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Designing Teacher Learning Circles for Improved Foundational Numeracy Outcomes

Findings from the National Numeracy Programme in Malawi

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Abbreviations and acronyms

DBIR   Design-based implementation research

FCDO   UK Government Foreign, Commonwealth and Development Office

NNP   National Numeracy Programme, Malawi

PEAs   Primary Education Advisors

TCPD   Teacher continuous professional development

TLC   Teacher learning circle

1. Introduction

The Malawi National Numeracy Programme (NNP)[1] was designed in 2020 in partnership with the Malawi Ministry of Education and Cambridge Education (Mott McDonald), funded by the UK Foreign, Commonwealth and Development Office (FCDO). This joint effort seeks to improve the quality of teaching and learning in mathematics in the early stages of schooling (Standards 1–4) in response to the consistently low levels of basic numeracy skills and learning outcomes in mathematics in Malawi primary schools (↑Kazima et al., 2022). In 2021, the government piloted the programme in 203 schools. In the school year, from September 2022 to August 2023, over 1,100 schools in different regions of Malawi participated in an extended pilot programme.

During **Term 1 of the 2022–2023** school year, EdTech Hub worked with the department implementing the NNP (Directorate of Quality Assurance Services, Ministry of Education) to conduct implementation research (↑Allison, 2023; ↑Correa de Oliveira et al., 2024) to inform the development of the NNP. We undertook in-depth qualitative research in four schools to obtain feedback on NNP materials from teachers, head teachers, and primary education advisors (PEAs). We used semi-structured interviews, focus group discussions, lesson observations, learning circle observations, training observations, and ethnographic methods. In addition, a mathematics specialist undertook an independent, in-depth desk-based review of the NNP teaching and learning resources to refine our analysis.

The research focused on the core components of the NNP model — the Learner Workbooks, the Teacher Guides, the school-based teacher learning circles, and the cascade model combined with the multiplier model of training. Our findings suggest that, although the NNP represents an improvement on the previous curriculum, some components, particularly the Teacher Learning Circles (TLCs) and the Learner Workbooks, need to be revised and refined to increase the programme's effectiveness.

Building on these findings, EdTech Hub proposed a new phase of design-based implementation research (DBIR) to be undertaken in **Term 2 of the 2022–2023 school year** to refine the school-based teacher continuous professional development (TCPD) model of the NNP. As part of the research, EdTech Hub would develop a new TLC guide to be tested in schools. Through

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[1] See https://nnpmalawi.org/ Retrieved 31 October 2023

observations, focus group discussions, and interviews, we would gather teacher feedback and use it to co-design the following guide.

Table 1. *Continuous improvement of school-based teacher professional development model*

Aug–Dec 2022	Jan–Mar 2023
Expert review and deep qualitative work in 4 schools to understand challenges	Support refining of content and delivery model based on feedback from teachers in 20 schools

Over the course of three months, four TLC guides—one guide per TLC session—were co-designed and tested in 20 schools in different regions in Malawi to answer the following overall research question.

> **How can features of school-based teacher continuous professional development be optimised to support Malawi's National Numeracy Programme to effectively improve numeracy instruction?**

In particular, we ask this subordinate research question:

> **How can Teacher Learning Circles, which are a major component of the continuous professional development programme, be tailored to become more effective at addressing issues to do with teaching and learning in the classroom?**

For this qualitative research, we adopted the following methods: lesson observation, teacher learning circle observation, focus group discussions, and semi-structured interviews. The research team was composed of researchers and research assistants with expertise in education research and teaching experience in the Malawi education system, as well as one mathematics expert who led the design of the TLC guides.

This report summarises the principal findings from the study. It also outlines the research background, methodology, findings, and recommendations for the programme moving forward.

Section 2 provides background information, including what TLCs are and our rationale for using these and following a DBIR approach. Section 3 focuses on our DBIR methodology, including details on the sample and limitations. Section 4 describes the four cycles of DBIR undertaken in schools, including

takeaways and iterations from each cycle. Section 5 defines cross-cutting findings from this process, which are unpacked and discussed in Section 6. The report concludes with Section 7, where we provide recommendations for our NNP implementing partners.

A final point—it is important to note that since the findings from this research were shared, NNP programme implementers have actively worked to address its recommendations, including significant refinements to the curriculum and teaching and learning materials. EdTech Hub continues to collaborate with the NNP to assess the impact of these revisions on the programme.

2. Background to the research

TLCs are small communities of teachers where knowledge is constructed through personal experience. In these communities, teachers meet regularly to learn from one another, reflect on their challenges and current practices, and collaborate to strengthen their teaching skills. This is a cost-effective model of continuous professional development that provides an alternative to passive and costly one-time training sessions and the traditional lecture-based, cascade training model. Furthermore, it promotes local ownership by empowering teachers to leverage their professional experiences and current practices as a basis for consistent improvements and become valuable and lasting resources to one another (↑Allier-Gagneur et al., 2020; ↑Collay, 1998; ↑Mohr & Morency Notario, 2016; ↑Suda, 2007).

Many teachers in the Malawi public education system are already familiar with the TLC model of school-based TCPD as it has already been adopted by another programme — the National Reading Programme (NRP). As TLCs are an integral part of the National Numeracy Programme, in this study, we proposed to investigate how we could optimise the features of the TLC model of school-based TCPD based on the challenges we found during the first cycle of research.

For this study, we followed the design-based implementation research (DBIR) approach. DBIR sits at the intersection of research, policy, and practice and focuses on designing effective, scalable, and sustainable interventions. ↑Fishman et al. (2013) describe the core principles of DBIR as incorporating:

1. Focus on persistent problems of practice from multiple stakeholders' perspectives

2. Commitment to iterative, collaborative design

3. Concern with developing theory and knowledge related to both classroom learning and implementation through systematic inquiry

4. Concern with developing capacity for sustaining change in systems (↑Fishman et al., 2013).

DBIR allows us to carry out an iterative approach and implement, co-design, adapt, and implement again through tight feedback loops. The notion of 'implementation research' in DBIR predates but is similar to current interest in implementation research in education (↑Allison, 2023).

The central ideas in this study build on the notion of 'intelligent professionalism' developed by ⬏Thompson (2021). This concept involves moving away from perceiving professional autonomy as mere adherence to government instructions, which often lead to increased work pressure on educators. Thompson proposes an alternative that emphasises the expertise inherent to the profession itself. This shift grants teachers the autonomy to nurture and apply their professional knowledge and judgement within their teaching context. Achieving this aspiration requires recognising and facilitating teacher leadership, alongside investing in and providing support for the continuous professional development of teachers.

Hence, attaining high-quality education systems requires recognising and enhancing both teacher quality and teaching quality. Teacher quality encompasses the amalgamation of individual attributes, competencies, and insights an educator brings to their teaching role. On the other hand, teaching quality pertains to the delivery of effective instruction that facilitates comprehensive learning among diverse students. This form of instruction aligns with the requisites of the subject matter, the instructional objectives, and the specific requirements of students within a given setting (⬏Campbell et al., 2022; ⬏Darling-Hammond, 2017). Table 2 below presents the attributes of both teacher and teaching quality.

Table 2. *Attributes of teacher and teaching quality* (↑Darling-Hammond, 2017, pp. 17–18)

	Attributes

Teacher quality	■ Strong content knowledge related to what is to be taught.
	 ■ Knowledge of how to teach others in that area and skill in implementing productive teaching practices.
	 ■ Understanding of learners and their development.
	 ■ General abilities to organise and explain ideas, observe and think diagnostically, and use adaptive expertise to make judgements about what is likely to work in a given context in response to students' needs.
	 ■ Teachers' dispositions to:
	   – Support learning for all students
	   – Teach in a fair and unbiased manner
	   – Adapt instruction to help students succeed
	   – Strive to continue to learn and to improve
	   – Collaborate with other professionals and parents in the service of individual students and the school as a whole.

Teaching quality	■ Teacher quality (teachers' knowledge, skills, and dispositions)
	 ■ Context of instruction:
	   – Curriculum and assessment systems that guide teachers' work
	   – Opportunities to learn from and work with colleagues
	   – Fit between teachers' qualifications and what they are asked to teach
	   – Teaching conditions.

↑Allier-Gagneur et al. (2020) outline areas for effective teacher professional development:

1. Encourage teachers to focus on their pupils' learning

2. Share effective practices with teachers using modelling

3. Acknowledge and build on teachers' existing knowledge, views, and experiences

4. Focus on developing practical subject pedagogy rather than theoretical general pedagogy

5. Empower teachers to become reflective practitioners and structure teacher education around practice-based cycles of trial and refinement

6. Incorporate peer support

7. Ensure teacher education programmes motivate teachers

8. Prioritise school-based teacher education

9. Schedule regular, ongoing teacher education

10. Provide supporting teaching and learning materials

11. Ensure support from school leaders

12. Create a coherent policy environment.

This study's approach to continuous professional development draws on these areas and is based on key evidence from prior research on sustaining and engaging practices. ↑Haßler et al. (2018) have also provided the following reflection on how TPD can drive deep pedagogical change:

> "*These include construing teachers as reflective professionals, alignment with local context, teacher-led discussion and joint reflection, promoting communities of practice, foregrounding and creating school-based opportunities for active experiential peer learning and classroom trials, with appropriate scaffolding, such as professional development materials.*" (↑Haßler et al. 2018, p. 62)

In addition, when researching teacher motivation and strategies that facilitators can implement to increase participation, ↑Haßler et al. (2020) found that:

> *"Seeing new pedagogies in action and teachers subsequently trialling these themselves constitutes a route to initiating pedagogic change. Seeing a peer trying out a new technique is a powerful motivator. In terms of extending beyond those teachers who are inherently keen to learn and interested, the facilitators recognised that they hold the key: they need to be practising a new approach in class themselves, both to persuade other teachers of the benefits and feasibility, and actually to demonstrate it in practice."* (↑Haßler et al., 2020, p. 11)

We note that much of the research by Haßler and colleagues was undertaken in the Zambian context, which has cultural groups that overlap with our present country of study (Malawi).

