of maths	Links to some extent to resourcefulness however the notion of self-efficacy is not directly addressed in Carr and Claxton
No indication of willingness to engage with others as an indicator of a productive disposition	Reciprocity – willingness to engage with others

Table 1: Cross mapping dispositional indicators within definitions (Hewana, 2013 p.44)

Both pre and post teacher responses and learner responses on dispositional instruments will be firstly fully transcribed, coded with respect to table 1 above and compared to see if there are any

apparent shifts with respect to the dispositional indicators. Responses to these questionnaire items will be categorised into themes to see whether there are any relations with how the teacher sees the learner, and how the individual learner places oneself, how s/he feels and thinks of mathematics. Finally, I will explore if are there any connections between the dispositional shifts and the shifts in mathematical proficiency. Focused learner cases which will prompt questions for teacher interviews will emerge from this analysis.

Pre-interview teacher questionnaires

The data collected using this method will be qualitative. The questionnaires will be transcribed and will be analysed using a thematic analysis. The analysis will inform and provide stimulus for the final teacher interviews.

Teacher Interviews

As indicated earlier I will conduct one-to-one interviews with each of the five club facilitators. This qualitative data will be transcribed. Qualitative stories (or teacher narratives) of learner's progression and of teacher's experiences of working with the learners in the clubs will be analyses using progression spectra, dispositional indicators and themes.

Research timeline

In the following table I provide a synopsis of how this research study is expected to unfold:

Month / Date	**Action to be taken**
August to Sept 2016 (subject to proposal approval)	Gain permission from teachers and learners' parents to access the collected data from the Pf{
	Request research permission from district, schools and teachers
2nd & 3rd week Sept 2016	Analysis of teacher-gathered PfP data
4th week Sept 2016	Administer the pre interview teacher questionnaire to five teachers
Early Oct 2016	Transcribe and analyse teacher questionnaires
Oct 2016	Conduct five one-to-one teacher interviews
Nov 2016 to Jan 2017	Transcription of interviews Member checks with teachers Final analysis, interpretation and discussion of data
February to March *2017*	Write up of research report
April 2017	Submission of final version of thesis

Evaluating the quality of this research

In qualitative research, there are many ways to evaluate the quality of a research study. This research will employ multiple strategies to ensure and enhance validity and reliability of the data.

The research instruments used by the PfP programme to collect learner progression and dispositional data have been used in the broader SANC project over the last five years to assess over 1500 learners a year. Thus they have proven to be effective for the assessment of learner progression as required by this study.

I will use *triangulation* (Koshy, 2005) by collecting data specific to this research study to add further dimensions to the data collected by SANCP using the methods as discussed above. The varied data collection methods will produce both quantitative and qualitative data and I will be able to cross check (triangulate) across these for coherence and possible disconnects. This will enable me to look at the research questions from multiple perspective so as to enhance the accuracy of the findings (Neuman, 2010). Such triangulation will also allow for thicker description of the progression of learners and teachers experiences of working with the learners in the clubs.

After the one-to-one interviews have been transcribed, I will use member checking. The transcripts will be made available to the teachers interviewed so they check that the transcript reflects what they said.

To ensure that conclusions made by means of this qualitative research are as accurate as possible, I will be aware of what Maxwell (2003) calls “reactivity”: the possible distortion caused by my own conceptions and values, as well as the effect that I may have had on the individuals and setting being studied Although the researcher as “human instrument” brings unique characteristics to the data collection process, the potential of bias and subjectivities should be identified and monitored (Merriam, 2002, p.5). I will discuss this further below and in the Ethical Approval later.

Positioning of the researcher and ethical considerations

I am aware that my role as both a district official and researcher makes my position complex. In this section I would like to clarify the nature of these roles. Figure 4 below summarises the relationships between myself as the researcher and other parties involved in the PfP programme and research study. Issues of an ethical nature are detailed in the accompanying Ethics Approval document.

