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An analysis of the Tanzanian curriculum

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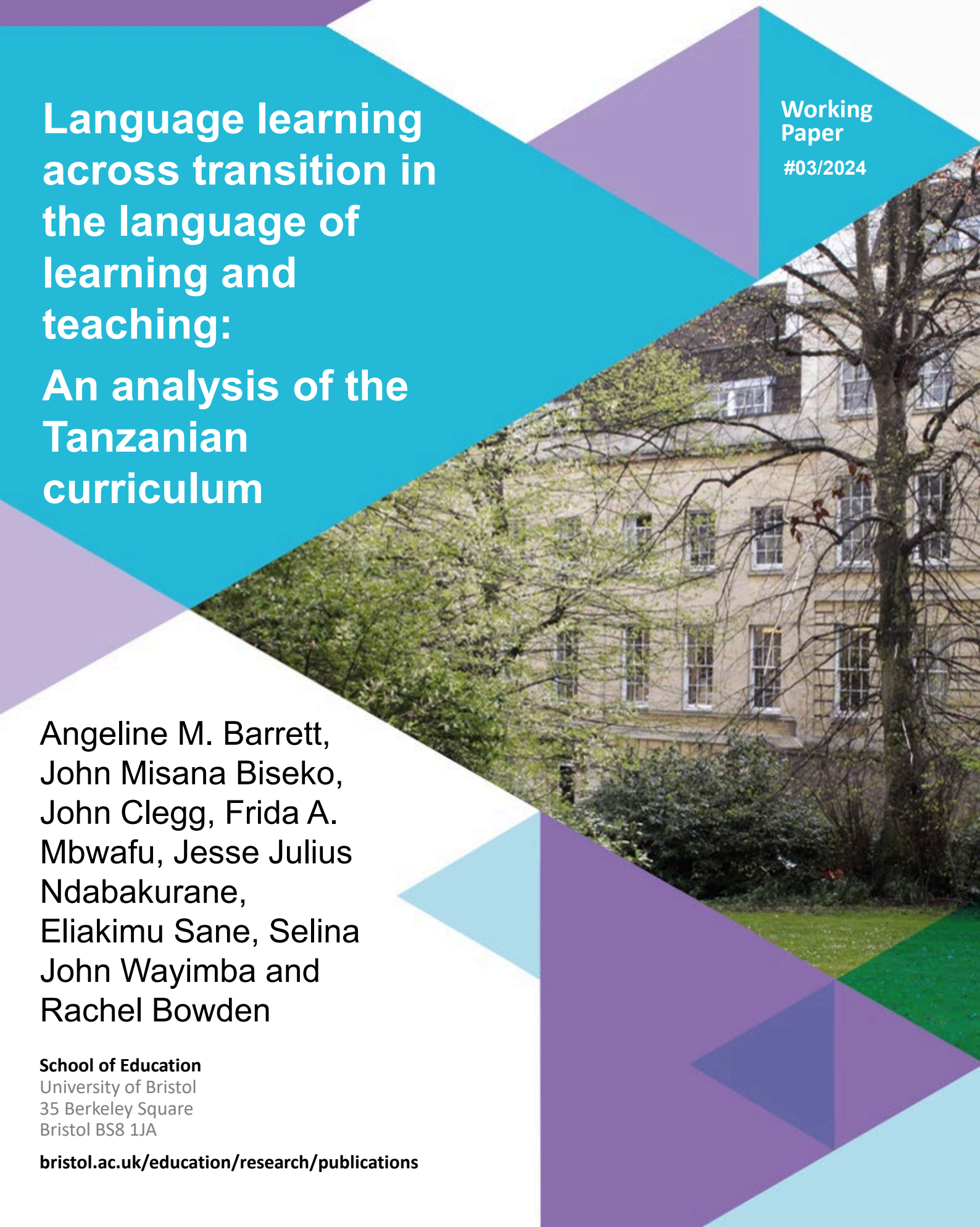

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Abstract

This paper reports on analysis of language skills targeted and assumed within Tanzanian curriculum documents, before and after the introduction of English as the language of learning and teaching (LoLT). In many multilingual contexts, children start their basic education in a familiar language but are later expected to transition to using a new, usually unfamiliar, LoLT. As arguments for extending the use of familiar languages beyond lower primary gain influence, it is instructive to study how curricula prepare and support learners through transition in the LoLT. In Tanzania, transition from using Kiswahili as the main LoLT to using English occurs at the beginning of lower secondary education. Lower secondary education is the point where the curriculum divides into discrete subject disciplines with their own specific academic language practices. Previous research shows that explicit teaching of academic language can reduce the linguistic challenge this creates. Analysis in this research focused on two types of documents that specify and elaborate the curriculum at the national level: syllabi and state authorised textbooks. Language skills targeted in the subject English language within Kiswahili medium primary schools were compared with those expected in the subject biology in the first year of English medium secondary education. Findings indicate a large gap between the reading, writing, talking and listening skills targeted by the specified curriculum for English language and those that are demanded by the biology curriculum. The primary education English curriculum was poorly specified with limited attention to developing the productive skills of writing and discussion, which secondary school curriculum assumes students have mastered. The biology textbook had a high density of technical vocabulary, making it difficult to read, and did not support development of academic language skills. The gap in language skills targeted in upper primary and those expected in lower secondary creates a broken language learning journey, which may be mitigated if science teachers know how to provide scaffolding for language learning. We recommend adjusting the pace of subject curricula to take account of the linguistic challenge of introducing a new LoLT and to allow time for explicit teaching of academic language skills. We also suggest that focusing on key scientific concepts and structures, whilst reducing the number of specific examples students are expected to recall would contribute to reducing the vocabulary range of textbooks.

Contents

List of Abbreviations

BNC	British National Corpus
CEFR	Common European Framework of Reference for Languages
ELSATS	Evaluating Language Supportive Approaches to Teaching at Scale
FKGL	Flesch-Kincaid Grade Level
FTNE	Form Two National Examinations
GSE	Global Scale of English
L1	Familiar or main language
L2	Second language
LoLT	Language of Learning and Teaching
LSTT	Language Supportive Teaching and Textbooks project
PhD	Doctorate in Philosophy
PO-RALG	President's Office – Regional and Local Government
PSLE	Primary School Leaving Examination
SFL	Systemic Functional Linguistics
TIE	Tanzania Institute of Education
UNESCO	United Nations Educational, Scientific and Cultural Organisation

About the authors

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1. Introduction

In many multilingual nations, children start their basic education in a familiar language that is spoken by the majority in their local community. However, at some point during the basic education cycle they transition to the use of a so-called international language. Across Africa, with the sole exception of South Africa, the language of learning and teaching (LoLT) in lower secondary education is officially one of either English, French, Portuguese or standard Arabic. Most commonly transition in LoLT occurs in the first three or four years of primary school but, in a small number of countries, a new LoLT is introduced in upper primary or lower secondary (Trudell, 2016). This study is focused on Tanzanian Mainland, where a new LoLT is introduced at the lower secondary level.

Research evidence has consistently shown that using an unfamiliar language for LoLT impacts negatively on school enrolments and learning (Pinnock & Vijayakumar, 2009; Heugh et al., 2017). As those already disadvantaged by poverty, location or gender, are disproportionately affected (e.g. Benson & Wong, 2017; Milligan & Adamson, 2022), language transition is an issue of social justice (Milligan, 2022). Swayed by the research evidence, international policy influencers, such as British Council (Simpson, 2019), the World Bank (2021) and UNESCO (Trudell, 2023), recommend extending the use a familiar language beyond early years education. There are signs that national governments are prepared to take up such recommendations. For example, in 2022, Nigeria, declared a policy of mother tongue education through all six years of primary education. LoLT transition at the lower secondary education, however, is not straightforward. Transition to secondary education is already a point of vulnerability for drop-out with children from low income and rural households most likely to exit formal education at this point (Edwards et al., 2014). It also the point where the curriculum begins to be organised into discrete subject disciplines, through which learners are introduced into the forms of language used in academic contexts (i.e. academic registers). It is, therefore, instructive to study how language transition is planned for within national education systems that have a long history of LoLT transition in the lower secondary phase of education.

In Tanzania Mainland[1], the national language, Kiswahili, which is also the most widely spoken language, is the LoLT in nearly all government primary schools, whilst English is the LoLT for most subjects[2] from the first year of lower secondary school. Previous research has demonstrated that this transition to a LoLT, which for most learners is an unfamiliar language (Qorro, 2009), is challenging for both students and teachers and impacts negatively on learning (Brock-Utne et al., 2006; Tibategeza, 2010). This study focuses on how language learning is planned for within the formal curriculum around the point of transition. It does so by analysing syllabus documents and textbooks for subject English at the upper primary level and a science subject, Biology, at the lower secondary level. At the time of writing, a revised curriculum is being created for Tanzania and it is hoped this research will inform the development and design of the new curriculum.

[1] The United Republic of Tanzania comprises of Mainland Tanzania and the semi-autonomous province, Zanzibar. Zanzibar has its own primary education system, within which English is the LoLT for some subjects only from Year 5 onwards. Zanzibar's primary curriculum is not included in the analysis presented here.

[2] Kiswahili continues as the LoLT for two subjects, Kiswahili and Religion.

1.2 Research question

The research question guiding the analysis was:

> What curriculum changes are needed to align language competencies targeted in English and language demands of lower secondary science?

The science curriculum for lower secondary is delivered as three separate subjects, Biology, Chemistry and Physics. Each has its own syllabus, textbook, timetabled lessons and National Examination in Form Two. Biology was selected for study because it is often regarded as the most linguistically demanding school science subject (Lo & Fung, 2020), particularly with respect to writing. Two types of documents were analysed for each subject, the syllabus and the learner's textbook.