In this study, our goal was to collaboratively create a context-specific TLC model based on the above ideas and, in partnership with teachers, to improve numeracy outcomes in primary schools in Malawi. This model was designed to encompass these specific areas, tackle the attributes associated with teacher and teaching quality, and centred on the concept of teacher leadership.

In Section 3, we focus on the methodology of the study.

3. Methodology

Given the objectives outlined above, to undertake qualitative research, we planned to visit schools to observe teacher learning circles and hold focus group discussions/co-design sessions to gather feedback to co-design TLC guides. Furthermore, we planned to observe lessons of classes in Standards 1–3 and conduct semi-structured interviews with teachers as part of the learning and feedback process. The adopted research methods are presented in the table below in greater detail.

Table 3. *Qualitative research methods adopted in the study*

Method	Description
Teacher learning circle observations	From the second term on, schools were oriented to run TLCs fortnightly. We developed four TLC guides to be used in the selected schools between February and March 2023. Our teams observed at least one TLC session pertaining to each guide across different schools. We used a TLC observation tool for this purpose. *15 teacher learning circles*
Focus group discussions/ co-design sessions	We conducted at least one focus group discussion with a sample of teachers who attended the TLC session in each school where we observed a TLC. The focus groups were held at the end of each session to collect feedback from teachers about the new TLC model. The discussions covered the session's content, how it was delivered and facilitated, the proposed activities for stimulus, practice and planning, the use of technology, the challenges faced, and suggestions and areas for improvement. This was a learning exercise that informed the design of the subsequent guides. *12 co-design sessions*
Lesson observations	We went to Standards 1–3 classes in different schools to observe the quality of teaching and learning and to identify challenges that teachers and learners could face. We used the observations to inform the content to be covered in the TLCs. The team's mathematics expert developed a tailored observation tool and trained the researchers to use it. *32 lessons observations*

Method	Description
Semi-structured interviews (SSI)	We conducted semi-structured interviews with teachers who deliver the NNP and attend the TLCs. The interviews aimed to learn about their experiences and challenges as NNP teachers, the type of support they need to improve their teaching practice, their perception of the new TLCs and how they are (or aren't) connected to their classroom practice. We also wanted to hear their ideas on how we can improve the model of school-based TCPD. Moreover, after every lesson observation, we interviewed the teacher who delivered the lesson to reflect on the challenges and successes of the teaching and learning. Apart from the teachers, we interviewed all the Primary Education Advisors (PEAs) overseeing the selected schools. These interviews aimed to understand the PEAs' backgrounds, their respective roles, their experience with the NNP, and their insights on how they might be effectively engaged in the programme. *52 teachers* *7 Primary Education Advisors*

For this study, a sample of 20 schools was selected by the Ministry of Education and Cambridge Education. The sample included schools from two different regions of Malawi—10 schools in the central region, more specifically in the city of Lilongwe, and another 10 schools in the southern part of the country, located near the town of Zomba. Schools were selected based on geography (10 urban schools in Lilongwe and 10 peri-urban and rural schools in the southern region) and the number of teachers working there. This choice was to help us explore the potential differences of running TLCs in schools of different sizes.

Figure 1. *Schools in the central region of Malawi (Lilongwe).*
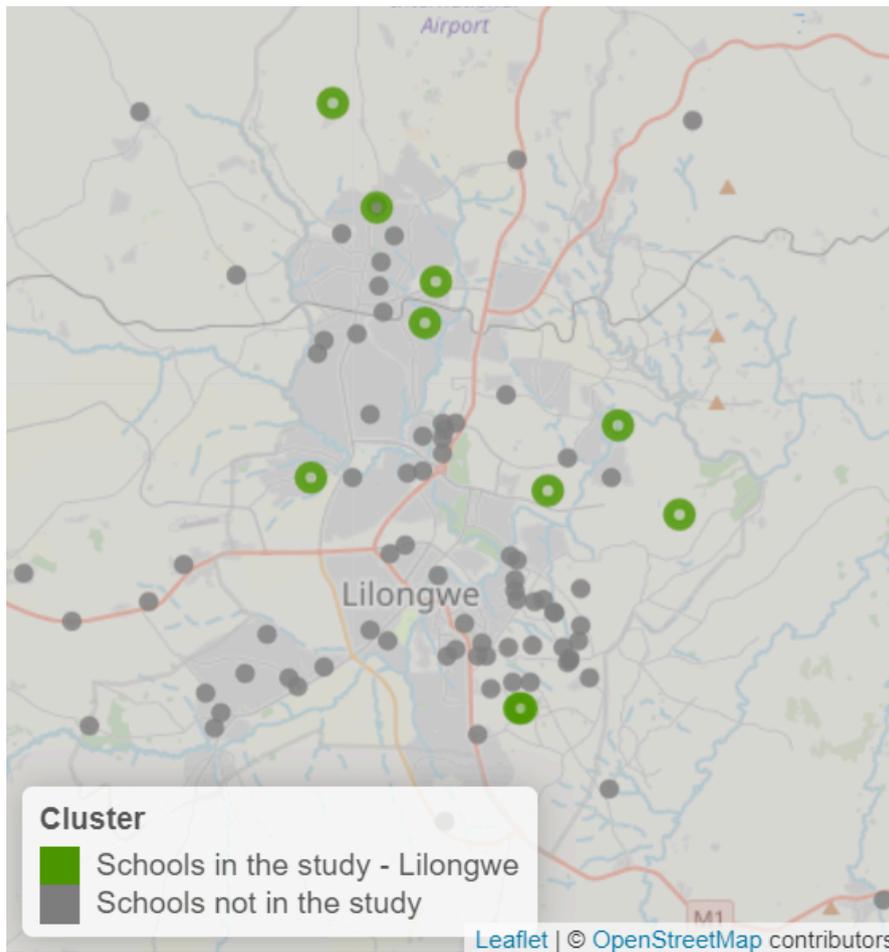
Out of the 10 schools in each region, we selected two schools for intensive research, which we planned to visit every week for lesson observations, semi-structured interviews, TLC observations, and focus group discussions. The remaining eight schools in the region were to receive the new TLC guides and run the TLCs normally, but they would be visited less frequently than the schools earmarked for intensive research.

Figure 2. *Schools in the southern region of Malawi (Zomba district)*
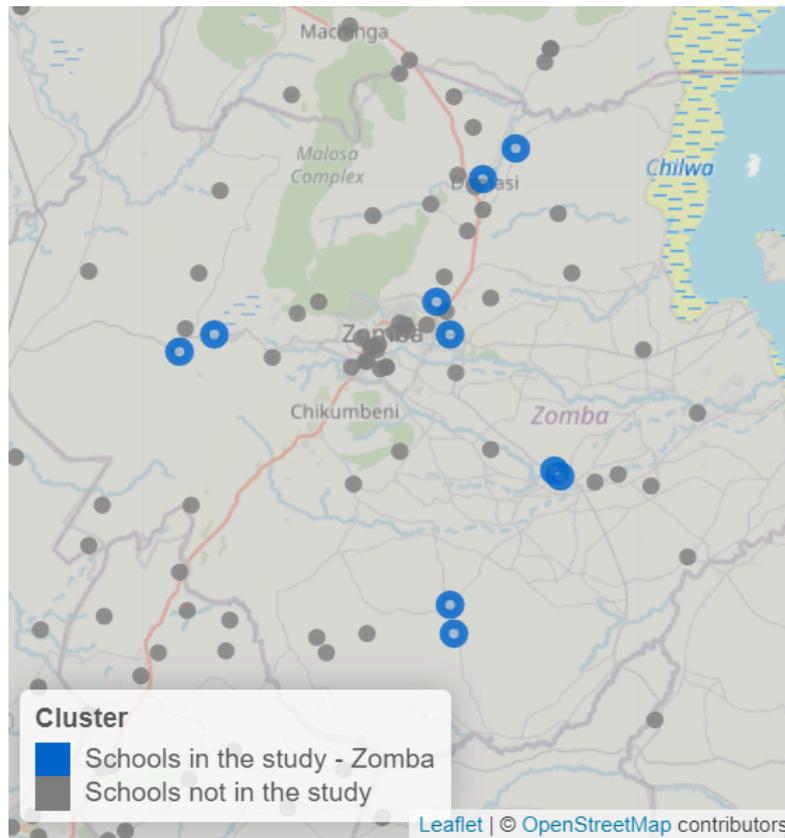
All interviews were recorded, and all TLCs and lessons observed were filmed. Before undertaking any research, we obtained formal written consent from all participants. Importantly, this consent included audio and video recordings of interviews, focus groups, lessons, and teacher learning circles. Data was only used for research purposes.

A list of the sampled schools is provided in Table 4 below, along with the GPS coordinates of each school.

Table 4. *List of schools used in the research sample*

District	Zone	School	GPS coordinates
Lilongwe	Dzenza	Dzenza	-13.8697, 33.7574
Lilongwe	Dzenza	Yepa	-13.8373, 33.7439
Lilongwe	Ngwenya	Ngwenya 1	-14.023, 33.8024
Lilongwe	Ngwenya	Ngwenya 2	-14.023, 33.8025
Lilongwe	Shire	Mtsiriza	-13.9522, 33.7371
Lilongwe	Mvunguti	Chipala	-13.9047, 33.7724
Lilongwe	Mvunguti	Lilongwe Demo	-13.8919, 33.7764
Lilongwe	Mphungu	Mphungu	-13.9559, 33.8113
Lilongwe	Mphungu	Kauma	-13.9363, 33.8328
Lilongwe	Mphungu	Kamuzu Palace	-13.9631, 33.852
Zomba	Chingale	Changalume	-15.3874, 35.2066
Zomba	Chingale	Chingale	-15.400, 35.183
Zomba	Mchengawedi	Domasi Government	-15.2802, 35.3986
Zomba	Songani	Matiti	-15.3869, 35.3748
Zomba	Songani	Chikupira 1	-15.3651, 35.3656
Zomba	Songani	Matandani	-15.2587, 35.4219
Zomba	Ntonda	Pirimit Boys	-15.4855, 35.4523
Zomba	Ntonda	Pirimit Girls	-15.4817, 35.4489
Zomba	St. Martins	Khuluvi	-15.596, 35.377
Zomba	St. Martins	St. Martin's Primary School	-15.572, 35.373

We interviewed 52 teachers and 7 PEAs, observed 32 lessons and 15 TLCs, and conducted 12 co-design sessions with teachers. All interviews were transcribed and tagged according to the school where they took place. After processing the data, we coded transcripts and field note observations and analysed the data using Atlas.ti software.