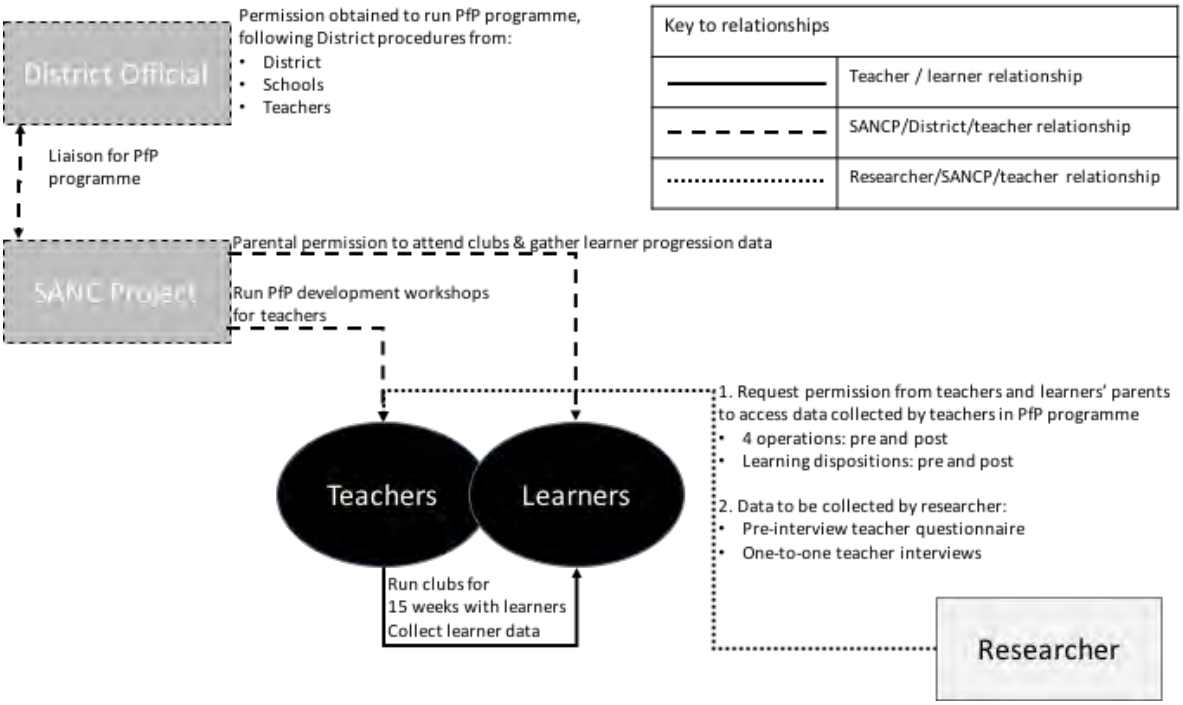

Figure 4: Summary of researcher relationships

My role as district official

I am currently a Senior Education Specialist (SES) and curriculum/subject advisor for mathematics in the General Education and Training (GET) band for the Intermediate and Senior Phases (ISP) under the Curriculum Management and Support directorate. I have been careful to draw up research questions that do not involve me researching or measuring the impact of the PfP programme on teacher practice in the schools that I work in. Rather I am investigating whether the clubs are a productive space for learners when run by teachers rather than the SANC project team members, the focus between my work responsibilities and my research is thus different. It is my intention that my current position will not negatively affect my research. This distinction will be made clear to the teachers both in writing and verbally.

Relationship with teachers and learners

I am aware of the possible power relations between myself and the teachers in this study who have facilitated the clubs and how this might influence the research process and their participation in it. I have endeavoured to establish a partnership with facilitators. I have been a teacher and a colleague to them through all my teaching years at Limekhaya high school in Kwa Langa township of Uitenhage. I also work closely with them as they are cluster leaders in our district. My relationship to them is based more on collegiality than authority. I have a long healthy working relationship with them and strive to maintain it as such. Furthermore, I have tried to ensure that my research questions do not investigate teacher learning and impact of their classroom practice, rather it seeks to understand their experiences of working in the club space.