1.3 Key concepts

1.3.1 Specified curriculum

Curricula can be broken down into three stages, the intended, practiced and achieved stages, as set out by Bheki Khoza and Fomunyam (2021). The intended stage is the curriculum as specified in formal documents. These are supposed to guide how teachers implement or enact the curriculum, which is the practiced stage, as well as the design and content of assessment. The achieved, or received curriculum is about experiences of students and what they learn. This study is focused on the intended curriculum. An accompanying study is focused on teachers' practices and students experiences of language transition. Zelime and Deutschmann (2016) identify another curriculum stage, which is the ideological level of more general socio-political aspirations, often expressed in high level policy documents or national curriculum frameworks. This has in the past and continues to be considerable debate around language ideology within Tanzanian education policy (Mapunda, 2022). However, in this report we focus on the intended curriculum as specified in the documents that are intended for use by teachers and students to guide the subject content and learning activities in the classrooms of government-funded schools. Henceforth, we shall use the term *specified curriculum* or *curriculum documents* to refer to these documents.

In Tanzania, documents that specify the curriculum are published by the Tanzania Institute of Education (TIE). The specific documents analysed were the syllabus and textbook for Biology in Form I, the first year of secondary education (Year 8 of the basic education cycle) and the syllabus and textbook for English in Standard 7, the last year of primary education (Year 7 of basic education cycle) [3]. For one part of the analysis, we also looked at the textbook for Form I English and the textbook for Baseline. Baseline is an orientation programme delivered to students in government-funded secondary schools by subject teachers over the first six weeks of Form I.

1.3.2 Academic language practices in secondary education

Our analysis focuses on how language skills are targeted within key curriculum documents across the transition from Kiswahili medium primary education to English medium secondary education. The language skills in which we are interested encompass reception and production skills and written reception and production skills, that is listening, speaking, reading and writing. Introducing a new LoLT at any stage of the basic education cycle is far from straightforward (Simpson, 2019) but the transition from primary to secondary education

[3] Mainland Tanzania plans to move to a new system in 2024 with a six-year rather than seven-year primary education system, so English will start to be used as LoLT from the seventh year of fulltime basic education.

presents its own set of challenges. By lower secondary education, the school curriculum is divided into discrete subject disciplines delivered by subject specialist teachers. These disciplines have their own distinctive ways of using language (registers), styles of writing (genres) and specialised vocabularies. Communication in some subjects is multimodal, with spoken or written language used in combination with other semiotic forms, such as chemical symbols or scientific diagrams. Classroom talk may also follow particular patterns. We treat all of these as language practices, consistent with our view of language as social practice contingent on speakers and contexts (elaborated in, Bowden and Barrett, 2022). Part of the work of secondary education is to gradually apprentice learners into the academic language practices used to share, debate and create knowledge within the various subject disciplines (Christie, 2012). Even in monolingual education systems, where a single dominant, widely spoken language is used as the LoLT across all educational phases, learning subjects in secondary education entails learning the academic language practices of those subjects (Daniels, 2016; Lemke, 1990). Hence, the idea of academic language practices, which we elaborate in Section 2, is central to the analysis and discussion in this report.

1.4 Background to this research study

The research was conducted as part of a research project, *Evaluating Language Supportive Approaches to Transition at Scale* (ELSATS), which consists of four studies including this one. The first study was an international literature review (Bowden & Barrett, 2022), which identified a need for system wide planning for language transition, including designing curriculum, learning resources and teacher education to meet the needs of second language learners (see also, Schroeder et al., 2022). A small scale action research study conducted in Addis Ababa integrated multilingual and language supportive approaches into a science course taken by student teachers on a B.Sc. programme (Atnafu et al., 2023). This report is concerned with analysis of the specified curriculum around the point of transition in LoLT in Tanzania Mainland, as set out above. The final study was conducted in secondary schools in Tanzania (Mainland and Zanzibar) and researched science teachers practices, knowledge and beliefs with respect to language learning within the subject Biology (the practiced stage of curriculum) as well as students experiences of transition and knowledge of scientific vocabulary (the achieved curriculum).

The research design is, necessarily, influenced by the positionality of team members and so, we share our previous experience of working with the specified curriculum in Tanzania. Whilst our previous experience as educators, may be viewed as a source of bias, it is also a source of expertise that has informed decision-making with respect to research design. Five of the eight authors were educated in Tanzanian government schools. Six of us have been employed as teachers in Tanzanian government schools, in which role we were daily engaged with interpreting and implementing the national curriculum. Five of us have in the past or currently work as teacher educators in Tanzania, preparing teachers to deliver the current curriculum, whilst two team members have worked as teacher trainers internationally, delivering continuing professional development on English language teaching across a range of country contexts. Three team members have been involved in writing and reviewing curriculum documents for TIE, although none of us were directly involved in developing the documents that were analysed for this research. The ELSATS project builds on previous projects in which four team members were involved. The most relevant of these to this curriculum analysis study is the *Language Supportive Teaching and Textbooks* (LSTT) project, a collaboration with TIE. This research found that the textbooks available at the time, which were produced by independent publishers, were hard to read with long sentences and a high frequency of obscure or technical words (Barrett, Mtana et al., 2014). It went on to develop three prototype textbooks for Form I learners, including a Biology

textbook (LSTT, 2015), designed to be easy to read and with activities to develop English language skills (Mtana and O-saki, 2017). This study builds on and expands the LSTT research by looking at syllabi as well as textbooks and by focusing on continuity of language learning across the transition from primary to secondary school. It also brings it up to date by analysing textbooks that are currently authorised for use in secondary schools, which were published by TIE between 2020 and 2021. In Section 5 of this report, we will refer to the LSTT prototype textbook for Biology as an example of a textbook that was designed to address the needs of second language learners, transitioning to Form I from Kiswahili medium primary schools.

1.5 Section conclusion

The next section reviews established literature on academic language skills and two types of transition: transition from primary to secondary education and language transition. Various methods were used to analyse the curriculum and these are outlined in Section 3. Findings are presented in Section 4 and discussed in Section 5. The concluding section sets out makes recommendations for curriculum and textbook design within Tanzania and more generally within multilingual education systems, as well as identifying priorities for further research.

2. Literature review on language transition and curriculum

This section takes a look at the language demands of science subjects in lower secondary education. It establishes some key concepts and terminology that inform the analysis within this study. The first section introduces the concept of epistemic justice to frame how language in education policies and curriculum design contribute to educational inequity. This then becomes a rationale to draw on literature from within the systemic functional linguistics (SFL) tradition. SFL is the study of how linguistic choices available for speech and writing depend on social context. It seeks to make explicit the system of linguistic rules, known as the register, that, when hidden, operate to hinder the participation of certain groups, such as lower classes or minoritised ethnic groups, within social institutions. The second sub-section turns to the context of secondary school science and draws on SFL research to describes the registers that characterise text and talk. SFL researchers argue that learners benefit from explicit teaching of the academic register, most especially second language learners. So, the third sub-section briefly sets out some strategies for explicit teaching of scientific language. In the last sub-section, the focus broadens beyond science education to highlight the importance of planning for language learning across the transition from primary to secondary education.

2.1 Language and curriculum as an issue of epistemic justice

In a review of successful multilingual education (MLE) programmes, Schroeder et al. (2022) identified factors associated with success. These included a curriculum and teaching and learning materials designed to support multilingual learners. Yet, in many contexts where there is a transition in the language of instruction, curriculum as well as teaching and learning materials are designed as if learners were already fluent in the new LoLT and had been using it as the LoLT up until that point (Barrett, Mtana, et al., 2014; Clegg, 2021; Milligan et al., 2016). This is a matter of epistemic justice (Milligan, 2022) because it has implications for learners' ability to access the specified curriculum. Epistemic justice in education concerns recognition of the knowledge and knowledge practices that learners bring from their home, community and earlier education. It also concerns the ways that schooling introduces learners to knowledge and knowledge practices that expand their horizons and future opportunities. How the specified curriculum targets the development of academic language practices is central to this second aspect of epistemic justice.

Young and Muller (2013) use the phrase 'powerful knowledge' to refer to specialised knowledge that is constructed and revised over time by disciplinary or scientific communities following systematic, accountable methods of inquiry. In lower secondary education, this is the knowledge acquired through the study of subject disciplines such as mathematics, geography, literature, music and science. As students progress through secondary education, they are inducted into the theoretical 'uncommonsense' (Christie, 2012: 149) knowledge of the different disciplines they study. Wheelahan argues that powerful knowledge is a matter of social justice because:

> it provides access to society's conversation about itself. … Students need access to knowledge if they are to participate in this conversation. .. they need access to 'disciplinarity' or disciplinary styles of reasoning so that they understand how knowledge is used and the broad criteria that need to be applied in evaluating the validity of arguments. (Wheelahan, 2012:2)

Disciplinary knowledge is not just learned through language. It is constituted through language practices, including, in some disciplines, multimodal literacies (for example, interpreting and creating graphs). As Daniels (2016) succinctly summarised, 'students do not learn science through talk, they learn to talk science'. We would add that they also learn to read, write and do science. In other words, disciplinary knowledge is synonymous with disciplinary practices of inquiry, that include but are not limited to academic language practices. Moving successfully through lower secondary into upper secondary involves mastering academic language skills for abstraction, technicality and argument.

The two forms of epistemic justice - recognition of learners' world view and access to disciplinary knowledge - are linked. Learning is a process of social interaction that builds on learners' pre-existing knowledge, extending and transforming it through a structured process organised by the teacher (Daniels, 2016). Allowing students to process new information in the light of what they already know is an essential step in the learning process. For learners navigating a transition to a new unfamiliar LoLT, this means expressing knowledge using the language practices of the previous LoLT or language practices developed in communities outside of school. For example, students who belong to indigenous rural communities often have detailed knowledge of the flora and fauna in their environment (see for example, Zelime & Deutschmann, 2019). This knowledge is the starting point from which they make sense of the subject Biology they encounter in school. Hence, allowing learners in secondary school to express their prior knowledge and understanding through exploratory talk in a familiar language is an important step in the learning process (Setati et al., 2002).