In Term 1 (↑Correa de Oliveira et al., 2024) we looked at the programme more broadly. For the research in Term 2, presented here, we focused on the TLCs, asking how they could be tailored to become more effective at addressing issues concerning teaching and learning in the classroom.

When analysing the data, the team utilised relational content analysis. This blended approach combines inductive and deductive analyses to delve into the interrelationships between variables while also testing theoretical assumptions (↑Bengtsson, 2016). The team adopted a deductive approach to coding the data based on the theoretical framework from the rapid study carried out in 2022, which identified common challenges in teaching and learning in the NNP context (↑Correa de Oliveira et al., 2024). This process provided a structured foundation for the data analysis.

Subsequently, the team employed inductive content analysis to examine the data within the established deductive framework. The deductive approach was applied to validate the theoretical framework used for coding the data, while the inductive approach was used to investigate relationships, leading to fresh insights.

3.1. Limitations and challenges

It is important to acknowledge that exceptional events compromised the continuity of the research in the southern region. Categorised as a 'Very Intense Tropical Cyclone,' Cyclone Freddy hit Malawi at the beginning of March 2023 (↑Save the Children, 2023), causing school closures, displacements, and a high death toll.

The findings from this study are detailed in Section 4.

Figure 3. *Map of Malawi*
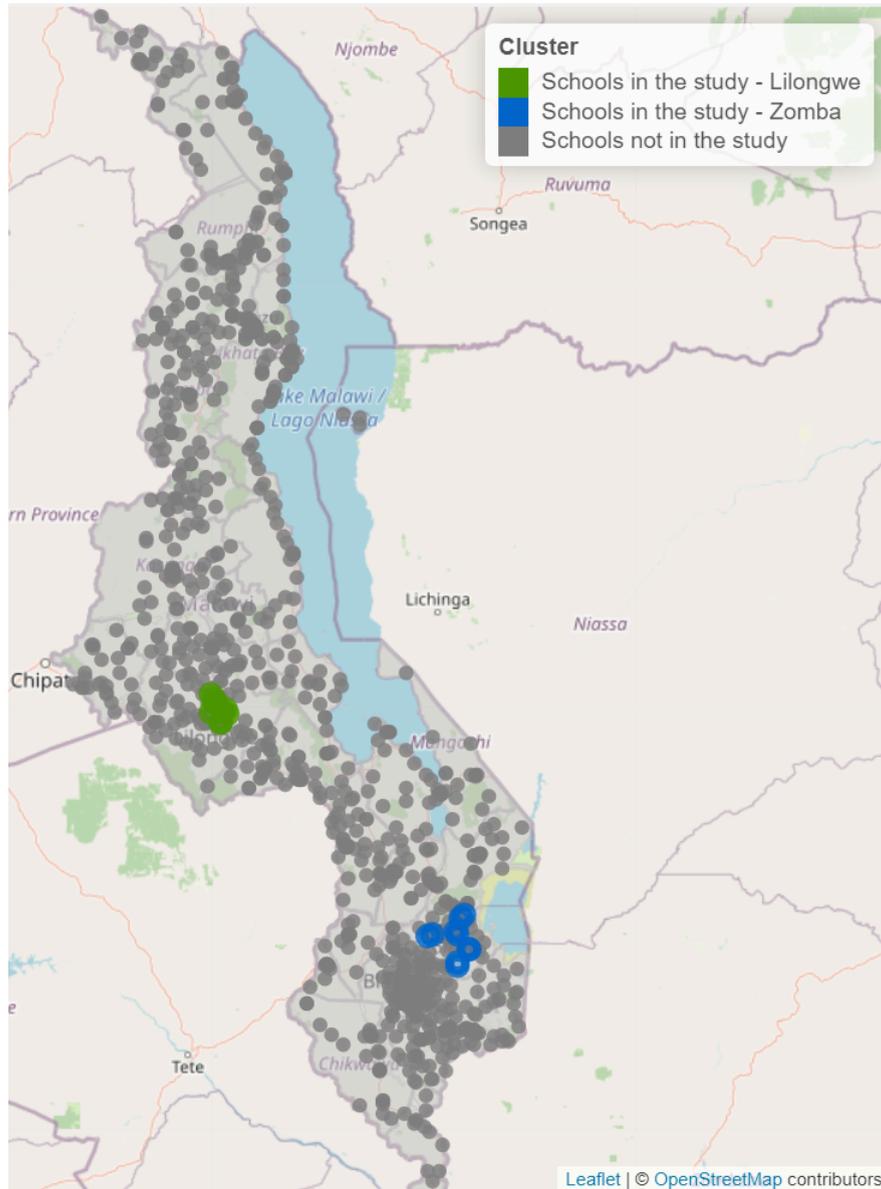
4. Description of the DBIR cycles

Each new TLC guide designed throughout this study focused on a pedagogical area teachers found challenging in lesson observations. The purpose was to develop TLCs covering actionable content directly connected to classroom practice. By simplifying the structure and content of the TLCs, we could tailor them to the needs of teachers and the reality of schools in Malawi. Furthermore, co-designing the TLCs with the teachers was a way to help them have a sense of ownership over the programme.

The findings of this study, which are expanded on in Section 5, informed the development of the TLC guides, along with input from teachers on the structure, format, and types of activities in the TLC. Rather than covering isolated topics, the new TLCs were developed to make a coherent programme that would allow teachers to consolidate their knowledge and strengthen their classroom practice on key concepts of numeracy and the NNP.

The approach consisted of several cycles, each iterating our approach to TLCs.

1. Cycle 1: TLC 1—Manipulating numbers: skills
2. Cycle 2: TLC 2—Manipulating numbers: strategies (Part 1)
3. Cycle 3: TLC 3—Manipulating numbers: strategies (Part 2)
4. Cycle 4: TLC 4—Manipulating numbers: devices

With design-based research, it is usually difficult to separate the research approach (the description that follows about the 'Cycles') from the actual findings. In this report, we navigate a middle ground. Where findings pertain specifically to a specific iteration, the finding is detailed in the subsection below. In Section 5, cross-cutting findings are discussed and further illustrated with quotes.

One important note: The section below includes details about two specific sections of TLCs that first need to be defined. These are:

■ 'Stimulus and discussion'—a TLC section where facilitators model activities and engage teachers in discussion to introduce key concepts and promote deeper understanding.

■ 'Practice and feedback'—a TLC section where teachers collaborate to improve their mathematics knowledge and teaching skills through practical activities.

The TLC structure arrived at in the conclusion of this study is defined in greater detail in Section 6.

4.1. Cycle 1 TLC 1—Manipulating numbers: skills

The first TLC guide focused on introducing skills for manipulating numbers, in particular:

- What is a number skill?

- What are the key skills that the learners will develop?

- The difference between skills and strategies

- Practice on how to teach some of the key skills

- Developing a lesson plan based on the topics covered in the session

Over 56% of the teachers interviewed acknowledged that they struggle with teaching skills and strategies for manipulating numbers. In an interview conducted before the beginning of the new TLC sessions, when asked about which topics the TLCs should cover, one teacher mentioned:

> *"What we need especially, these facilitators, first of all, they have to remind us or giving us, especially in manipulating numbers. They have to focus on that. Mmh […] because in counting, most learners are doing well. However, in manipulating numbers, they can't do very well. There are only few who are doing very well."* (Teacher 5, School C)

The first TLC session was observed in five different schools. Each observation was followed by a co-design session where teachers provided feedback on each aspect of the TLC and input on how to improve them. In terms of teacher engagement in the sessions, i.e., whether teachers actively participated, shared their challenges, and interacted with each other's ideas—we observed a high level of engagement in only one school. In two schools, the level of engagement was at a medium level, and in the other two, it was low, with teachers not actively participating in TLC discussions. In all schools, the discussions would sometimes veer off-topic, going from skills for manipulating numbers and teaching and learning challenges to structural problems or issues related to the logistics of the NNP.

In 80% of the schools, we observed that the use of interactive activities was at a medium level, as the peer facilitators spent more time lecturing than was originally intended. In the same four schools, connections with key concepts

Moreover, the focus on classroom practice was weak, as the sessions were more theoretical than practical, and the discussions and feedback were superficial and had little focus on classroom application. We observed that the goal of having actionable takeaways was only partially reached in 80% of observed schools.

Our observations, coupled with the inputs from teachers collected during co-design sessions and subsequent interviews, fed into the design process of the subsequent TLC guide. In the focus group discussions, teachers provided useful feedback, for example, on limiting the independent reading time during the session, as it is time-consuming and teachers are already tired from work and will not absorb as much knowledge from it; arranging discussions in groups rather than in pairs; increasing the time of the stimulus segment, either by watching a video or the peer facilitator modelling an activity; changing the lesson planning segment, as they did not find it very useful to plan a whole lesson during the TLC.

On the other hand, teachers let us know that they found it very relevant to gain more clarity on what 'skills' are, which skills learners need to develop in manipulating numbers, and how to work with them. When asked about her experience in the specific TLC session where we received the above feedback, one teacher explained:

> *"I was motivated just because we learn(ed) more especially… I remember we were doing manipulating numbers skills and strategies. So I was able to know the skills which I can use in class so that the learner should be able to understand on the given problem." (Teacher 2, School A)*

Another teacher shared a similar experience, noting that:

> *"The TLC that happened last week, it was about manipulating numbers—number skills. So we learnt some of the skills that we did not come across. Maybe we […] we were taught, but we did not understood them, but now there was clarity of those skills—of how we can use them. Skills like completing tens, counting in groups. And those ones—maybe counting in fives, bridging, […] doubling, and halving. Those skills […] some of us, maybe we were not using all of them, but now because of the TLC that was done last week, now are able to apply those skills in our teaching lessons."* (Teacher 3, School F)

Emphasising the importance of learning the meaning behind the mathematical concepts used in the NNP, one teacher explained that she enjoyed the TLC because:

> *"The most part that was* […] *that motivated me — is also the strategies of how do we know the meanings of the strategies. Like defining manipulating numbers, doubling and halving, breaking down, building numbers, we also* […] *ahhh* […] *planning activities."* (Teacher 3, School C)

As examples of the skills she had learnt from the session, the teacher mentioned doubling and halving, single arithmetic numbers, and completing tens.