In this way the relationship with the teachers will be carefully managed to promote a situation of mutual benefit and collaboration and not one of authority.

For the purposes of this research, I will have had no direct contact with the learners in the clubs. All the data has been collected by the teachers in the club space. I will request permission from each teacher and learners' parents to access this data for the purposes of my research.

Relationship with SANC

I have a twofold relationship with the SANC project. The first is as a district official where I have been responsible for liaison with the SANCP team in setting up the PfP programme in my district as I believed that the programme would be beneficial for teachers and learners. My part in this programme with this set of teachers is now complete as this initiative has already taken place. No doubt I will continue to maintain this relationship with the SANC project after my research is complete.

My second relationship is with my supervisors, one of whom was the facilitator of the PfP programme. She was responsible for obtaining parental permission for learners to participate in the programme and for collecting the learner data for monitoring the programme from the participating teachers. The SANC project will use and analyse the data to combine with other similar data from other PfP programmes to gauge the possible impact of clubs on learner progress. Once permission has been granted by teachers and parents to access learner data, I will analyse the data for my own purposes to address the research questions for this study. Further, as mentioned before, the analysis of this data will inform the specific data I am collecting for this study.

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RU FACULTY OF EDUCATION: ETHICAL APPROVAL APPLICATION

IMPORTANT: The following form needs to be completed by the researcher and submitted with their research proposal to the Education Higher Degrees Committee. The details to which this form relates should also be evident in the text of the proposal.

GENERAL PARTICULARS

MEd (Full thesis)	Faculty of Education

TITLE OF RESEARCH: Investigating Grade 6 learners changing mathematical procedural fluency and earning dispositions through participation in after school mathematics clubs.

DEPARTMENT/INSTITUTE: Mathematics Education

DATE: August 2016

RESEARCHER: Noluntu Baart

SUPERVISORS: Dr. Debbie Stott & Prof. Mellony Graven

ETHICS

NB: You must read the Faculty of Education Ethics Guideline *prior* to completing this form. Please indicate below how your research supports the indicated ethical principle:

Respect and dignity

The teachers and schools were invited to participate in the PfP programme as described earlier and permission was granted on a district level for the programme and the clubs to run. SANCP sought written parental permission for the learners to participate in clubs and to collect progression data.

For this study specifically, I will write to each teacher who ran clubs and request their permission to undertake the research and to gather a range of data related to their experiences of learner progression and working with the learners in the clubs. I will also seek their permission to use recording devices during the ono-to-one interviews. I will explain that participation is entirely voluntary. I will inform all participants that they will remain anonymous. Pseudonyms for teachers, schools and learners will be used in the research write up. They will also be informed about their rights to withdraw from my research whenever they feel like.

Transparency and honesty

Participants will be informed of the nature of my study, the aim of the research and possible the implications of the research for my own work and theirs. I will make it clear that the research will in no way report on their teaching practice in the classroom or on the impact of the PfP in the

classroom. The findings of my research will be shared with my participants and in the case of transcripts from teacher interviews I will offer member checks of the transcripts from these.

Accountability and responsibility

Access to the schools was negotiated with the Uitenhage Department of Education, the District Director and school principals by sending letters asking for permission to run the PfP programme. I will write additional letters to school principals and all participating teachers for permission to conduct my research. They will be informed about the nature and purpose of the research and the time frame of the research.

Integrity and academic professionalism

The relationship with the teachers will be carefully managed to promote a situation of mutual benefit and collaboration and not one of authority.

I will present the information of my research report which correlates with my data, even though the observation and outcomes might not be in line with my expectations. I will also show respect to academic work by acknowledging other people's work and ideas in my research.