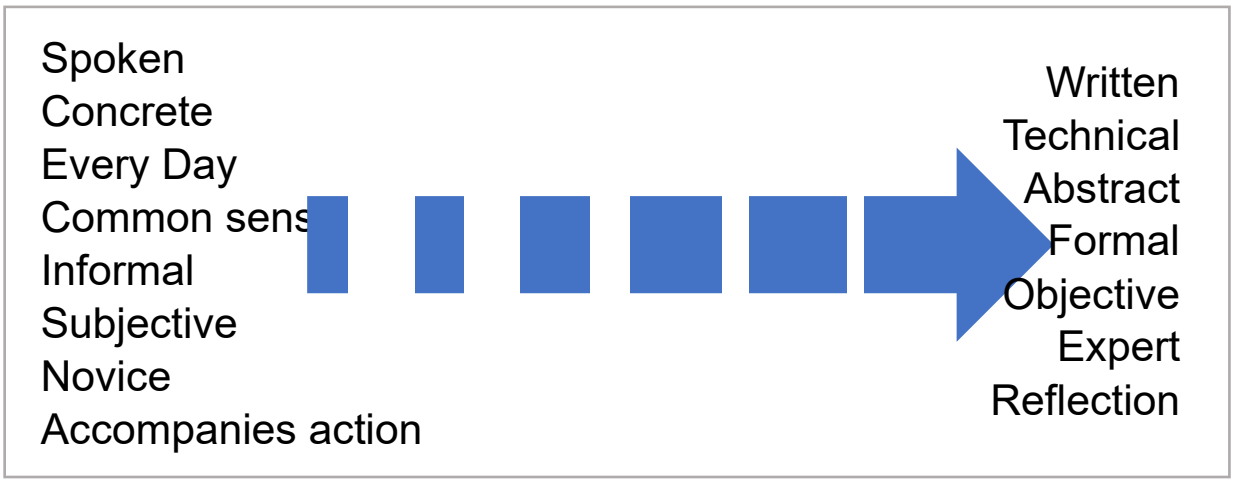
Halliday recognised the relationship between knowledge and language when he said, 'language is the essential condition of knowing, the process by which experience becomes knowledge' (Halliday, 1993:94). He developed systemic functional linguistics (SFL) to explore how grammar creates a system of choices for making meaning and how language is used to perform different functions in various social contexts. His interest in the relationship between grammar and social context arose from his observation that hidden, overly restrictive, linguistic rules were used to exclude people from different classes and cultures from social institutions, such as higher education (Christie, 2008). SFL research sets out to explicitly describe academic language practices, hence making them accessible to learners from diverse cultural backgrounds. More recently, SFL has been taken up by researchers concerned with inclusion of multilingual leaners (Harman, 2017). In the next section, we draw on insights from research that has applied SFL to describe the features of spoken, written and multimodal texts which learners are expected to interpret and produce within secondary school science.

2.2 Language of secondary school science

2.2.1 Registers of secondary school science

Academic language practices engage skills of oral and written reception and production, i.e. listening, talking, reading and writing. The language practices, that is the grammatical patterns and selection of vocabulary, of academic and professional contexts differ from those of social communication. This is captured by the concept of register. If we imagine register as a continuum (see figure 2.1), then at one extreme is language that accompanies action and is often less important than the action for conveying meaning. An example might be a football player waving and shouting for a team mate to pass her the ball. At the other extreme of the continuum, written language is the main means of communication, as for example, in an academic paper.

Figure 2.1: The register continuum



Registers are associated with social contexts. Talk in lower secondary education typically alternates between formal and informal registers, as teachers seek to draw connections between learners' experience and subject content (Halliday, 1993). In textbooks, the register tends to become more formal with progression from primary education through secondary education to higher education (Guo & Yao, 2021). This progression in formality and grammatical complexity is illustrated by the extracts, in Box 2.1 and Box 2.2, taken from science textbooks designed for use in South African schools in Year 7 and Year 10 respectively.

Box 2.1: Extract from Year 7 science textbook designed for schools in South Africa

> Flower petals are usually the brightly coloured parts of the flower. They attract pollinators, such as insects and birds and also bats and mice. We will look more at pollination a bit later.
>
> (Siyavula, n.d.b p. 82)

Box 2.2 Extract from Year 10 life sciences textbook designed for schools in South Africa

> There is a close inter-relationship between transpiration and leaf structure. The rate at which transpiration occurs refers to the amount of water lost by plants over a given time period. Plants regulate the rate of transpiration by opening and closing of stomata (Figure 6.15).
>
> Siyavula, n.d.a, p. 170

In lower secondary education, the curriculum divides into discrete subjects. Each subject discipline has its own set of academic language practices that support its distinctive knowledge practices and methods of inquiry. Secondary school science apprentices students into reproducing well-established foundational principles and procedures including through acquiring language practices for expressing abstracted principles (Christie & Derewianka, 2010). Christie (2012) observes that secondary school scientific language practices are distinguished by four main characteristics:

i. precise use of technical vocabulary;
ii. grammatical patterns that avoid attributing agency through heavy use of nouns and the passive tense;
iii. reading and writing longer pieces of text that follow certain conventions of presentation and style, known as genres; and

iv. interpreting and creating multimodal texts that include scientific diagrams, graphs, tables and equations.

We discuss each of these features in turn.

2.2.2 Technical vocabulary

Perhaps the most obvious feature of scientific language practices is the density of technical terms. Secondary school science textbooks pay careful attention to introducing technical vocabulary, which students are then expected to use with precision (Christie, 2012). Consider the example in Box 2.3, taken from a Year 8 (second year of lower secondary) textbook compatible with the National Curriculum in South Africa. To explain the process of photosynthesis, it uses several other technical terms (chloroplasts, cells, stems, pigments, chlorophyll, molecules, radiant energy, chemical potential education). Two of the terms (radiant energy, chemical potential energy) have been introduced in preceding text, supported by images. Three other terms (chloroplasts, pigments, chlorophyll), emphasised using bold text, make a first appearance in this text. Two of these are very specific to Biology (chloroplasts and chlorophyll) and these are explained within the text.

Box 2.3: Extract from Year 8 science textbook designed for schools in South Africa

> Photosynthesis takes place in small structures called **chloroplasts**, which are inside the cells of the leaves and stems of green plants. Inside the chloroplasts are green **pigments** called **chlorophyll**. This is what gives plants their green colour. Photosynthesis is the process in which chlorophyll molecules absorb the radiant energy from the sun and transfers it into chemical potential energy. The only function of chlorophyll is to trap the sunlight energy; chlorophyll is not produced or used up during photosynthesis.
>
> (**emphasis** in the original; highlights have been added, Siyavula, n.d.c:5)

In previous research analysing Form I textbooks in Tanzania, we found that attention to technical subject specific vocabulary is even more marked within textbooks that have been designed for second language learners, including those designed for African contexts (Barrett, Mtana, et al., 2014).

2.2.3 Grammar that avoids attributing agency

Box 2.4: Extract from Year 8 science textbook designed for schools in England

> Each pollen grain contacts a male gamete (sex cell). Pollen grains ripen inside anthers, which then split open. The grains are carried away and transferred to the stigmas of other flowers. This is called **pollination** and is carried out by animals, wind or water. Flowers have different structures depending on how they are pollinated.
>
> (**emphasis** in the original, Levesley et al., 2014:28)

The last sentence in Box 2.4 shows how agency is removed through use of the passive voice and heavy use of nouns. The second and third sentence in the second paragraph could be written more simply using one sentence in the active voice as *Animals, wind or rain carry the grains of pollen to the stigmas of other flowers.* However, this would fail to introduce the key technical term 'pollination'. Agency is removed from the animals, wind and rain in three ways: first, through use of the passive voice ('The grains are carried away …', '… is carried out by'); second, through nominalisation ('**Pollination** is carried out by'); and lastly, in the third paragraph by creation of a noun group ('animal pollinators' rather than

'animals that pollinate'). All three of these – passive voice, nominalisation and noun groups – are typical features of scientific texts found in lower secondary education.

2.2.4 Scientific genres

Genre refers to widely applicable, predictable and relatively stable styles of writing. Polias (2016) in his book '*Apprenticing Students in Science*' identifies 13 different genres of scientific writing that secondary school students are expected to read and produce. He relates these to five scientific processes (see table 2.1 below). Some genres may include the use of figures or images. Secondary school science textbooks always include figures, such as scientific diagrams, graphs, tables and equations, including the specialised symbols of chemistry (Christie, 2012; Ge et al., 2018; Liu, 2018). Arguably, the multimodal complexity of science classrooms has increased with the expanding availability of digital technologies and the internet. Students are expected to access and interpret resources such as videos of animations and demonstrations, virtual laboratories or online dictionaries (He & Forey, 2018).

Table 2.1 The genres of writing constituting school science (based on Polias, 2016:12)

Scientific process	Genres
doing things scientifically	Experiments and Protocols Laboratory Reports Investigations
describing and organising	Descriptions Comparisons Components Classifications
explaining phenomena	***temporal*** *– Sequential Explanations* ***non-temporal*** - Factorial/Consequential Explanations ***non-temporal*** – Theoretical Explanations
arguing	Arguments Discussions
acknowledging scientists	Biographies

2.3 Explicit teaching of scientific language

SFL researchers, such as Christie (2008, 2012), argue that it is not enough to assume that children and young people will 'pick up' scientific genres simply through exposure to them. Rather they need to be explicitly taught the structure and organisation of subject specific genres. Explicit teaching of academic language is even more of an imperative for second language learners (Lo et al., 2018). Polias (2016), drawing mainly on experience from Hong Kong and Australia, sets out three ways in which teachers can explicitly support academic language learning, which he calls macro-scaffolding, meso-scaffolding and micro-scaffolding.

Macro-scaffolding concerns organisation of the curriculum, so that learners are introduced to progressively more technical language and more complex genres (see table 2.2). This is a process that a teacher may plan across a series of lessons and that curriculum designers can plan across grade levels. 'Meso-scaffolding' (2016:82) concerns the design and sequencing of learning activities within a lesson. It is the sequencing of learning activities so that students move from less formal contingent interactions, such as unstructured discussion in groups, to more planned activities that require use of technical language, such as groups giving a formal presentation. It is relevant to the design of activities and exercises that are presented within textbooks. Finally, 'micro-scaffolding' refers to classroom dialogue in which

the teacher, often opportunistically, uses questions and prompts to move students from a less formal to a more formal description or statement, within which scientific terms are used with precision. This concerns classroom talk and is less relevant to analysis of the specified curriculum.