Moreover, teachers provided other insights into their general experience with the NNP. Some concerns raised included:

- The NNP curriculum often lacks connections between lessons and activities

- Teachers should be able to dedicate a day of the week (E.g. Friday) to revise the topics covered during the week and support the learners who are lagging behind

- The daily workload is too heavy for teachers and learners to manage

- There are some topics in the NNP, such as 'Data Handling', that were missing from the training and that teachers struggle to teach.

There were three key takeaways from Cycle 1.

1. **More scaffolding is necessary** to allow teachers to grasp the NNP curriculum fully and link the knowledge gained in the TLCs with their classroom practice. Having a clear structure with targeted resources to drive teachers' experiences to achieve the learning objectives is important to enable facilitators to implement the guides autonomously and ensure fidelity.

2. **TLC guides needed to be more comprehensive** and have more prompts and questions to support the peer facilitator, as the success of the sessions that we observed varied according to how prepared and/or skilled the facilitators were.

3. **The majority of the TLC session should be practical**, with interactive activities where teachers could watch someone model or practise themselves.

4.2. Cycle 2 TLC 2 — Manipulating numbers: strategies (Part 1)

The second TLC session was set to take place one or two weeks later, depending on school schedules. When distributing the second guide to the 20 schools, the Hub team met with the facilitators to provide them with pointers to support their work. The second TLC introduced the topic of strategies for manipulating numbers, although this time, the topic was broken down and covered across two sessions. This made it possible to reduce the scope of each session and simplify the content, limit the amount of lecturing and independent reading, and increase the time dedicated to practising in order to provide actionable takeaways.

In Cycle 2, we observed four TLC sessions (two in Lilongwe and two in the southern region). The level of engagement improved in this cycle compared to the first — out of the four schools we observed, the level of engagement was considered high in three. Peer facilitators appeared more comfortable performing their roles and could follow the guide and manage the discussions to ensure they did not veer off scope. In three schools, we found that the peer facilitators were still lecturing more than advised. In contrast, in one school, the facilitator successfully avoided lecturing and involved the teachers in the interactive activities.

Figure 4. *Cycle 2: TLC Session 1*
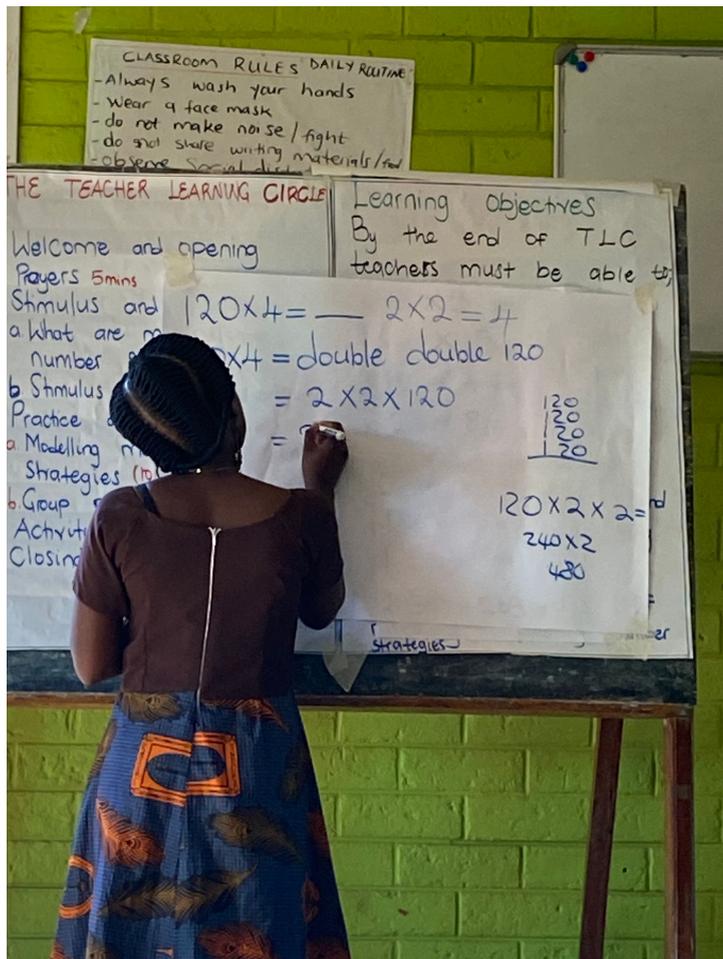
There was an improvement in the connections with classroom practice and key concepts, as facilitators were able to link this TLC to the previous one. While answering the facilitator's questions, teachers demonstrated that they were starting to differentiate skills from strategies. In three schools, we found that the sessions could improve further in becoming less about information recall and more about understanding and applying ideas. In one school, however, we observed a highly functional TLC, where teachers were engaged, practising and providing feedback to one another, and the peer facilitator was able to offer actionable advice to help teachers strengthen their classroom practice. For example, during the discussion and practice on number lines, the peer facilitator wrapped it up by explaining how to simply and practically show learners the use of the number line:

> *"If I have 293 and my friend has 460, how many steps do I need to take to get to my friend? We can use physical steps or hops to show the method of the number line." (School L)*

Our findings from the observations on the second cycle reiterate what we had discovered during lesson observations and interviews: there are significant gaps in how well prepared teachers are to deliver the NNP. We found that many teachers were approaching curriculum topics with little familiarity. If teachers struggle to understand and utilise key numeracy strategies, they will be unable to support learners in developing them.

During the co-design sessions, most teachers (83.3% in two schools, 100% in the third, and 77.8% in the last) elected 'practice and feedback' as the most valuable part of the TLC. One teacher noted that:

> *"I was not sure how to use the number line to solve problems, so it was helpful to learn from others in the group." (School C)*

Another teacher shared a similar experience:

> *"I did not know how to use the strategies, so I learned a lot." (School C)*

Even though only a minority of teachers chose "stimulus and discussion" as the most valuable part of the TLC, teachers emphasised that it is an important introduction to the work they will be doing in the session. In Cycle 2, a video modelling lesson was used as the stimulus — teachers had a positive attitude towards this, as it is helpful to see how their fellow teachers use numeracy strategies.

The challenge of access to digital content was brought up by the teachers, and did not go unnoticed in our observations. In fact, because some schools had no means to watch the video, we had to use our own equipment. Some teachers explained how, previously, the NNP would direct them to watch videos to prepare for their lessons. However, not all schools have tablets or computers, and many teachers reported that it would be difficult for them to watch the videos from their personal phones due to data and storage issues. For these reasons, the NNP withdrew the videos as a key step in lesson preparation. However, we incorporated these same videos into this new TLC model to test how teachers would engage with them while potential solutions for the access challenges are currently being pursued.

Figure 5. *Cycle 2 TLC: Session 2*

The lesson planning segment received mixed reviews from teachers in the co-design sessions. Our observations showed that very few teachers left the TLC with a complete lesson planned. The majority only listened to the facilitators' instructions but did not complete the task. In one co-design session, we asked how many teachers had left the TLC with an actual lesson planned, and out of the six teachers present, only one raised her hand. Some teachers noted that they already know how to write a lesson plan, so this activity is less valuable. Other teachers mentioned that planning a lesson in detail requires time and resources (such as charts for the teacher-led activity), both of which were lacking in the TLC session. However, we received feedback that lesson planning is nonetheless a useful exercise, as some teachers do not know how to create a lesson plan.

The key takeaways from Cycle 2 are:

1. **Covering key concepts of foundational numeracy is useful,** as some teachers reported they were not familiar with aspects of the content covered in the session, even though they have to teach it every day.

2. **Considering the time constraints, the lesson planning exercise needs restructuring** to be productive and feasible.

3. **The challenge of access to video content** needs to be considered.

4.3. Cycle 3 TLC 3 — Manipulating numbers: strategies (Part 2)

The third TLC session was scheduled to take place two weeks after the second one. Although the schools in Lilongwe could run it according to plan, the ones in the southern region were affected by Cyclone Freddy and had to close for an indeterminate period. Therefore, the research was disrupted in the region during that time. We observed three TLC sessions in Cycle 3 (only in Lilongwe).

The third guide was planned as a continuation of the previous one and covered the second part of strategies for manipulating numbers. Based on our findings from the lesson observations and the interviews, this session had the following objectives:

1. Teachers can confidently help learners understand any number's 'place value' and use place value to correctly write numbers.

2. Teachers can confidently use 'doubling and halving' and 'rounding and compensating' strategies in their teaching.

3. Teachers gain more experience in modelling strategies for manipulating numbers.

The principal adaptation tested in this cycle was the adoption of live modelling as a stimulus instead of the video. Having the peer facilitator model a place value exercise or a specific strategy satisfies the teachers' demand to watch their peers in action. We were testing if teachers would respond to it as positively as they had responded to the videos.

We found that modelling was generally a well-accepted adaptation. The level of teacher engagement was high in all three sessions we observed, and teachers were sharing challenges and interacting with each other's ideas. While modelling, the key facilitators ensured that teachers grasped not only what place value is but how to model it so that they could impart this knowledge to their learners. In one session, the peer facilitator modelled two different simple, practical, and visual examples of how teachers could teach this topic to their learners. First, she had a chart with Kamba bars (a local food

item) attached to it. There were three groups of ten Kamba bars each, plus five separate bars. First, the facilitator asked: "How many bars?"