Signature: 

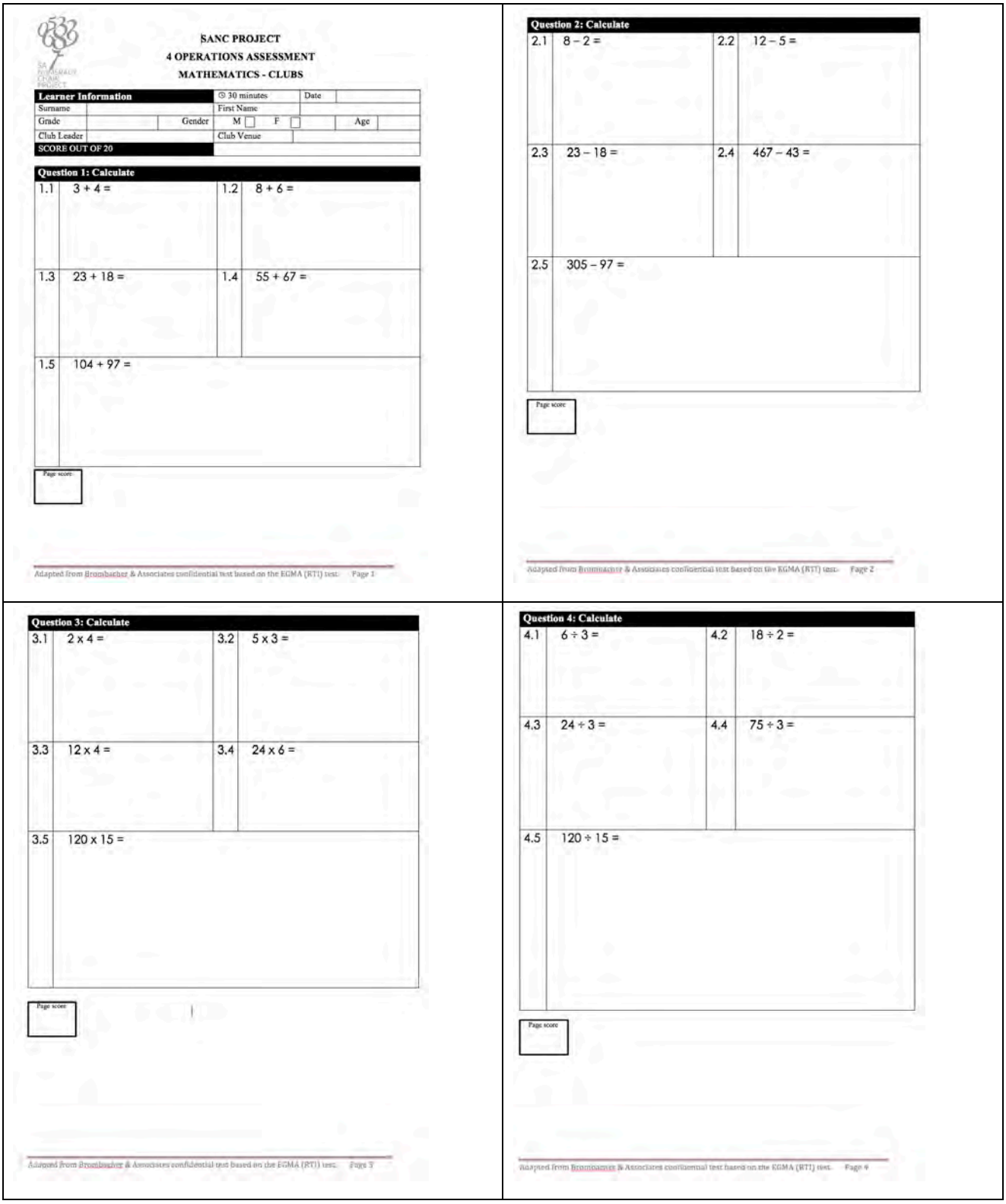
Signature (supervisors) 

Date: September 2016

Place: Port Elizabeth

APPENDIX ONE: Pre and post assessment for learner progression

For the purposes of this proposal, I have reduced the size of these pages.