Table 2.2: A sample macro-scaffold (based on Polias, 2016:79)

Sequence	Genre and register	Example text
1	Experiment	Record and compare any colour changes
2	Procedural Recount	We recorded and compared any colour changes. Any colour changes were recorded and compared.
3	Sequential Explanation with human agency	We record and compare any colour changes. Any colour changes are recorded and compared.
4	Sequential explanation without human agency	The carbohydrates are sent to different parts of the plant and oxygen is given off through the stomata.

2.4 Academic language across the transition from primary to secondary education

Transition from primary to secondary education is a point of vulnerability, particularly for students from low socio-economic backgrounds. In low income contexts of the Global South, it is a point at which many children leave the formal education system (Edwards et al., 2014). This includes Tanzania, where around 25% of primary graduates do not start secondary school (calculated from basic education statistics published by PO-RALG, 2023). Research has associated various student and school characteristics with vulnerability to drop out, such as longer journey from home to school or weaker teacher-student relations than those in primary school (Ávila Francés et al., 2022; González-Rodríguez et al., 2019).

Curriculum overload, can also exacerbate vulnerability to drop-out (Beatty & Pritchett, 2012; OECD, 2020). Curriculum overload in the primary cycle may mean that children have failed to develop fundamental skills in reading and writing needed for secondary school. Overload in secondary education can lead to a sense of feeling overwhelmed, generating stress for students and teachers (OECD, 2020). However, coherent curriculum design can avoid overload. A recent OECD report (2020) described a coherent curriculum as one where learning objectives are planned across subjects, across grades and across educational phases and one where objectives are appropriate to age and grade of the learners. One aspect of a coherent curriculum is explicit planning and support for academic language learning. However, little attention is given to language development either in the literature on primary to secondary transition or in the literature on curriculum coherence.

Writing from a SFL perspective, Christie (2012:190) describes the period of around late primary to early secondary as one of two “phases of greatest pressure and challenge” for language learning across the schooling cycle. (The first is the point of entry to primary education.) Late primary/early secondary is the point at which children are introduced to language practices for abstraction, interpretation and evaluation. Christie (*Ibid.*) is drawing on 25 years of research on children’s writing, mainly conducted in Australia. However, she claims that research conducted by herself and others in Indonesia and with Spanish speakers, suggests that first and second language learners follow a similar language developmental trajectory.

We only found one study that looked at progression in academic language for second language learners across the transition from primary to secondary education. Guo and Yao (2021) analysed the vocabulary and grammar targeted within textbooks for English for second language learners in Hong Kong. They found that each new educational phase introduced a new language challenge. Texts for use in upper primary (Years 4 – 6) were concerned with direct experience and close to spoken language or dialogue; lower secondary texts were concerned with reporting; and upper secondary texts were concerned with expounding, exploring and recommending.

As a transition in LoLT multiplies linguistic challenge for learners, it may be expected that the subject learning challenge students can manage is reduced. This is supported by empirical studies conducted in Tanzania, which have found that the use of English as LoLT in secondary education presents considerable linguistic demand that generates stress for learners and compounds the challenges of transition to secondary education (Adamson, 2022; Brock-Utne et al., 2010; Joyce-Gibbons et al., 2018; Vuzo, 2018). With respect to science learning, linguistic demands of English LoLT have been found to inhibit participation and learning in lower secondary science classrooms (Mkimbili & Ødegaard, 2019, 2020; Mwinsheikhe, 2009). In Hong Kong, where some learners enter English Medium secondary schools following Chinese Medium primary education, a meta-analysis (Lo & Lo, 2014) found a consistent pattern of relative underachievement in subject learning compared to learners, who continued with Chinese medium secondary education.

Cummins (1980) proposed that language skills already developed in a familiar language (L1) are more readily attained in a second language (L2). So, for example, a child, who has attained basic literacy in L1, will more quickly acquire it in L2 than a child learning to read and write for the first time using their L2. The idea of cross-linguistic transfer is supported by empirical studies, which show that higher levels of L1 literacy correlate with higher levels of L2 literacy (Bialystok, 2001). This provides a strong justification for a late transition, whereby L1 is the main LoLT up to the end of primary or into lower secondary (Bunyi & Schroeder, 2017). It also provides a justification for, wherever possible, continuing to develop academic language practices in L1 even after the introduction of L2.

2.5 Section conclusion

The review of literature in this section points to two key qualities that we would expect to see in curriculum and textbooks designed to support students through late language transition. The first is curriculum coherence which involves a balance between the pace at which subject content and practices are introduced and the pace at which students are expected to master the related academic language practices. The second feature is explicit teaching of academic language through macro-scaffolding and micro-scaffolding. The next section sets out the methodology and methods of our analysis.

3. Methodology

This section sets out the methodology and methods used in the analysis of the Tanzanian specified curriculum. The research consisted of two studies and these are briefly introduced in the next sub-section. The second sub-section explains the rationale behind the selection of subjects and documents for analysis and sets out the document sample used in each of the two subjects. The third and fourth sub-sections outline the methods used within each Study 1 and 2 respectively. Limitations of the research are outlined in the fifth sub-section.

3.1 Overview of research design

The overarching question research question, given in section 1.2, was approached through two studies. Study 1 was guided by the question:

a. What curriculum changes are needed to align language competencies targeted in English and language demands of lower secondary science?

To address research question 2a, we compared the language skills that are explicitly articulated or assumed within the Form I Biology curriculum with learning objectives targeted by the Standard 7 English curriculum for Kiswahili medium schools.

Study 2 was addressed to the research question:

b. What are the challenges and opportunities for developing language supportive teaching and learning materials in Tanzania?

Analysis to address research question 2b centred on the TIE Form I Biology textbook and included measurement of its readability, vocabulary range and inspection of key features that support interpretation of the text.

3.2 Selecting the subject and documents

Both studies focus on Biology. The science curriculum for lower secondary is delivered as three separate subjects, Biology, Chemistry and Physics. Selecting just one science subject allowed for more comprehensive and detailed analysis than would be possible if we attempted all three. Biology was chosen because previous analysis of Form I science textbooks in Tanzania (Barrett, Mtana, et al., 2014) suggested that it is the most linguistically challenging science subject.

Both studies are concerned with the key documents that specify the curriculum (see section 1.3). These are produced centrally and intended to guide teaching and learning in classrooms throughout an education system. In Tanzania Mainland, the curriculum is specified in detail for each subject through two main documents, the syllabus and the state-authorised textbook, both of which are published by TIE. TIE is a parastatal organisation that reports to the Ministry of Education, Science and Technology. Among other functions, it acts as the national curriculum authority. Only textbooks published by TIE are allowable for use by students in government-funded secondary schools. Teachers can draw on other textbooks as reference books to inform and enhance their teaching. In this context, the TIE textbooks serve as a very detailed specification of the curriculum, providing guidance not only on content to be covered but also the type of learning activities, including formative assessment practices, that are expected in the classroom. It is for this reason that Study 2 focuses on the Biology textbook.

3.2.1 Study 1 document sample

Study 1 compares across Biology and English Language subjects. The main part of the analysis compared the Biology Syllabus (Tanzania Institute of Education, 2005) and TIE textbook (Tanzania Institute of Education, 2021) for Form I (the first year of secondary education and Year 8 of basic education) with the English Language syllabus (Tanzania Institute of Education, 2019) and TIE textbook (Tanzania Institute of Education, 2020) for Standard 7 Kiswahili medium schools. This selection allowed us to compare skills that students were expected to develop by the end of primary education with those needed for learning Biology in the first year of secondary school. Hence the study focused on curriculum coherence with respect to language learning across the primary to secondary transition (see section 2.4).

Aware that how the curriculum is interpreted by teachers is influenced by assessment, se also reviewed national examination taken two years into the lower secondary phase, the Form Two National Examinations (FTNE).

Table 3.1: Study 1 document sample

Curriculum subject:	**Biology**	**English Language**
Main focus of analysis:	• Biology Form I (Year 8) TIE textbook • Biology Form I (Year 8) Syllabus	• English Language Standard 7 textbook • English Language Standard 7 Syllabus for Kiswahili Medium Schools
Other documents:	• FTNE past papers for years 2015, 2016 and 2017.	• English Language Form I (Year 8) TIE textbook • FTNE past papers for years 2015, 2016 and 2019

Within document sampling

As well as sample curriculum documents, to make the analysis manageable, we also had to select sample sections to analyse from within the documents. For Form I Biology, we were interested in sections of the syllabus that are most likely to be delivered near the beginning of the school year. Hence, we focused on the first topic, titled 'Introducing Biology', and the sub-topic 'Basic concepts and terminology of Biology'. This corresponded to the first chapter of the textbook, titled 'Introduction to Biology' (Tanzania Institute of Education, 2021:1-13).

To ascertain the skills targeted within Standard 7 English Language subject, we reviewed the entire Standard 7 syllabus but focused on benchmarks at the average and good level. The English Language Standard 7 TIE textbook covered the same skills within each chapter, and so we would expect them to progress in difficulty through the book. So, for example, reading passages that students are expected to read in later chapters should have greater complexity than those in the first chapter. For this reason, we focused on the last unit of the book.