Figure 6. *Cycle 3: TLC session —Kamba bars*

With the help of the teachers, they found 35. The facilitator then proceeded to explain that many learners, although they might be able to count up to 35, might need help understanding what the number 35 is and how to write it. Some learners will write 53, and others will write 305. Therefore, they must be prepared to explain place value to the learners. She demonstrated that, in a two-digit number, the first number is the digit in the tens place and indicates how many groups of 10s there are in that number. The second number is the digit in the unit's place and indicates how many units there are. The peer facilitator then used a wire with bundles of sticks hanging from it to model how teachers could explain place value for three-digit numbers.

In another school, the facilitator brought 47 maize grains and modelled how to teach the number 47 by showing four groups of ten grains plus 7 units of grains.

These are examples of how modelling can benefit teachers in the TLCs. Peer facilitators can be creative and use different resources to inspire their peers to do the same in the classroom and provide them with pointers on how to run a

successful teacher-led activity and model. Throughout the stimulus, we found the teachers appeared to be interested and engaged, and they would ask the facilitator questions and provide feedback.

One issue that emerged in this cycle was that some facilitators struggled to model and manage questions and comments simultaneously, which led to some sessions overrunning the proposed time due to the various discussions. Although we do encourage discussions and exchanges between teachers, we advise facilitators to keep the session under one hour and thirty minutes to avoid exhausting the teachers and negatively affecting their attitude towards the TLCs. Furthermore, because the peer facilitator was using modelling, much of the session was spent on the 'stimulus and discussion' segment rather than on 'practice and feedback'. After one of the sessions, one facilitator approached us, asking for guidance on improving her modelling and time management.

The key takeaway from this cycle was that **modelling is a positive stimulus for the TLCs**. Facilitators need coaching on how to model and what aspects to emphasise to support teachers in strengthening their classroom practice.

4.4. Cycle 4: TLC 4 — Manipulating numbers: devices

The fourth cycle was the final TLC session in Term 2, as the last two weeks of the term are usually dedicated to exams. In this cycle, we observed three TLC sessions (two in Lilongwe and one in Zomba). This session covered the topic of devices for manipulating numbers. The topic had been identified as a challenge for teachers and learners alike. The objectives of the session were:

1. Teachers can support their learners to gain fluency in number skills.

2. Teachers can confidently help learners practise manipulating numbers using devices such as number chains, bubbles, pyramids, and tables.

3. Teachers gain more experience in modelling strategies for manipulating numbers.

Figure 6. *Cycle 4: TLC session*

At Cycle 4, the facilitator and the teachers appeared to be more familiar with the new TLC model and know how to successfully navigate and engage with the activities. The 'practice and feedback' segment focused on the devices most commonly featured in the NNP Learner Workbook: number chains, pyramids, bubbles, flow diagrams, and tables. Teachers were divided into groups, each assigned a different device. First, the groups were asked to refer to the Teacher Guide to read the description of the device. Then, they were asked to complete four activities from the Learner Workbook using the device. Finally, they modelled how to use the device to complete a calculation and identify the strategies or skills involved.

In the co-design sessions, one teacher mentioned that she did not know how to use pyramids, so she found the session very useful. Two other teachers shared a similar experience, emphasising that they struggled to teach using those devices, but the TLC provided them with knowledge and practise to teach successfully. One teacher said:

> "[…] *I was teaching Standard 3, and I was struggling a lot to teach number chain, pyramid, etc. Now that we are practising, I won't make mistakes anymore and will be able to assist others."* (School L)

This template and examples illustrate what we were aiming to achieve with the process of refining the new teacher learning circles, reaching a prototype that:

1. Is teacher-led and teacher-empowering
2. Is simple but tailored to cover the gaps in the teachers' ability to deliver the NNP
3. Is strongly connected to classroom practice and provides teachers with actionable takeaways
4. Provides a space for teachers to practise
5. Provides a space for teachers to watch each other practise
6. Covers fundamental concepts of foundational mathematics and the NNP (e.g. skills, strategies, and devices) and breaks down the curriculum to enable teachers to understand how these concepts are interconnected.

These core TLC features are explored further in Section 6.

5. Cross-cutting findings

5.1. Quality of teaching

Below, we summarise our cross-cutting findings relevant to teaching quality based on our work in NNP schools. It should be noted that since the findings from this research were shared, NNP programme implementers have actively worked to address its recommendations, including conducting significant refinements to the curriculum and teaching and learning materials. Where relevant, steps taken by the NNP to address these findings are listed. EdTech Hub continues to collaborate with NNP to assess the impact of these revisions on the programme.

5.1.1. Teachers struggle to understand the 'sequence' within the curriculum

The NNP was designed with a robust mechanism whereby teaching and learning of mathematics are improved through the interplay of its curriculum and its key components — the teacher training, the TLCs, the Learner Workbook, and the Teacher Guide. The curriculum, as set out in the Learner Workbooks and explained in the Teacher Guide, forms a coherent whole. At the bottom of each page in the Learner Workbook, an icon in the form of a puzzle piece indicates a link to the Teacher Guide. Teachers can find orientation on the topic, skills and / or strategies being developed or practised on that page.

Through observations and interviews, we identified that teachers need help understanding how the pieces of the curriculum fit together. For example, in schools that joined the programme in the extended pilot, teachers had only been exposed to the NNP for two terms. They did not have sufficient time or support to build a complete picture of the curriculum. In other words, teachers were not always aware that the NNP curriculum has precise sequencing between topics, across weeks, terms and, indeed, across the years (it is a 'spiral curriculum'). This was evident in the lessons we observed: teachers lacked a sufficiently clear grasp of the curriculum. For example, teachers typically do not connect the lesson topic to a previous lesson nor communicate to learners that specific skills or strategies will be used in the next lesson.

A key contributing factor in this isolated treatment of lessons seems to be that most teachers reported that they were instructed to complete "one page of

the Learner Workbook per day". This instruction is likely to be the root cause of two common practices affecting teaching and learning quality.

First, teachers deliver each page as an entirely new topic that is treated in isolation from previous lessons, and even within the same lesson, teachers struggle to establish the relationships between the tasks. This lack of continuity hinders the cumulative development of fluency as conceptualised by the programme. For example, in one lesson that we observed, the first exercise of the page required learners to count in fives, as pages illustrated hands with five fingers in each, and they had to write the total number of fingers. The teacher modelled the activity, and most learners were able to provide the correct answer. Further down on the page, there was a different type of activity that also required learners to count in fives—however, many learners solved the problem by counting in ones. The teacher missed the opportunity to establish a connection between this exercise and the one that they had done in the beginning. This kind of practice was very common in the lessons that we observed.

Second, due to the belief that it is mandatory to complete one whole page in one day, most teachers would move on to the next activity. Teachers did this even though the majority of learners had yet to understand the concept or be able to complete the activity. During the interviews after the lessons, when teachers were asked to reflect on the quality of the lesson, many of them demonstrated that they were aware that the learners were struggling but felt they had to move on; otherwise, they would not be able to complete the entire page. This is a prejudicial practice that could result in many learners being 'left behind' and having to proceed to a more complex or different activity or topic without having fully grasped the concepts of the previous one.

The NNP has since revised the curriculum in Standards 1 and 2 into a topic-by-topic sequenced curriculum and provided additional explanation regarding the logic of the curriculum to teachers in Standards 3 and 4. Further changes to the sequencing of the curriculum are being considered.

5.1.2. Teachers noted the extensive student workload as a challenge to learning

Teachers and PEAS both mentioned workload as one of the most common challenges. At least 52% of the teachers raised the issue of workload, noting that the work in the NNP is too much and too complex for the learners' levels. When asked to reflect on the quality of teaching and learning that took place in her lesson, one teacher explained that:

"Time was not enough, comparing with what the learners were supposed to do. There are a lot of things they have to do per day. So if you think of the standard three learners, they are just kids. The work that they are given per day is a lot that a learner can't finish in an hour. They always fail to finish. So, instead of solving, they just guess the numbers. They are just guessing the answers instead of solving properly." (Teacher 2, School J)

One PEA echoed the same concern:

"Because in some pages there is a lot of work. So with the rule which the teachers heard that it's a work a page per day […] They are striving and that's why we are saying that some work is […] is covered like some things are missing and are being skipped in learners heads because the teachers are just rushing to finish off the page." (PEA 2)

Another PEA shared a similar experience:

"Another experience is that the work per page, the teachers are struggling to finish the page with leaving the learners what? Behind. Whether the learners have understood or not, they still continue the workbook page. […] They are leaving the learners behind." (PEA 7)

The NNP has recently made efforts to lessen the workload required by revising the curriculum for Standards 1 and 2. Additionally, guidance has been provided to teachers in teacher training and written memos to schools.

5.1.3. Teachers struggled to link the NNP approach to classroom practice

The NNP is built around the belief that children should be able to select their own strategies to solve any calculation. Teachers have been oriented to avoid dominating the lesson and, instead of telling learners what to do, enable them to think critically and come up with the strategies themselves. In every lesson that we observed, we found that teachers follow the protocol rigorously: they begin the lesson with a teacher-led activity, in which they are supposed to model an exercise similar to the one in the workbook, only with bigger numbers, and then ask learners to work independently in their workbooks.

However, in many lessons, teachers appeared to struggle to perform what they believe the NNP requires of them. In practice, the teacher-led activity is usually conducted as follows: the teacher solves the activity collectively, asking

different learners to provide answers at every step. If a learner provides an incorrect answer, the teacher says, "no, that is incorrect," and asks the learner to sit down. If a pupil provides the correct answer, the teacher asks their classmates to congratulate them (with one clap of hand, for example) and asks: How did you come up with that answer? Here, if the activity is about addition, for example, the learner would say, "I added the numbers."

Along the process, because teachers believe that they should not dominate the lesson, there is little to no explanation of key concepts or an introduction to the strategy and how and why it works. The learners who already have the knowledge appear to be able to keep up with the lesson and complete the activities in the workbook during independent work time. However, the learners who need help understanding usually do not get the support they need from this model of teacher-led activity. As a result, we found that, during independent work, these learners either leave the activities blank, copy the numbers the teacher wrote on the chalkboard (even though they refer to a different activity), or just guess the answers.