SANC PROJECT
4 OPERATIONS ASSESSMENT
MATHEMATICS - CLUBS

Learner Information			30 minutes	Date	
Surname			First Name		
Grade		Gender	M ☐ F ☐	Age	
Club Leader			Club Venue		
SCORE OUT OF 20					

Question 1: Calculate

1.1	3 + 4 =	1.2	8 + 6 =
1.3	23 + 18 =	1.4	55 + 67 =
1.5	104 + 97 =		

Page score

Adapted from Bromhacher & Associates confidential test based on the EGMA (RTI) test. Page 1

Question 2: Calculate

2.1	8 – 2 =	2.2	12 – 5 =
2.3	23 – 18 =	2.4	467 – 43 =
2.5	305 – 97 =		

Page score

Adapted from Bromhacher & Associates confidential test based on the EGMA (RTI) test. Page 2

Question 3: Calculate

3.1	2 x 4 =	3.2	5 x 3 =
3.3	12 x 4 =	3.4	24 x 6 =
3.5	120 x 15 =		

Page score

Adapted from Bromhacher & Associates confidential test based on the EGMA (RTI) test. Page 3

Question 4: Calculate

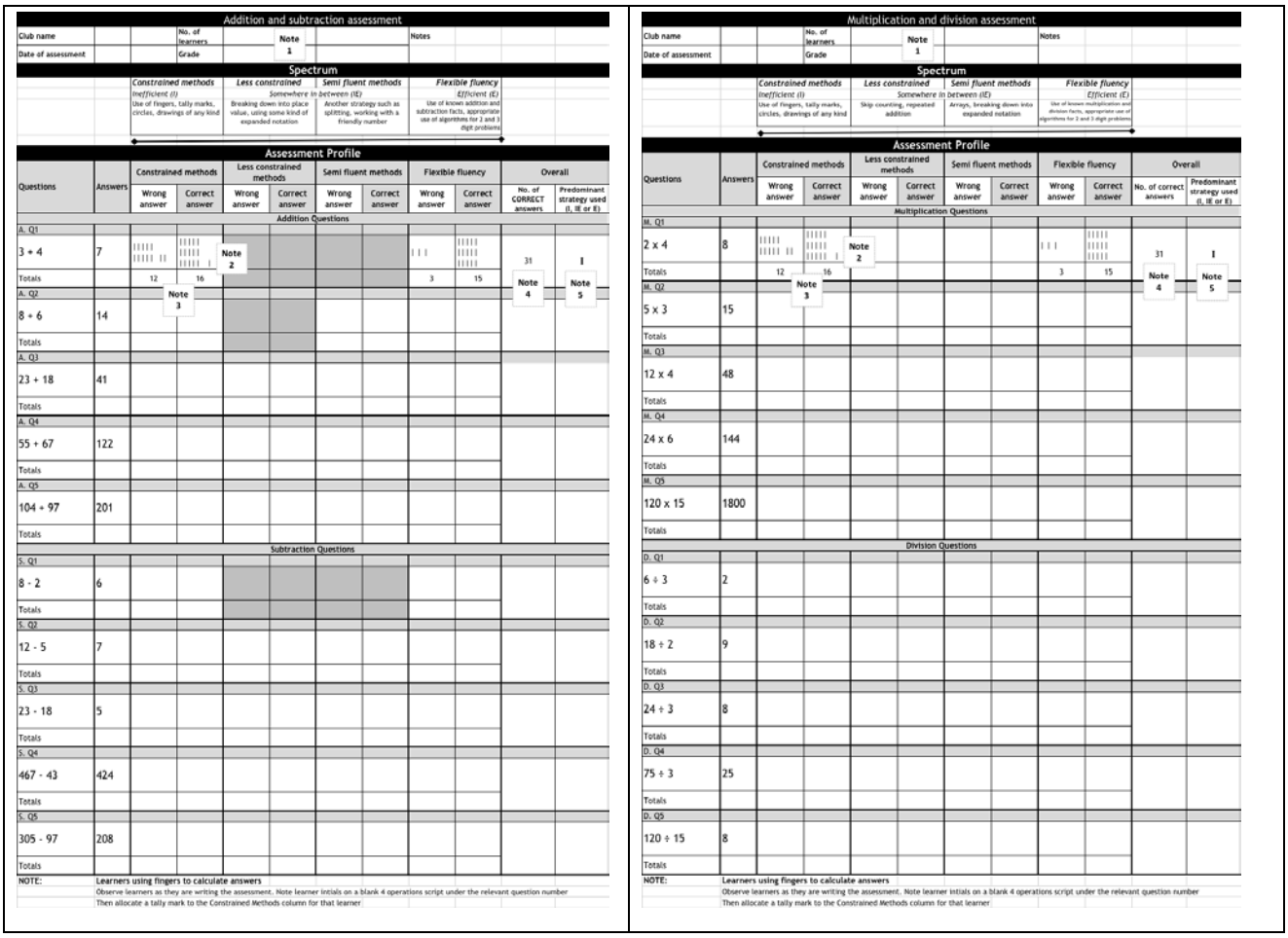
4.1	6 ÷ 3 =	4.2	18 ÷ 2 =
4.3	24 ÷ 3 =	4.4	75 ÷ 3 =
4.5	120 ÷ 15 =		