Table 3.2 Study 1: within document samples

	Biology – Form I (Year 8)	English Language – Standard 7

Syllabus	Topic 1 'Introducing Biology', sub-topic 1.1 'Basic concepts and terminology of Biology'(pp. 1-2)	Standard 7 (pp. 59-74)
TIE textbook	Chapter 1: Introduction to Biology (pp. 1-13)	Unit 16: School Ceremony (pp. 122-129)

3.2.2 Document sample for study 2

Study 2 is an analysis of one curriculum document, the Biology Textbook (Tanzania Institute of Education, 2021) published by TIE for use by Form I students, *Biology for Secondary Schools: Student's Book Form One*. For some parts of the analysis, the whole textbook was used. For other parts, sampling was necessary. Details of within document sampling are included in section 3.4, alongside the account of methods. One part of the analysis compared the TIE Biology Form I textbook with four other TIE textbooks for Form I, to provide an indication of how the readability of the Biology textbook compared other subjects and with subject English at the Form I level. One of these was the textbook that was designed to support Baseline, the six week language orientation programme at the beginning of Form I.

Table 3.3: Study 2 document sample

Main focus of analysis:	• Biology Form I TIE textbook
Other documents:	• Geography Form I TIE textbook • History Form I TIE textbook • English Language Form I TIE textbook • Baseline TIE textbook

3.3 Study 1: Methods of analysis

Two qualitative methods were used to compare the language skills demanded by the Form I Biology with language skills targeted in English.

1. Inductive comparison of the language expectations in Biology Form I and skills targeted in English Language Standard 7 for Kiswahili medium schools; and
2. Comparison of Biology Form I and English Language Standard 7 with Common European Framework of Reference for languages (CEFR).

As both methods were dependent on the researchers judgement, this allowed for triangulation. However, each method also generated insights not available through the other.

3.3.1 Inductive comparison

The first method was an inductive comparison of the language expectations in Biology and skills targeted in English. The learning activities specified or necessary to engage with the Form I syllabus and TIE textbook were used to draw up a list of expected language skills. These were then compared with skills targeted within specified competences of the Standard 7 English Language syllabus for Kiswahili medium schools and the skills developed through exercises and activities in the English Language Standard 7 TIE textbook.

Syllabi for secondary education in Tanzania set out specific learning objectives for each topic. In the primary school syllabus, the term 'specific competencies' is used rather than learning objectives. In the secondary syllabus guidance is provided on teaching and learning activities and assessment criteria and these were use to infer the language skills for speaking, listening, reading, and writing that were demanded of learners. In addition, we inspected the activities and exercises within the textbook. The TIE primary school syllabus

uses the term ‘competencies’ rather than learning objectives. Various activities, which students are expected to perform, are detailed against each specific competence. Description of the specific competences is not very detailed in the English Language syllabus, and so, we relied on the TIE English Language Standard textbook for elaboration of the competencies.

3.3.2 Comparison with CEFR descriptors

Second, the language skills expectations of both English Standard 7 and Biology Form I were matched to the level descriptors in the Common European Framework of Reference for languages (CEFR). The CEFR for languages served as an external scale with which to compare language skills explicit or assumed in the Biology and English curriculum. The CEFR was designed to guide teaching, learning and assessment of languages within the European Union. It provides a common set of reference levels, each described in detail. It has the advantage of being a widely used and widely recognised framework designed for second language learners. We used an adapted version, the Global Scale of English (GSE) (Pearson, 2022a, 2022b). Pearson has elaborated the Global Scale of English through a set of descriptors for young learners (Pearson, 2022b), which we used for analysis of the English Standard 7 curriculum. It has also created a version for academic learners (Pearson, 2022a), which we applied to the Biology Form I curriculum.

Like the inductive comparison, we only used benchmarks for average and good performance in the primary English syllabus when comparing with the GSE for young learners.

3.3.3 Quantitative indicators of readability

Applied linguists have developed tools for analysing text and measures of readability. Quantitative analysis of the readability of the texts provides an indication of the reading skills expected. We used the Compleat Lexical Tutor (www.lextutor.ca/), to generate different indicators of readability of the comprehension passages that appear in the Standard 7 English Language textbook and for text in the Biology Form I textbook. Compleat Lexical Tutor produces a range of indicators of readability. We used three well established indicators. These were the Flesch-Kincaid Grade Level (FKGL); the vocabulary range and CEFR level. CEFR levels have been introduced above. We now introduce FKGL and vocabulary range.

Flesch-Kincaid Grade Level (FKGL)

FKGL is an estimate of readability that is calculated using two statistics: the average number of syllables per word and the average number of words per sentence (Tanprasert & Kauchak, 2021). It is intended to indicate the number of years of education that would allow a person to read a text with ease. It was initially designed for assessing the readability of technical materials which were used by the United States Navy, and hence for a very specific American target population (*Ibid*.) but has since been used across a wide range of contexts. We use FKGL here, in combination with another indicator, vocabulary range, for the purposes of comparing the readability of textbooks for different subjects and as an indicator of whether the reading difficulty is appropriate for students in their eighth year of basic education.

Vocabulary range required to read text book

Vocabulary acquisition is central to second language learning, competency and communication in general (Decarrico, 2001). It has been estimated that to comprehend a textbook, learners should understand the meaning of 95% of words appearing in the textbook (Nation, 2006). To read it independently with no assistance or dictionary, they should comprehend 98% of the text. This indicates the size of vocabulary that would give a reader a good chance of successfully reading the book. Word families in the English

language have been organised into lists by researchers according to the frequency with which they appear in the British National Corpus (BNC). BNC is a collection of samples of written and spoken English from a wide range of sources, selected to be representative of how English is spoken in Britain in the late twentieth century up (the latest edition was released in 2007) (http://www.natcorp.ox.ac.uk/, accessed 01.09.23). So, the first 1000 are the 1000 most frequent words within the corpus, the second 1000 the next most frequent and so on. A full discussion of the literature on vocabulary coverage, how we measured this and our findings is presented in Biseko and Ndabakurane (in press).

3.4 Study 2 methods: Analysis of Biology textbook

The analysis of the Biology textbook was informed by the characteristics of language practices in secondary school texts, presented in section 2.2. These concern technical vocabulary and grammatical complexity, for which we used indicators that could be measured with the lexical analysis software (see table 3.4). To arrive at an indicator of vocabulary range, we entered the entire text into the lexical analysis software. For other indicators, we used a sample of three of the eleven chapters in the Biology textbook, accounting for around 20% of the pages in the book (see table 3.5).

Table 3.4: Quantitative indicators for linguistic features of the text

Features of text	Indicators
Technical vocabulary	– **Vocabulary range required to read text book** with support – Vocabulary range required to read text book fluently – Percentage of words in the text that are academic words – Percentage of words in the text that are specific to a disciplinary subject
Grammatical complexity	– FKGL – Word length of reading passages – Average sentence length – Frequency of passive voice verbs as a percentage of total number of words in the text – Frequency of subordinate clauses as a percentage of the total number of words in the text

We were interested in how the Biology textbook compared with other Form I textbooks, so as an extension to the lexical analysis, also analysed sections from four other textbooks, listed in table 3.3.

Table 3.5 Biology textbook chapters sampled for Study 2

Research component	**Sampled chapters**		
Study 2	Chapter 1	Introduction to Biology	13 pages
	Chapter 5	Waste Disposal	18 pages
	Chapter 10	Classification of living things	10 pages
Study 2: activities and exercises only	Chapter 2	Biology Laboratory	25 pages
	Chapter 3	Scientific Process in Biology	16 pages
Study 2: vocabulary range only	Chapters 1-11	Entire book	197 pages

We were also interested in features of the textbook that support learning of technical vocabulary and scientific genres. This includes non-lexical features of the text, such as images and formatting, which can support interpretation of the text and the learning of technical vocabulary. Features that support vocabulary learning include illustrations, glossaries, vocabulary lists that translate words into a familiar language and entertaining vignettes. As well as supporting learners to interpret unfamiliar vocabulary, some of these features can help them remember key information and use textbooks independently. Formatting and presentation features enhance readability by creating space in the page, so the text is less dense and hence less intimidating for readers. In addition, they make it easier to quickly find information and navigate a textbook. Using the sample of three chapters listed in table 3.5, we inspected two types of non-lexical features of the Biology textbook: features that convey meaning, and presentation and organisation.

Table 3.5 Features that enhance readability for second language learners

The meaning of key- subject specific words conveyed by:	Presentation and organisation
• Pictures • Figures, tables, scientific diagrams • Translation or glossary in Kiswahili • Glossary	• Division into sub-topics (e.g. headings, numbered or bulleted lists) • Length of paragraphs • Use of connecting words

We were also interested in whether and how activities and exercises that students are expected to attempt either in class or on their own, provide meso-scaffolding for learning scientific language practices (see section 2.3). Evaluating these required qualitative analysis. All activities and exercises across five chapters were analysed. Chapter 2 'Biology Laboratory' and Chapter 3 'Scientific Process in Biology' were purposively added to the sample at this stage because they had a focus on doing scientific inquiry. The analysis included activities and exercises that appeared in the main body of the sampled chapters as well as the revision exercise at the end of each chapter. Activities that engage learners in reading, writing and talking were inspected to see how they scaffold academic language learning. The questions that guided this part of the analysis are presented in table 3.6.

Table 3.6: Questions guiding analysis of language supportive activities

Support for talking Are there any activities which ask learners to talk (normally in pairs, groups)? Are there any support activities which help the learner to talk (e.g. in support of 11 above)? E.g.: • a word list • sentence starters
Support for reading Are there any support activities which help the learner to read the text? E.g.: • multiple choice or true/false questions • fill in a chart • label a diagram • fill gaps • match items (e.g. words with definitions, beginning and endings of sentences
Support for writing Are there any activities which ask learners to write?

Do these writing activities require long (e.g. whole sentences) or short (e.g. one or two words) answers?

3.5 Limitations of the research

The study focuses only on curriculum documents. It does not and is not intended to provide insight into what actually happens in classrooms and we approached the documents without making assumptions about how they are interpreted implemented by teachers or received by students.

3.5.1 Limitations of Study 1 qualitative comparison

As a qualitative comparison, Study 1 necessarily depends on the researchers' judgements, particularly when identifying the language skills that expected within the Biology curriculum, as these were not explicitly stated. It is for this reason that in section 1.4, we share some details of the research team members' professional and research experience, so as to be transparent regarding the depth and breadth of experience on which we drew.