During the interviews and focus group discussions, some teachers acknowledged that they struggle to teach some of the devices commonly featured in the learner's workbook, such as pyramids, bubbles, number chains, and flow diagrams. This aligns with our lesson observations, where many learners struggled to use these devices even after the teacher had modelled them in the teacher-led activities. Many learners appeared to have little to no sense of how the devices work and what was expected of them, despite being in the middle of the second term of the school year and having used the devices since Term 1.

These findings reveal significant gaps in the teachers' ability to deliver the NNP. Teachers appear to be working hard to become 'NNP teachers', and almost every interviewee expressed a strong desire to receive more and sufficient training to be better prepared to teach the NNP. From our conversations with teachers, we found that some of them feel that they are no longer teaching mathematics but are teaching a new subject called NNP. They feel that they have to leave all their teaching knowledge at the door and have to teach a new subject that they do not fully understand and teach it in a new way.

Significant changes have been made to the NNP curriculum in Standards 1 and 2, which seek to remediate some of these challenges. Here, revised materials follow an episodic approach, which is clearly sequenced and explained to teachers in their Teacher Guide. Internal monitoring results from

the NNP demonstrate that teachers' effective uptake of the NNP approach is significantly improved. In Standards 3 and 4, additional guidance and modelling of teaching approaches have been provided to further support teachers in their application of the NNP approach in the classroom.

In Section 5.2, we explore our findings on the quality of learning in the schools that participated in this study.

5.2. Quality of learning

5.2.1. Learners struggle to keep up with curriculum progression

Both in its pilot and extended pilot phase, the NNP has been implemented from Standard 1 up to Standard 4 (in some schools, up to Standard 3) simultaneously. This entails a change of curriculum for learners in Standards 2, 3, and 4 despite their lack of exposure to the programme in previous school years. Teachers have raised this matter with concern, as the NNP is more demanding than the previous curriculum and has become a great challenge for learners. One teacher explained:

> *"So teachers from Standard 2 and 3 were complaining that they are having hard time to find simple ways to teach the learners so that they should understand since they are coming from Standard 1 where they only knew numbers from 1 to 9. So getting to Standard 2 and meet this chart of 1–100 numbers […]. It will be difficult for them to understand it in Standard 2 compared to when they started it in Standard 1."* (Teacher 4, School K)

As learners are expected to build on their skills and strategies as they progress across their infant and junior school years in the NNP, there is a gap between the knowledge that Standard 2 or Standard 3 learners are carrying from Standard 1 or 2 and what is required of them now under the new curriculum. This is particularly true for teachers in Standards 2 and 3 who need to be made aware of what skills and strategies their learners should know from Standard 1 or 2. For example, a learner in Standard 3 can solve an activity if they count fluently in fives—a skill they will have learned in Standard 1 under the NNP and practised in Standard 2. But, as this is the first year of the extended pilot, most Standard 3 children have not learned this skill.

NNP's revised curriculum for Standards 1 and 2 seeks to address these challenges through a slower progression and a more step-by-step introduction of key concepts. Additional guidance for teachers on how to

ensure learners can follow the curriculum's progression has also been provided in teacher training.

5.2.2. Learners struggle to write and understand numbers

One critical shortfall that we found from our lesson observations and interviews is the issue with writing and understanding numbers. In all observed classes, about 50% of learners can chant by rote counting numbers. The rest mouth the words or sit quietly and pretend. However, evidence shows that many of the learners do not know what they are chanting or how these numbers relate to each other.

It is unclear that learners recognise that the word 'twenty-three' is made up of the number 'twenty' and 'three'. They do not appear to recognise that the number 'seventeen' is one more than the number 'sixteen'. If they have 16 objects and the teacher adds 'one more', then the only way they have to say how many objects they now have is to count from one again. It is not just about moving from rote learning to relational understanding. It is also about gaining familiarity with the counting words and being able to match the word with the number and understand that the numbers are in order and represent a given size.

For instance, in the majority of lessons observed, one of the most common challenges found across schools was place value. Many learners appeared to have been struggling with writing numbers due to misconceptions, either inverting the position of units and tens (e.g., writing 05 instead of 50) or separating the number (e.g., writing 135 as 100 30 5). Our observations suggest that teachers struggle with the topic and lack the methods and strategies needed to support their learners in understanding place value. Some teachers also raised this issue in interviews. While reflecting on the challenges and successes of the lesson that she had just delivered, one teacher mentioned:

> *"Mostly, as a teacher, I need to deal in areas concerning numbers. How to write numbers.* […] *The students know the numbers but have challenge in writing them. For instance, they might know "21" but have difficulty in how to write "21". Instead, they can start with writing 1, then 2. Unlike the previous syllabus, we were able to teach the pupils how to write numbers. We used to take the pupils to the school ground and let them be writing the numbers on the ground."* (Teacher 2, School O)

The same teacher explained that the root of the problem is that the NNP curriculum did not orient teachers to teach pupils how to write and understand numbers. Other teachers echoed this experience during the interviews.

> *"The pupils have challenges in writing numbers because the NNP programme doesn't tell us teachers to teach learners on how they can write numbers."* (Teacher 2, School O)

Newly revised NNP materials begin with carefully introducing numbers and allowing learners adequate time to understand and write number symbols before performing operations.

5.2.3. Learners struggle with word problems, problem-solving and understanding and using mathematical vocabulary

Moreover, some activities require that learners can read, understand the concept, and use mathematical vocabulary such as 'one more', 'one less', 'how many', 'how many altogether', 'how many more' ', how many left', 'share', 'share equally'. For example, for learners to be able to recognise and follow the verbal instruction 'find one more', they would ideally go through the following cycle:

➔ Teacher models what adding 'one more' looks like with concrete objects (using Chichewa if helpful)

➔ Learners come to the front and model 'one more' using concrete objects

➔ Teacher writes the words 'one more'

➔ Learners learn to read and recognise the instruction 'one more'

➔ Teacher gives the learners lots of practice using objects, using the number line, and finally, using mental calculation.

A cycle like this needs to be included in the learner book or Teacher Guide. Without this cycle, learners will be unable to read and correctly interpret what they are asked to do to answer a word problem.

One area intersecting the issues outlined above is problem-solving. From lesson observations and interviews with teachers, we found that learners struggle with problem-solving activities. Over 45% of the teachers acknowledged that they struggle with teaching problem-solving. The majority of learners that we observed could not complete problem-solving tasks, even when they had found the correct answers to preceding activities. One teacher shared his challenge of teaching problem-solving under the NNP:

> *"We should not give, for example, we should not give the strategy to the learners, but we should just introduce the task, and learners, they should start thinking on their own on how to complete that task. So it's like […] we should be asking questions like provoking question for them to be thinking on what to do. But when it came to problem-solving, I thought like that thing can't work […]. Because it's like […] in word problem, they are not aware of the […] like they cannot understand English on their own. They cannot think on to say, maybe, we should multiply, we should divide. So for me, I was taking that as a very difficult thing for a learner that he can come up with his own ahh […] strategy on to deal with that problem […]. Until now, I find difficult for the learners to do the task on their own that is on problem-solving."* (Teacher 3, School J)

When asked about the topics that she feels less confident in teaching, another teacher shared a similar experience:

> *"Word problems. For example, in addition and subtraction […] As I have already said that learners, most of the learners, they don't know numbers. Especially big numbers, they don't know them. So it's difficult for learners when I read a question or a problem to them, of course, I use both Chichewa and English. But when they come to solving the problem, they become ahh […] They fail to find the answers."* (Teacher 1, School G)

Furthermore, big concepts in mathematics—such as fractions—are introduced as part of a lesson and then applied later in some lessons, with no opportunity for learners to develop understanding and consolidate their thinking. In fact, before they are introduced to simple fractions, they are asked to share some Kamba bars equally among a group of children. Then they are introduced to simple fractions and asked the same questions about sharing Kamba bars equally. Learners are not guided as to how they can share equally without fractions or how they can write their answers with fractions.

The NNP has begun to address these significant challenges. Recent teacher training encourages teachers to code-switch between English and Chichewa (or other local languages) to ensure learners understand the problems with words. Revised curriculum materials for Standards 1 and 2 also address this through episodic teaching, where teachers assess learners after completing one lesson, to ensure learners understand it before moving to the next.

5.2.4. Conceptual leaps: Learner Workbooks transition to abstract representations without proper guidance

A closer look at the Learner Workbooks reveals significant conceptual leaps that must be addressed. The workbooks jump from introducing a mathematical concept using practical objects to representing the concept abstractly without guiding learners across the gap. For example, they jump from using the four operations (addition, subtraction, multiplication, and division) in word problems that can be modelled using concrete objects to doing calculations using the symbols of +, -, ×, ÷ and in the abstract, without any guidance. The Standard 3 Term 2 Learner Workbook also introduces fractions (halves, thirds, quarters, fifths, and sixths) through the practical activity of sharing a Kamba bar equally between children. Then, six months later, in Standard 4 Term 1, the workbook introduces the symbols for these fractions and expects learners to be able to operate with these symbols.

These findings indicate that significant areas of mathematics content and pedagogy are missing from the programme, which, as a result, affect the quality of learning that is taking place in the classrooms. Learners have limited opportunities to consolidate their knowledge and develop fluency in basic numeracy. These broader issues cannot be addressed solely through improving the TLCs, as some of the other key components of the programme must be revised. However, the next section will focus on how the TLCs have been refined to support teachers in overcoming these challenges.

Revised NNP materials seek to address the above-mentioned concerns by encouraging teachers to use concrete resources before jumping to abstract representations.

5.3. New model of school-based teacher continuous professional development in the Malawian context

Over 85% of the teachers who were interviewed demonstrated a positive attitude towards the TLCs and stated the TLCs support them in strengthening their classroom practice. For them, the NNP is a novelty that brought significant changes to the way they were teaching mathematics, shifting the focus to different skills and strategies and enabling a more learner-centred learning environment that is less teacher-dominated. To reach this goal, teachers understand that they need to refine their teaching practice and acknowledge that they need support in this area. Such perceptions can be

found in the following remark, where a teacher explains what motivates her to attend the TLCs.