Page score

Adapted from Bromhacher & Associates confidential test based on the EGMA (RTI) test. Page 4

APPENDIX TWO: Operations teacher marking and profiling forms

For the purposes of this proposal, I have reduced the size of these pages.



Addition and subtraction assessment

Club name | No. of learners | Note 1 | Notes

Date of assessment | Grade

Spectrum

Constrained methods	Less constrained	Semi fluent methods	Flexible fluency
Inefficient (I)	*Somewhere in between (IE)*		*Efficient (E)*
Use of fingers, tally marks, circles, drawings of any kind	Breaking down into place value, using some kind of expanded notation	Another strategy such as splitting, working with a friendly number	Use of known addition and subtraction facts, appropriate use of algorithms for 2 and 3 digit problems

Assessment Profile

Questions	Answers	Constrained methods		Less constrained methods		Semi fluent methods		Flexible fluency		Overall	
		Wrong answer	Correct answer	Wrong answer	Correct answer	Wrong answer	Correct answer	Wrong answer	Correct answer	No. of CORRECT answers	Predominant strategy used (I, IE or E)
Addition Questions											
A. Q1											
3 + 4	7	IIII II	IIII IIII I	Note 2				III	IIII IIII	31	I
Totals		12	16					3	15	Note 4	Note 5
A. Q2		Note 3									
8 + 6	14										
Totals											
A. Q3											
23 + 18	41										
Totals											
A. Q4											
55 + 67	122										
Totals											
A. Q5											
104 + 97	201										
Totals											
Subtraction Questions											
S. Q1											
8 - 2	6										
Totals											
S. Q2											
12 - 5	7										
Totals											
S. Q3											
23 - 18	5										
Totals											
S. Q4											
467 - 43	424										
Totals											
S. Q5											
305 - 97	208										
Totals											

NOTE: Learners using fingers to calculate answers

Observe learners as they are writing the assessment. Note learner intials on a blank 4 operations script under the relevant question number

Then allocate a tally mark to the Constrained Methods column for that learner.

Multiplication and division assessment

Club name | No. of learners | Note 1 | Notes

Date of assessment | Grade

Spectrum

Constrained methods	Less constrained	Semi fluent methods	Flexible fluency
Inefficient (I)	*Somewhere in between (IE)*		*Efficient (E)*
Use of fingers, tally marks, circles, drawings of any kind	Skip counting, repeated addition	Arrays, breaking down into expanded notation	Use of known multiplication and division facts, appropriate use of algorithms for 2 and 3 digit problems