3.5.2 Limitations of quantitative indicators of readability

Study 2 employed established indicators of readability. Texts are sociocultural products that are designed to be used within certain social contexts, such as schools. Indicators of readability have been developed within specific contexts and purposes. As indicated in section 3.3, FKGL was initially designed as a measure for a specific type of text (technical materials) to be read by a specific audience. The measure of vocabulary range is deduced from an enormous sample of written and spoken texts gleaned from Britain in the late twentieth century. There are no indicators we are aware of that have been developed or adapted specifically for Tanzania or any other African context. However, both FKGL and vocabulary range are used by linguists internationally across a wide range of contexts, including as indicators or readability for speakers of English as a second or foreign language. We do not regard any of the indicators of readability as precise or definitive measures of readability. However, they each provide us with useful information that we interpret alongside that yielded by qualitative analysis.

3.6 Section conclusion

This section has set out the methods used for each of the two studies, including short descriptions of quantitative indicators and descriptive scales where these were used. Findings are presented in the following section.

4. Findings

This section presents findings for Study 1, which compared the language skills demanded by the Form 1 Biology curriculum with the language skills targeted in Standard 7 English. This is followed by a presentation of findings from Study 2, which analysed the Form I Biology textbook in more detail, including looking at how it supports learning of scientific language practices. The section ends with a short summary of key findings.

4.1 Study 1: Comparison of language skill demand of Form I Biology with language skills targeted in Standard 7 English

4.1.1 Overview of findings

Across all four language skills of reading, writing, listening and speaking, there is a large gap between the language skills required for learning Biology through English in the first year of secondary school compared to those that children are expected to have learned in the subject of English Language by the end of Kiswahili medium primary school. This can be seen from table 4.2, which summarizes findings from the inductive comparison of skills either explicitly required or assumed by the Biology Form I TIE textbook and syllabus and those that are targeted in the Standard 7 English language TIE textbook and syllabus for Kiswahili medium schools.

Table 4.3 gives an overview of the findings from a comparison of the syllabus and textbook with the learning objectives specified in Pearson's Global Scale of English (GSE), which reinterprets the CEFR levels for teachers of English as second language. The skills targeted in the Standard 7 English were best described by learning objectives in the GSE for Young Learners aged 6-14, whilst the Biology skills were best described by the GSE for adult academic learners. This is not surprising. Whilst the primary curriculum for English is concerned with developing generic language skills appropriate for younger learners, the lower secondary education curriculum demands academic language skills from the beginning of Form I. It is also appropriate to the age of learners, who tend to be 13-15 years of age in Form I.

The remainder of this section reports findings from both the inductive comparison and comparison using CEFR level, organised according to the four skills reading, writing, listening and speaking.

4.1.2 Reading Skills

Together, Studies 1 and 2 provide both qualitative and quantitative indicators of the reading difficulty. Table 4.3 provides an overview comparison of the quantitative indicators for Standard 7 English and Form I Biology, yielded by lexical analysis software. All three indicators show a large jump in reading difficulty between the Standard 7 subject English textbook and the Form I Biology textbook, suggesting that students would need around four additional years of education to be able to bridge the gap. The Biology textbook appears to be more appropriate for students in upper secondary (Form V-VI) or university students.

Table 4.1: Comparison of skills required for Form I Biology and those targeted in Standard 7 English

Skills	Targeted in Standard 7 English	Language skills needed for FI Biology
Reading	Read a text on a general-purpose topic; answer questions on language items Read a story; answer questions	**Explicit:** Read a text, unsupported, about complex subject topics Understand technical scientific and general academic vocabulary Understand certain language functions appropriate to the subject Interpret visuals (charts, diagrams etc) while reading about complex subject topics **Assumed:** Follow complex grammar in reading about complex subject topics Follow signals of textual organisation when reading about complex subject topic
Writing	Write a short text focussing on language items Write a short text on a general-purpose topic	**Explicit:** Write a text, unsupported, about complex subject topics Understand technical scientific and general academic vocabulary in writing about complex subject topics Express certain language functions appropriate to the subject **Assumed:** Use grammar accurately in writing about complex subject topics Use simple signals of textual organisation in writing about complex subject topics Use visuals (charts, diagrams etc) while writing about complex subject topics
Listening	Understand a single simple sentence Understand a simple story	**Assumed:** Understand the teacher talking about complex subject topics Understand technical scientific and general academic vocabulary when listening to the teacher talking about complex subject topics Follow signals of textual organisation when listening to the teacher talking about complex subject topics Understand certain language functions appropriate to the subject Interpret visuals (charts, diagrams etc) while listening to the teacher talking about complex subject topics
Speaking	**Deduced by researchers:** Speak in pairs and groups in short simple sentences, supported by structure, prompts etc Speak unsupported in pairs and groups about subjects in short (ca 5 words) simple sentences using undemanding general-purpose vocabulary	**Explicit:** Speak unsupported in pairs and groups using simple sentences, about more complex subject topics Speak unsupported in pairs and groups using technical scientific and general academic vocabulary Speak unsupported in pairs and groups expressing certain language functions appropriate to the subject while talking about complex subject topics **Assumed:** Speak unsupported in pairs and groups using grammar accurately when talking about complex subject topics, in particular using longer and more complex sentences

Table 4.2 Pearson GSE learning objectives for TIE Standard 7 English textbook (TIE2020) and TIE Form I Biology textbook (TIE2021) and Source for young learners descriptors: Pearson (2022b); Source for Academic English: Pearson (2022a)

CEFR level Pearson GSE scale	A1	A2 Young Learners	A2+ Young Learners	B1 Academic English	B1+ Academic English	B2 Academic English
Reading		Can understand the main points of short, simple dialogues related to everyday situations, if guided by questions. Can follow simple stories with basic dialogue and simple narrative.			**With scaffolding** Can understand cause and effect relationships in a simple academic text, if clearly signalled. Can understand relationships between ideas in a simple academic text, if guided by questions.	Can understand definitions of technical terms presented in a linguistically complex academic text. (B2+, AL)
Writing		Can write very short, simple notes to family or friends relating to matters of immediate need, given prompts or a model.	Can write a very simple story, given prompts or a model. Can write simple structured paragraphs and short, simple texts of more than one paragraph.	**With scaffolding** Can write a basic paragraph containing a topic sentence and related details, if provided with a model. (AL)		Can contrast two ideas when writing a simple academic text by using discourse markers. (AL)
Listening	Can follow a short, familiar traditional story, if supported by gestures and repetition.	Can understand slow, clear standard speech on familiar matters, with some repetition or reformulation by the other person.				Can recognise generalisations and their supporting ideas.
Speaking		Can exchange information and express ideas on familiar topics in simple terms, provided the other person helps if necessary.			Can effectively participate in a classroom discussion about an academic topic. (AL)	

To provide some context for these findings, in 2013, a survey of 320 Form I students from 21 schools found that the majority were able to interpret a text with a FKGL of 4 but not a text with FKGL 5 (Barrett, Mtana, et al., 2014). A separate study, found that first year undergraduate students at a Tanzanian university, had an average vocabulary range in English of around 4000 words (Biseko, 2023). Hence, the Standard 7 English textbook is likely to be challenging for many Standard 7 learners to read, whilst the text of Form I Biology textbook is likely to be impenetrable to the majority of lower secondary school students.

Table 4.3: Summary of findings for indicators from all studies

Indicator	Standard 7 English	Form I Biology
FKGL of textbook*	5-6	9-10
Vocabulary range required to read textbook with support	3000 words	7000 words
Vocabulary range require to read textbook fluently	5000 words	13000 words
Readability CEFR level†	A2 – B1	C1-C2

***Range of findings across sampled textbook chapters and examination papers.*
†*Range indicated by lexical analysis of textbook and examination papers.*

There is a disparity between the CEFR levels yielded by the text analysis software for both books and that found through qualitative approach, presented in table 4.2, with the latter being 1-2 levels lower. This is because judgement for the qualitative comparison is less influenced by technical vocabulary and tends to focus on grammar and functions of language practices. Nonetheless, across all methods for evaluating readability, there is a considerable and abrupt step up in the complexity of texts that students are expected to read and interpret.

Reading texts in the Standard 7 English textbook are much shorter than those in the Biology textbook (400-600 words compared to 700-1300 words). They tend to be short stories that describe actions. Comprehension questions require extraction of factual information. Each passage is followed by a very short list of two to four questions or a larger number of short answer questions. Questions include those that require extraction of concrete information from the text to more open questions that stimulate independent reflective writing. For example, 'What lesson have you learnt from the story' (TIE, 2020: 119). The grammatical and lexical features of the Biology textbook are presented in section 4.2.

4.1.3 Writing Skills

Writing in the Biology textbook is mainly elicited through activities and exercises that are described in the section 4.2.4 and also indicated by suggested learning activities in the Biology syllabus. These assume learners can write answers of a few sentences in length that define, describe and compare (or differentiate between) objects, organisms, processes, and operations, as well as explain the reasons for operations and the importance of processes and concepts. The writing abilities that completing these activities and exercises involve are listed in table 4.3. The table also indicates that the English curriculum for Standard 7 does not target any of these abilities but focuses on much simpler skills of writing a short text focused on practicing grammar or on a general purpose topic.

4.3.4 Listening skills

Neither the Biology syllabus not the Biology textbook explicitly specify listening abilities that students require, which is typical of lower secondary school science curricula. Hence, we were dependent on text within the Biology textbook, which is described in section 4.2.1 – 4.2.2, as an indicator of listening demand. We assumed that the level of difficulty of the text corresponded to the level of difficulty of teacher talk. This generated the set of assumed listening abilities that are listed in table 4.3. The listening demand could be reduced by teachers through micro-scaffolding or translanguaging in the lesson, as described in section 2.4.