> *"You really wanted to participate because that is where we discuss our challenges. And telling each other what to do, encouraging each other […] because we are human beings. We reached a point of asking each other: is this NNP going to work? So we encourage each other that let's keep going as this is the beginning and the beginning is always difficult."* (Teacher 4, School K)

For instance, when asked about the benefits of the TLCs, one teacher stated:

> *"It has an impact. It helps us to be reminded and also polish in areas we are not doing good. It's very important. It's very important."* (Teacher 1, School O)

Another teacher emphasised the importance of the TLC to improve her teaching skills, as she recognised that there are some areas that she has been struggling with.

> *"I go there to […] to improve my […] my teaching skills. Yeah. So, there is some sort of improvement from the time I started. Yeah. And reaching this far, I can see that there were some areas I was lacking and lagging. So by and by, I can see areas I need to improve […] we should improve here. So, TLC is very important. It is very important and needs to be happening frequently."* (Teacher 1, School E)

When asked if the TLC session she had attended the previous week was useful to strengthen her classroom practice, one teacher explained how the TLCs supported her to be a more effective teacher.

> *"It helps me to teach effectively. To impart knowledge to my learners. For example, as I have already said that there are some problems that are difficult to explain to learners. But through TLC we gain some other knowledge as well as skills."* (Teacher 1, School G)

In our qualitative sample, over 75% of the teachers have also stressed that they value learning from their peers by observing how they teach, which strategies and methods they use, and how they deliver the content.

> *"Since we conduct the TLC with our fellow teachers […]. So we teach each other in small groups. For instance, the Standard 1 teachers, we can choose a topic and a person to teach us. We*

correct him or her whenever they are wrong. The same as others. So if you have a challenge in a certain area where your colleague is good at, you can easily see and this that this is the right direction to go." (Teacher 2, School O)

When asked about what motivates her to attend the TLCs, one teacher emphasised a "strong desire" to learn from her peers:

"I think the delivery of the lessons. Yeah, because this is the new thing to us, we have a strong desire to learn how our colleagues are doing, and we learn a lot of things from our colleagues. We learn from our peers. Yes. And sometimes you can even do better than your friend. So some people can also learn from you. For instance, me as a mathematics teacher, I can learn from the Standard 4 on how they are doing their lessons, and I gain some skills of which I can apply to my students." (Teacher 2, School B)

These remarks reveal that teachers are receptive to the collaborative and teacher-led model of professional development proposed by the TLC and find it helpful not only to share and discuss with their peers but also to learn by watching them. This discovery fed into the process of designing the new TLC guides, particularly in using videos and modelling as stimulus, and developing practice and feedback exercises. We will explore these components of the TLC model further in Section 6. However, before delving into that topic, we address some of the remaining challenges identified in our study, below.

5.4. Remaining challenges

Despite the attempt to overcome some of the key shortfalls found in the quality of teaching and learning in mathematics—and the implementation of the NNP more broadly—some challenges remain. Some of these challenges are a matter of budget constraints; others are related to broader issues of the Malawi education system, while others will require further action from the NNP. In this section, we will explore some of the remaining challenges that affect the quality of teaching and learning and of the TLCs, as well as some relevant points of discussion.

5.4.1 Teachers' perception that face-to-face training is the most valuable model

When asked what kind of support they need to deliver the NNP, over 54% of the teachers mentioned needing more training. Teachers claim the training they have received is insufficient and that they require regular ongoing

training—once a term—to ensure that they are adequately prepared to deliver the NNP and hone their skills. When asked about the challenges, one teacher noted:

> *"We need training. We have difficulties in maybe doing other work in this book in terms of other classes. The work is too much and other mathematics are difficult for the teachers to do it. So more [...] training is needed."* (Teacher 4, School L)

Another teacher reported that, in his view, the training provided by the NNP was too theoretical.

> *"The training was only theoretical with no practical. Since there was no practice, we complain a lot as we don't know whether we are in the right track or off track. Had it been there was practice, we, the teachers, would have been guiding each other, saying let's do this or let's do that. Unlike the National Reading Programme, we just did a training which ended in suspense [...] With NNP, its giving us a lot of challenges as we don't know the right direction to go."* (Teacher 2, School O)

Through these remarks, we found that teachers are eager to improve and refine their practice to teach the NNP, but many still believe that training is the best or the only way to do so. Many teachers appear to appreciate the TLCs, but fail to see them as sufficient for their continuous professional development. As one teacher mentioned:

> *"For me, I think if we can have more trainings of these because the period we had a training was not enough. So if we can have training and remind us where we have forgotten can be good. Although we have TLCs, I think it's not enough."* (Teacher 4, School M)

It is expected that teachers may perceive training as more relevant and useful than the TLCs because of its nature: it is an official event where teachers dedicate their time and attention to one specific agenda carried out by people trained to do that. On the other hand, TLCs might be seen as more informal and less substantial because they are teacher-led and have a less rigid structure. However, we argue that this is a misconception that can be changed by refining the structure of the TLC, as we have done in this study. This can include improving the support provided to facilitators to run the TLC sessions, and advocating for the importance of the TLCs as an integral part and critical instrument for the continuous professional development of teachers.

5.4.2. Lack of refreshments as a challenge to engagement

Complaints about the lack of refreshments during the TLC sessions were prevalent among teachers during the interviews and focus group discussions. At least 63% of the teachers raised this issue as the most significant limitation of the TLCs. Teachers explained that most of them begin the school day very early (around 6 or 7 a.m.) and have to teach several subjects to large classes single-handedly. They emphasised that this is exhausting work, and that after learners leave school (usually around or after 12 noon), they need to plan the lessons for the following day. For those reasons, attending a TLC session without eating and without being provided refreshments represents a great challenge for them, as much as they enjoy the session. When asked about the limitations of the TLCs, one teacher noted that:

> *"Mostly the TLCs are conducted during late hours. So during the late hours you are always tired, and you will go there to learn without being provided with some refreshments. This makes other teachers to abscond the TLCs because they are tired and hungry."* (Teacher 2, School J)

Another teacher shared a similar view, emphasising how being hungry negatively affects her motivation to attend the TLCs.

> *"We conduct the TLC maybe after classes. As we knock off we are gathered together and to do TLC. So sometimes it means that we have hungry. We are failing to keep attention to what the facilitator is […] teaching us. As a result, I feel negative.* (Teacher 1, School G)

The issue of lack of refreshments is rooted in the programme's budget constraints. Outside the NNP, schools receive funds to dedicate to continuous teacher professional development, including TLCs, so these funds could be used to purchase refreshments. However, the funds are minimal, and mathematics is just one subject among many, so school managers claim that it is not feasible for the school to bear this burden. To address this issue, we advise that, since foundational mathematics has become a priority for education in Malawi, part of the school funds should be dedicated to refreshments for the TLCs. Alternatively, the budget for the NNP would have to be planned to accommodate this demand.

5.4.3. TLC sessions were crowded

During TLC observations, we found that a larger number of teachers in one session can affect the quality of the session. With a smaller group of attendants, sessions tend to be more intimate, and teachers have more opportunities to share, engage with each other's ideas, and practise in front of their peers. Moreover, issues such as disruptive talking in class, discussions veering off-topic, and lack of attention and engagement can be more easily managed in small sessions. While some schools we visited only had around 10 to 14 teachers per session, others had over 80 teachers. Although it is not impossible to run an effective TLC with so many teachers, it requires stronger facilitation skills. Managing a crowded classroom with children is not the same as managing a crowded classroom with adults, and activities may need to be adapted to those circumstances. Alternatively, the programme can propose different arrangements for larger schools, such as running two sessions instead of just one.

5.4.4. Difficulties assessing learners and providing individual feedback in large classes

The Malawi education system has a prevalent issue of large classes, particularly in the infant years (Standards 1 and 2). While some of the lessons we observed had around 60 children, in others, the number of learners could go up to 180 or 200. Except for a few cases, in most lessons, we observed the teachers were alone in the classroom, without anyone to assist them. In this context, teachers find it extremely challenging to deliver the lesson, manage the classroom, mark the learners' workbooks, assess their level of understanding, and provide individual feedback for those who are struggling—as is expected in the NNP. When asked about what kind of support she needs to teach mathematics, one teacher noted that:

> *"The support is greatly needed, as you can see, in my class there are a lot of learners. So, being one teacher, it's very hard for you to handle all those learners. You have to write for each and every one and then check if they writing correctly. It is very hard for one teacher. It is difficult. And also the kind of mathematics requires you to have someone who can be helping you. So I don't have anyone who can help, and this is very much difficult."*
> (Teacher 2, School J)

Even though this issue is not exclusive to mathematics and the NNP and affects the quality of teaching and learning in all subjects, we found that teachers require strong orientation on how to help learners develop numeracy

fluency under these circumstances. This is particularly true for learners failing to keep up with lessons.

6. Discussion

In our research, we intended to answer this question:

> **How can features of school-based teacher continuous professional development be optimised to support Malawi's National Numeracy Programme to effectively improve numeracy instruction?**

In particular, we intended to answer the subordinate research question:

> **How can Teacher Learning Circles, which are a major component of the continuous professional development programme, be tailored to become more effective at addressing issues to do with teaching and learning in the classroom?**

The findings of this study, coupled with the tight feedback loops whereby we could test one intervention, reflect upon our learnings, co-design the next intervention, and then test it again, allowed us to build a TLC model with the features listed below.

6.1. Features of effective TLCs

Below, we outline several core features identified through our design-based implementation research, which, we believe, will lead to effective TLCs in NNP schools.

6.1.1 Connecting pieces of the NNP curriculum puzzle

Teachers are the key players in delivering the NNP. On a daily basis, they need to make sense of the NNP resources available to them to ensure that learning is taking place. If teachers do not fully grasp the curriculum and struggle to understand the underlying concepts or use the featured devices—in other words, if teachers lack ownership of the pedagogical content, the programme will struggle to be successful.