Assessment Profile

Questions	Answers	Constrained methods		Less constrained methods		Semi fluent methods		Flexible fluency		Overall	
		Wrong answer	Correct answer	Wrong answer	Correct answer	Wrong answer	Correct answer	Wrong answer	Correct answer	No. of correct answers	Predominant strategy used (I, IE or E)
Multiplication Questions											
M. Q1											
2 x 4	8	IIII II	IIII IIII I	Note 2				III	IIII IIII	31	I
Totals		12	16					3	15	Note 4	Note 5
M. Q2		Note 3									
5 x 3	15										
Totals											
M. Q3											
12 x 4	48										
Totals											
M. Q4											
24 x 6	144										
Totals											
M. Q5											
120 x 15	1800										
Totals											
Division Questions											
D. Q1											
6 ÷ 3	2										
Totals											
D. Q2											
18 ÷ 2	9										
Totals											
D. Q3											
24 ÷ 3	8										
Totals											
D. Q4											
75 ÷ 3	25										
Totals											
D. Q5											
120 ÷ 15	8										
Totals											

NOTE: Learners using fingers to calculate answers

Observe learners as they are writing the assessment. Note learner intials on a blank 4 operations script under the relevant question number

Then allocate a tally mark to the Constrained Methods column for that learner.

REE: teachers' checklist for learner dispositions (pre and post)

	day	month	year	Club (Grade or teacher name)	
	TICK OR CIRCLE UP TO 8 DISPOSITIONS THAT DESCRIBE EACH LEARNER'S MATHS DISPOSITION IN YOU CLUB/GROUP				

		*		*		Guesses answers		Explains thinking		Thinks/wor things out
		Clever		Waits to be told		Keeps trying		Works independently		Scared of r
		Shy		Develops own methods		Thinks before answering		Doesn't answer questions		Listens wel
		Does not listen		Slow learner		Follows rules		Gives up easily		Good at ma
		Weak at maths		Works hard		Does not work		Asks for help before trying		Likes math
		*		*		Guesses answers		Explains thinking		Thinks/wor things out
		Clever		Waits to be told		Keeps trying		Works independently		Scared of r
		Shy		Develops own methods		Thinks before answering		Doesn't answer questions		Listens wel
		Does not listen		Slow learner		Follows rules		Gives up easily		Good at ma
		Weak at maths		Works hard		Does not work		Asks for help before trying		Likes math

JR: Learner productive dispositions questionnaire (pre and post)

_____ DATE: _____ CLASS: _____

sentence)

weakest
ent in the class

Put a circle around yourself

Sam is the strongest
student in th

ut **Mpho** in the Maths class:	Tell me about **Sam** in the Maths class:
ed of maths because	**Sam** loves maths because
maths or are you scared of maths?	What do you do if you don't know an answer in maths cl

E: pushing for progression development timeline

eek 0	Weeks 1 to 3	Week 3	Weeks 4 to 9	Week 9	Weeks
orkshop One	Run 3 weekly club sessions	Workshop Two	Run 6 weekly club sessions	Workshop Three	Run 6 w
th April 2:00 – 16:00)	w/c 18th April w/c 25th April w/c 09th May	Sometime in week beginning 09th May (12:02 0 – 16:00)	w/c 9th May w/c 16th May w/c 23rd May w/c 30th May w/c 6th June w/c 13th June	Sometime in week beginning 13th June ** (12:00 – 16:00)	w/c 20th (then sc w/c 18th w/c 25th w/c 1st A w/c 8th A w/c 15th
ientation hy progression? troduce spectra ssessments and profiling -depth look at the ogramme for 1st 3 clubs	1st session: administer assessment and profile learners	In-depth look at the programme for next 6 clubs with a focus on addition and subtraction	On-going informal assessment and profiling of learner progress	In-depth look at the programme for next 6 clubs with a focus on multiplication and division	On-goir assessm learner p In 15th s assessm learners
andbook including and ectra -week programme plan ssessment tasks, arking and profiling rms EETLE game ice and cards for cilitators		Grocotts series pack Dice and cards for learners TIA packs for learners		Multiplication game and dice	