4.1.5 Speaking skills

None of the speaking skills that are explicitly required or assumed by the Biology Form I syllabus and textbook are covered in the Standard 7 English textbook or syllabus. The Biology syllabus provides teachers with examples of learning activities for each specified competence. Many of these involve engaging students in talk about Biology, for example:

> Students in groups to discuss the basic biological concepts and terminologies such as life, cell, living things/organisms. (TIE, 2005: 2)
>
> The teacher to lead student to brainstorm using Visualization in Participatory Programme (VIPP) cards on the importance of life, living things and studying biology. (TIE, 2005: 2)

Speaking activities in the Biology textbook are discussed in section 4.2.4 above. Typically, instructions for discussion are not accompanied by any form of structured support.

By contrast, speaking activities in the English language Standard 7 textbook are limited to reading poems and short dialogues out loud. The dialogues include greetings and concerns concrete everyday activities, for example:

> Act out the following dialogue and answer the questions that follow:
> Juma: Hello Uncle!
> Uncle: Hello Juma! How are you?
> Juma: I'm fine. Thank you, Uncle!
> Uncle: You're warmly welcome. I'm cleaning the coop for my chickens.
> Juma: I can see you've got so many chickens.
> Uncle: Yes. I've also got a lot of cows. (TIE, 2020: 101)

There are no explicit instructions to engage in unscripted speech, although teachers could use the dialogue as a model for a role play, an activity specified in the English Syllabus for Standard 7.

4.1.5 Reducing linguistic demand

Some of the GSE descriptors specify what students at a particular CEFR level are able to do when some kind of support or guidance is provided. The descriptors, designed to be used for teaching, learning and assessment, thus show that teachers can reduce the demand through providing scaffolding. We did not find within Biology syllabus any explicit guidance on how to provide scaffolding for reading, writing, talking and listening. The only place we did find such explicit guidance to teachers, was in the introduction to the TIE Baseline textbook. Features of the Biology textbook that support academic language learning were analysed as part of Study 2.

4.2 Study 2: analysis of the Form I Biology textbook

4.2.1 Vocabulary range and readability

Quantitative indicators of readability are presented in table 4.3, showing that the Biology textbook is much harder to read than would be expected for a lower secondary textbook. More specifically, indicators of vocabulary range were high. This is illustrated by the excerpt provided in box 4.1, in which less frequent words are highlighted. We also found a high proportion of academic and subject specific words (see table 4.4).

Box 4.1 A short excerpt from TIE Form I Biology textbook with low frequency words highlighted *(Source: TIE, 2021, p. 73)*

> Gaseous wastes
>
> These are wastes in gaseous form, for example ammonia, carbon dioxide, and sulphur dioxide gases from industries and motor vehicles as shown in Figure 5.3.
>
> Gaseous wastes have the capacity to spread over a wide area. This endangers both the environment and human beings. Hence, appropriate control measures are recommended in order to prevent its negative effects. Such effects can include worsening of respiratory diseases, and corrosion of iron sheets and walls of buildings.

An inspection of the TIE textbooks for Form I, suggested that the Geography and History textbooks are also difficult to read. So, we compared their readability with Biology through analysis of a short sample from across 2-4 pages, using lexical analysis software. We also analysed the readability of two Form I textbooks, Form I subject English student book and the Baseline student book, used during the language orientation programme at the beginning of Form I. This showed a high percentage of subject specific words appeared in the Geography text and the TIE Baseline book, which targets English for academic purposes.

Table 4.2: Comparison of readability of Form I Biology, History and Geography textbooks.

Indicator	Biology	History	Geography	English Form I	TIE Baseline
FKGL	9	9.7	12	10.5	9.7
Average sentence length	12	12	15	19	12
% academic words	5	7	12	4.4	9
% subject specific words	11	7	16	6.4	10.6

4.2.2 Syntactical features of the Biology textbook

In terms of grammar, the passive voice was used frequently (2% of all words were passive voice verbs). Subordinate clauses were present in each text but only in low numbers. Long noun phrases were found in all three passages analysed, often taking the form of lists. However, good use was made of connecting words and phrases to show the flow of argument. Overall, the syntactical features of the Biology Form I textbook were consistent with descriptions of lower secondary science texts described in section 2.4.

4.2.3 Features that convey meaning

Readability of a textbook can be enhanced through tables, images and other types of figures. Formatting can help to break down a text and signal that some text is more important to read than others. Such features are discussed below.

Pictures and diagrams that illustrate, demonstrate and instruct

Images were used extensively. There were 179 visual images across the book's 186 pages. Photographs and colourful hand-drawn pictures illustrate the text throughout the book. For example, the text on gaseous waste reproduced in Box 4.1 was accompanied by a drawing of lorry pulling up next to a factory showing fumes emerging from the lorry's exhaust and a factory chimney.

Some images support learning of practical skills. For example, there were photographs or drawings of laboratory apparatus typically found in a well-equipped school laboratory. Experiments were illustrated with photographs of secondary school children performing specific steps or actions (e.g. measuring the temperature of a boiling liquid using a thermometer) or drawings that reinforce or illustrate instructions in the text (for example, a drawing of a set up for an experiment to investigate the conditions preferred by earthworms).

Tables, diagrams and charts that display and organise information

Tables, diagrams and charts were used to display and organise information. Tables were used the most. There were 19 tables in total and only one complete chapter did not contain a table. They were frequently used to facilitate comparison, for example, between the causes and symptoms of different diseases. However, some tables were exceptionally long. Eight out of the 19 tables that appear in the book spread across more than one page. These long tables organised and effectively 'warehoused' content. For example, the longest table, which spread over 11 pages, detailed cases, risk factors, symptoms and prevention of 16 diseases.

Diagrams were used to display information regarding structures or processes and labelled diagrams supported learning of technical vocabulary. Nearly all diagrams of structures were labelled. Diagrams were used most extensively in the chapter on microbiology to show the structure of different cells or the process of viral reproduction. Only two charts appear in the book. A flow chart to demonstrate the generic steps in a scientific investigation (p. 48), and a tree diagram to show ranks of classification of living things (p. 157).

4.2.4 Features of the text that support development of academic language skills

Learners transitioning to a new LoLT benefit from structured support for learning academic language with explicit teaching of scientific vocabulary and the grammar of scientific writing (see section 2.3). In particular, use of a familiar language in the classroom is essential to meaning making, helping learners make connections to their prior knowledge and to develop plurilinguistic language skills. The Form I Biology textbook has no multilingual or bilingual features. Even the glossary is entirely in English. There is some support for learning vocabulary but very little and very inconsistent support for academic reading, writing and talk.

Support for vocabulary learning: chapter introductions, chapter summaries and a glossary

The textbook has features that support learners to acquire new vocabulary and to digest and summarise content. These include chapter summaries and an English language glossary at the back of the book, which provides concise definitions of key biological terms, such as *active immunity*, *chloroplast*, *environment*. Exercises for revising chapter content appear at the end of each chapter. These included a number of questions that reinforce learning of specialist vocabulary, often in the form of multiple-choice questions.

Support for reading
Formatting helps to organise information and can enhance the readability of long lengths of text. The Biology textbook used formatting to enhance accessibility of the text. All three chapters analysed contained long passages of 700 to 1300 words. However, these were broken down into smaller digestible chunks through the use of short paragraphs and sub-headings. Numbered lists were used throughout the book, for example to break down instructions for experiments into steps. Different types of information (e.g. tasks, safety information) were differentiated using coloured boxes. Pages were formatted into two columns, creating more space on the page.

Box 4.2: Example of chapter introduction (Source: TIE, 2021, p. 151)

> Introduction
>
> There are different kinds of organisms in the world. Some organisms are too small to be seen by naked eyes and they are called micro-organisms. Due to the existing diversity of organisms, it is difficult to clearly understand their characteristics. In this chapter, you will learn about the concept of classification, classification systems, ranks of classification, and binomial nomenclature. The competencies developed from this chapter will enable you to identify and classify new organisms by comparing their characteristics with the already classified organisms.

One-paragraph chapter introductions (see example in Box 4.2) help to orient students to the chapter topic. The chapter summaries, which were longer numbered lists of around eight key points to remember, also help with reinforcing learning. True or False questions in the revision exercise provided opportunities to practice reading scientific statements and appreciation of precise use of language in science.

Support for writing
A very narrow range of sub-genres of writing were repeatedly required within exercises. These were comparisons (usually phrased as 'differentiate between'), sequential explanations and theoretical explanations (see table 2.1). There was no support for writing. Writing exercises were not organised so as to provide macro-scaffolding through gradual introduction of progressively more complex genres. Neither was there any meso-scaffolding to provide structured support with writing tasks (see section 2.6).

Support for developing multimodal literacies, scientific talk and science process skills
Tasks in the Biology Form I textbook took the form of activities and exercises. These provided opportunities to practice academic writing, to engage in discussion and cooperative learning. However, very little scaffolding was provided to support learners to write or discuss in pairs. The one exception was that scaffolding was provided for multimodal communication, specifically creating tables to organise and present findings from practical investigations.

Activities within the chapters mostly targeted science process skills of observing (10 out of 16 activities) and classifying (nine out of 16) (some activities covered more than one process skill). The chapter on Scientific Process had a focus on measurement and half of its six activities involved measuring and using numbers. All activities included a reporting step, most commonly through discussion in groups or individual note taking. Boxes 4.3 and 4.4 are examples of instructions for the reporting step. Measuring activities and some observation activities required students to record results in tables and structured support

was provided for this. Some tasks engaged students in drawing diagrams. In the chapter on the Biology Laboratory, a revision question required students to draw apparatus, whilst four activities across three chapters involved drawing as part of an observation activity. One activity required students to create a poster. However, no structured support was provided for this within the textbook.