Due to budget and time constraints, providing regular and comprehensive training for every teacher is neither feasible nor sustainable, but leaving teachers without a model of consistent training and support would be ineffective. Even though discussions about how the NNP training can be refined to be more substantial are necessary, the TLCs can play a significant role in regularly and consistently supporting teachers in making connections across the curriculum. They can also strengthen their knowledge, practice, and ability to navigate and successfully use the available resources.

In this study, we did so by tailoring TLC content to cover key concepts and how they relate to each other to form the 'full picture', demonstrating how the Teacher Guide and the Learner Workbook are connected and complemented.

6.1.2. Comprehensive guides with notes, prompts, questions for discussion, and resource sheets

TLC guides need to be simple, straightforward, and clear, while also being comprehensive and detailed enough to ensure the peer facilitator is sufficiently supported and oriented. Creating such guides is a challenge. For example, during a discussion, it is a challenging task to be able to ask the right questions that will lead the teachers through specific thought processes towards a particular goal or understanding. In the practice and feedback segment, teachers must be provided with specific activities to help them develop the target skills.

In this study, we produced guides that provide useful notes and prompts to help the facilitator lead the session, focusing on what is important for the learning objectives to be met, as well as presenting the relevant questions and activities. This approach aligns with the 'whole programme scaffolding' feature of TPD proposed by ⬆Haßler et al. (2018) aiming to enable fidelity in the delivery by facilitators and manage the dilution that comes with some degree of cascading.

6.1.3. Learning from watching your peers teaching

Teachers have emphasised how useful it is to watch their peers teaching and using strategies. In this study, we facilitated this by including videos showing snippets of a teacher modelling an activity or using a specific strategy or skill as a stimulus for the discussions. Furthermore, modelling is a beneficial practice, as it allows teachers to see how to model the activities with their learners, step by step.

In the 'practice and feedback' segment, teachers can experience what it would be like to sit in a peer's classroom and observe how that peer taught a specific topic. The theme of 'seeing' strongly resonates with similar practices referenced in ⬆Haßler et al. (2018).

6.1.4. Learning from practising

Apart from the pilot schools, teachers have been experiencing the NNP for the first time in the 2022–2023 school year. In the face of novelty, practice is crucial to build familiarity and confidence. In the NNP lessons, the teacher-led activity

sets the foundation and dictates the tone of the lesson. It is where the teacher introduces the skills or strategies, helps the learners understand the mechanism behind the devices, and models the activity. Teachers must have the opportunity to practise, for example, how to deliver an effective teacher-led activity or support their learners when they are struggling to understand a specific topic.

By exposing teachers to situations they regularly encounter in the classroom (for example, through role-playing activities), we can help them refine their teaching skills and develop the knowledge, skills and confidence to deal with classroom challenges related to foundational mathematics. This feature strongly aligns with what ⬆Allier-Gagneur et al. (2020) have gathered from evidence, particularly around enabling teachers to become reflective practitioners and promoting learning based on practice-based cycles of trial and refinement.

6.1.5. Coaching facilitators to build capacity

The peer facilitators have the critical role of leading their peers through a session where learning, exchanging, and practising are expected to occur. To do so, they need to encourage teachers, make them feel comfortable, manage the discussions, be creative, be able to model and ensure that actionable knowledge is being transferred. In our observations, we found that the quality of the TLCs varied according to the facilitators' skills and confidence.

We noticed that simply distributing a comprehensive guide did not suffice — peer facilitators need coaching to fully understand the learning objectives and ensure that they are met, as well as strengthen their facilitation skills. This resonates with previous research (⬆Haßler et al., 2018), highlighting the importance of facilitator preparation. "*Expecting facilitators to conduct workshops without their own extensive prior learning and without scaffolding is simply unrealistic.*" (⬆Haßler et al., 2018, p. 65)

In this study, we met with the facilitators once before the TLC session to review the guide, answer their questions, and give advice. Although it is not viable to have someone coaching every facilitator before each TLC session, we can explore how to incorporate technology into this process to ensure this support is available. For example, the NNP is currently developing and testing a coaching app with different functions, one of which could be dedicated to the peer facilitator and offer coaching in the form of videos, audio clips, or text. Another option would be to send WhatsApp messages or texts to the facilitators with valuable tips and advice. Recent reviews of tech-enabled

teacher professional development could also be reviewed as a source of ideas and best practices for how these tools might best support teachers (literature review: ⬆Hennessy et al., 2022; policy recommendations: ⬆D'Angelo et al., 2022).

6.1.6. Simple and actionable takeaways and strong connections with classroom practice

Whenever we asked teachers about the NNP, all of them could explain its objectives to us and what it is. Teachers appear to have a good understanding of the programme in general — and in theory. However, when observing lessons, we found that that theory barely translated into practice. Teachers talked about how the NNP focuses on skills and strategies without understanding the nature of and differences between skills and strategies, how to identify and teach them, and how to support their learners to develop them. Teachers talked about how the NNP focuses on developing critical thinking without knowing how they could enable that in practice.

Therefore, an effective TLC needs to close the gap between theory and practice and provide teachers with actionable takeaways that can be put into practice inside the classroom immediately. As the TLCs are a continuous model, there is no need for the scope of each session to be overly ambitious; rather, simple learning objectives that are actionable and in which teachers can visualise how they link to what happens in the classroom are effective in ensuring teachers' continuous improvement.

6.2. The structure of effective TLCs

The TLCs undertaken as part of this study and recommended for continued TPD generally adhere to the following structure:

- Welcome, opening prayers, and setting of learning objectives

- Stimulus and discussion

- Practice and feedback

- Planning for progression

- Closing remarks

Each session has clear learning objectives that the facilitator must set out at the beginning and revisit at the end to ensure all teachers meet them.

'**Stimulus and discussion**' is a short oral session focusing on a concern or challenge identified during lesson observations. In this section, facilitators are often instructed to model an activity and engage teachers in discussing it. This section aims to introduce teachers to the key concepts of the session, help them visualise how these concepts translate into practice through the modelling exercise, and ask questions that will lead to more in-depth understanding.

'**Practice and feedback**' encourages teachers to work together to improve their own mathematics knowledge and pedagogy to strengthen teaching and learning of key concepts or strategies in the curriculum. This section takes place in three parts: the first is the introduction to the concepts/strategies, usually through a card-matching activity (matching question and answer cards); the second one entails group work using the Teacher Guide to practise specific skills or strategies needed to answer questions, and the third one is a group sharing of findings.

In '**Planning for progression**', teachers are encouraged to plan for the next five or ten lessons. They are instructed to familiarise themselves with the activities on the next five or ten pages, identify the connections between activities on a page, and think about how learning progresses across the five or ten lessons. There are meaningful connections between the activities on one page of the workbook, as skills and strategies used to answer the first activity can be used to help solve the other activities on the same page. Further, learning on one page develops from learning that has taken place in previous lessons and/or will support learning in subsequent lessons. This section was designed to help teachers recognise the importance of looking for the connections between activities on a page and links between previous and/or future activities in the hope that such planning for progression will be integrated into lesson planning and schemes of work.

7. Conclusion and recommendations

Our research has shed light on a pathway towards optimising teacher continuous professional development to bolster the effectiveness of Malawi's NNP. The TLC model we have developed, characterised by a holistic approach, comprehensive guides, peer modelling, hands-on practice, facilitator coaching, and actionable takeaways, addresses many of the challenges identified in the study and has the potential to assist educators in improving numeracy instruction in Malawi primary schools.

In light of our findings, we make the following recommendations.

1. **Use technology-based solutions to ensure ongoing support to facilitators**

   Considering the key role played by facilitators in guiding effective TLCs, we recommend a continued focus on coaching and capacity-building for this group. To achieve this, we suggest exploring innovative approaches, such as utilising messaging platforms like WhatsApp to provide timely tips and leveraging existing technology resources from the NNP and other relevant programmes to disseminate instructional videos tailored to facilitators' needs. Such a tech-enabled strategy aligns with the evolving landscape of teacher professional development and offers a practical means to enhance facilitator skills and TLC effectiveness.

2. **Create professional incentives for teachers**

   A more refined approach to discussing incentives for teachers to attend TLCs periodically is warranted. While specific incentives, like offering refreshments and stipends, might require a financial commitment from the government, there are alternative strategies to recognising and appreciating teachers' dedication in ways that can boost morale and motivation. We recommend that the NNP establishes a system of meaningful TPD certification that duly acknowledges and rewards teachers who consistently participate in and contribute to TLCs with certificates, plaques, or public recognition. There is evidence to support the effectiveness of practices such as certification. ⬆Haßler et al. (2020, p.11) found that:

> *"A potentially effective incentive may be certification, which was frequently requested by teachers. Certification should be locally accredited, and relevant for career progression."*

Integrate the NNP with other programmes

Given how foundational learning has become a priority for the Government of Malawi, other interventions are being rolled out in primary schools, such as the Building Education Foundations Through Innovation & Technology (BEFIT) and NexGen. These interventions focus on foundational literacy. These programmes aim to improve foundational literacy and numeracy skills and are working towards incorporating educational technology into their models. The NNP currently lacks a strong EdTech component, and we advise seeking partnerships with other programmes to strengthen this component and expand the programme's effectiveness. Coordination between the different programmes is crucial to align curricula, integrate assessments and the technology and interfaces used.

3. Address gaps in mathematics content and pedagogy in the NNP

While we appreciate the benefits of the TLCs in supporting teachers and strengthening their classroom practice, some issues should not be addressed by the TLCs alone. These are more foundational to the programme and require a revision of the components—particularly the Learner Workbooks, the Teacher Guide, and the training. To meet this objective, the NNP has recently partnered with UK-based maths curriculum experts White Rose Education to review the curriculum and the Learner Workbooks for Standard 1. We consider this a crucial step to ensure the programme's effectiveness, as the TLCs are only a part of the mechanism.

EdTech Hub will continue its partnership with the NNP to strengthen the programme's continuous professional development model and advise on implementing technology-driven solutions to address some of the remaining challenges identified by this study. By refining this model, we aim to improve teacher and teaching quality, promote teacher leadership, and bolster learning outcomes and numeracy skills for children in Malawi's primary schools.

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