Box 4.3 Example of discussion activity with some structure

> 4. In your groups, discuss the things that you have observed by answering the following questions.
> (a) Which ones are living? Why?
> (b) Which ones are non-living? Why?
> 5. Compare your findings with those from other groups.
>
> (TIE, 2021: 4)

Box 4.4 Example of discussion activity with no structure

> 3. Discuss with your classmates the effects of poor waste disposal on visited areas.
>
> (TIE, 2021: 84)

4.3 Section summary

Findings presented in this section can be summarised as follows:

- There is a substantial gap in the reading, writing, listening and speaking skills that are targeted in the English language primary curriculum and those expected in Form I Biology.
- Textbooks have no bilingual features and syllabi do not explicitly mention use of multilingualism.
- The Form I Biology textbook has a large vocabulary range. Some other Form I TIE textbooks also have a large number of subject specialist and general academic vocabulary. This is the main factor making the books hard to read.
- The Form I Biology textbook does have features that support learning of scientific vocabulary.
- The Form I Biology textbook does have features that convey meaning and therefore assist students to interpret the text.
- Talking and writing tasks in the Biology textbook do not scaffold learning of scientific genres.
- There is some scaffolding for creating tables, particularly to record and organise findings of practical investigations.

5. Discussion

The findings presented in the last section show that the specified curriculum does not plan for a continuous language learning journey for students transitioning to secondary school from Kiswahili medium primary schools. We also found that this is not a problem for subject Biology alone but extends to humanities subjects. Tanzania is not the only country where there is a disjuncture between the language skills required for learning subjects and those targeted in the subject English Language. Clegg (2021) provides specific examples from Rwanda and South Africa, whilst arguing that this is a wider issue for all systems that use an unfamiliar language for teaching and learning. In this section the findings are discussed in relation to key concepts developed in Section 2. First, the language skills disjuncture is treated as problem of social justice. In subsequent sub-sections, it is treated as a problem of curriculum coherence, pace and scaffolding for language learning. Comparisons are drawn between the TIE Biology textbook and the LSTT textbook, designed previously by team members and others (see section 1.4). The LSTT textbook is used to illustrate how it is possible to design a textbook matched to the TIE syllabus that explicitly supports learning of scientific language practices. This moves the discussion towards drawing out recommendations, which are presented in the final section of the report.

5.1 Curriculum language coherence as a social justice issue

Language coherence in the curriculum is a social justice issue. In Tanzania, the contours of inequality it reproduces are shaped by access to fee-paying private schools, or the very few government-funded English medium primary schools. Results from national examinations, known as the Primary School Leaving Examinations (PSLE) taken at the end of Standard 7, indicate a dramatic disparity between private fee-paying English Medium and government-funded Kiswahili medium primary schools. Taking the example of Dodoma City Council, 16% of children who sat the PSLE in 2022 were enrolled in English medium primary schools. 99.95% of this group passed the English PSLE, the mean score being 47 out of 50 marks. By comparison only 33% of children enrolled in Kiswahili medium schools passed the exam and the mean score was 19.

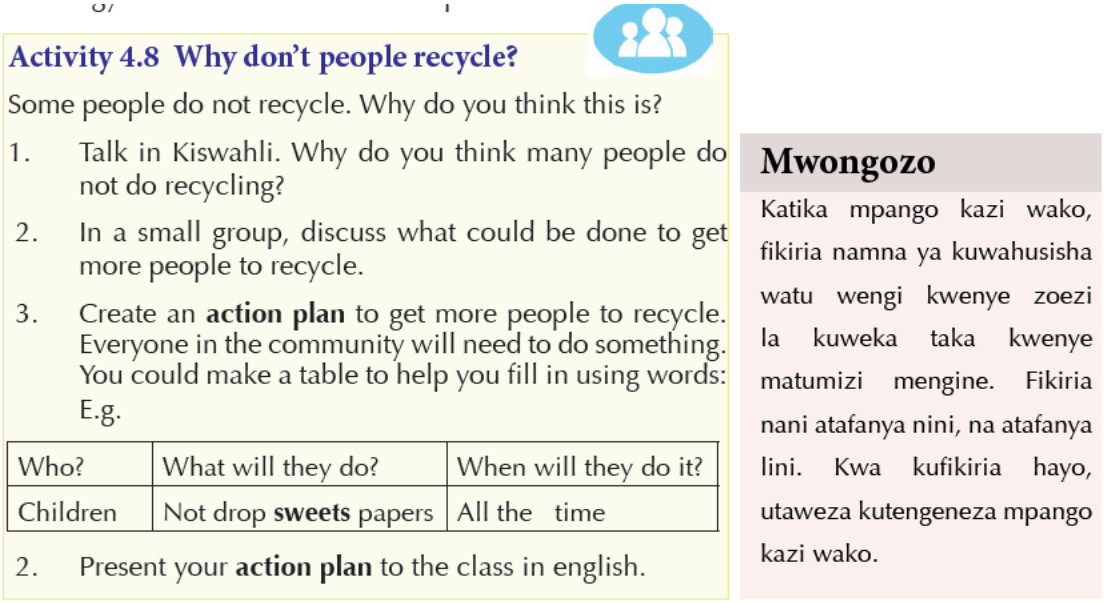
Access to English medium primary education largely depends on parental income and location. There are very few government funded English medium primary schools, all of which are located in cities. Private schools are also concentrated in urban areas. Around 22% are in Dar es Salaam (Kamukulu, 2023), whilst 30 rural districts, had no private school with a Standard 7 class in 2022 (PO-RALG, 2023). In total, only 4% of Standard 7 pupils (4% of girls, 4% of boys) are enrolled in non-government primary schools (calculated from basic education statistics published by PO-RALG, 2023). Gender equality is a privilege of the relatively wealthy living in urban locations. The gender parity index for enrolments in Standard 7 non-government schools is 1.0, compared to 1.09 for non-government schools (PO-RALG, 2023), indicating that more boys than girls are exiting the system before completing their primary education.

Kiswahili medium primary education does prepare children with the language skills they need for secondary education. Across Mainland Tanzania, the pass rate for the Kiswahili PSLE was 88%. For graduates from Kiswahili medium primary schools, the gap in their language learning journey is created by replacing Kiswahili with English as the LoLT. Further, the scores in the English PLSE suggest that there is currently no capacity in primary schools to extend the use of English across the curriculum and priority should rather be given to strengthening the subject English.

5.2 Reducing linguistic demand through meso-scaffolding

Whilst our analysis found an excessive density of general academic and scientific vocabulary in the Form I Biology textbook, the grammatical complexity of the text was in line with the general features of lower secondary science texts identified in by SFL research (Schleppegrell et al., 2002; Christie, 2012). However, the reading, writing, listening and speaking tasks that students were expected to be able to perform in Form I Biology were linguistically far more demanding than those within the Standard 7 English Language curriculum materials for Kiswahili medium schools (see tables 4.3 and 4.4). Christie (2012) observes that mastering the progressive complexity of grammar of school science texts often poses a greater challenge for learners than does the mastering of technical vocabulary, but that students can be supported to master the grammar through explicit teaching of scientific language. We also found that the linguistic demand could be reduced if teachers provide scaffolding for activities (see table 4.2). However, we did not find any explicit guidance for teachers on scaffolding within curriculum documents except in the introduction to the Baseline textbook.

Figure 5.1 Structured task for talking, with guidance in Kiswahili {LSTT, 2015 #730:20}



Activity 4.8 Why don't people recycle?

Some people do not recycle. Why do you think this is?

1. Talk in Kiswahli. Why do you think many people do not do recycling?
2. In a small group, discuss what could be done to get more people to recycle.
3. Create an **action plan** to get more people to recycle. Everyone in the community will need to do something. You could make a table to help you fill in using words: E.g.

Who?	What will they do?	When will they do it?
Children	Not drop **sweets** papers	All the time

2. Present your **action plan** to the class in english.

Mwongozo

Katika mpango kazi wako, fikiria namna ya kuwahusisha watu wengi kwenye zoezi la kuweka taka kwenye matumizi mengine. Fikiria nani atafanya nini, na atafanya lini. Kwa kufikiria hayo, utaweza kutengeneza mpango kazi wako.

Previous research has demonstrated that it is possible to design curriculum materials that follow the Form I Biology Syllabus and that have a much lower vocabulary range and less grammatical complexity (Barrett, Kajoro, et al., 2014; Mtana & O-saki, 2017). The *Language Supportive Teaching and Textbooks (LSTT)* project demonstrated how to do this by creating an exemplar Biology Form I reference book (LSTT, 2015). The book provided structured support for learning academic English language in three ways. First, English to Kiswahili glossaries provided translation of the key words on the page where the words first appeared. This enhanced readability by providing a ready-to-hand translation of an infrequent word without distracting attention away from the main text. In addition, key scientific terms were included in these lists to help students make a connection to their prior learning in Kiswahili medium primary school. Second, tasks provided meso-scaffolding, guiding students to explore a scientific concept in Kiswahili and then providing support for producing a simple written statement in English (see the example in Figure 5.1). Third, structured support was provided for writing sentences, giving students opportunities to rehearse the grammatical forms used in lower secondary science (see the example in figure 5.2). As the book was

targeted as students in their first year of using English as the LoLT, mainly support for writing focused on writing single sentence statements (Barrett, Kajoro, et al., 2014).

Figure 5.2 Structured support for writing a sentence (Barrett, Kajoro, et al., 2014:17)

Use the substitution table to make complete and true sentences about the advantages and disadvantages of viruses.

Viruses	cause disease in	human being	for example small pox, measles, polio
		domestic animals	for example foot and mouth disease
		crops	for example tobacco mosaic, potato mosaic
Viruses	are used	for studying of cellular and molecular biology	
		for making vaccines	
		for controlling bacterial infections.	
		in genetic engineering to insert genes from other organisms into bacteria.	

The LSTT textbook is much easier to read than the TIE one. We measured its FKGL as 5, which is in line with the readability of the Standard 7 English textbook. However, as the PSLE results, presented in section 5.1, show, the majority of Form I students are not achieving against the Standard 7 English language benchmarks. This made it necessary to provide instructions for activities in Kiswahili as well as English (provided under the heading 'Mwongozo' in Figure 5.1).

5.3 Reducing vocabulary range and strengthening conceptual coherence

Christie (2012) observes that a high density of technical vocabulary is a feature of secondary school science texts from the lower secondary level upwards and that science teachers emphasise precise use of technical vocabulary (Christie, 2012). However, the vocabulary range of the Form I Biology textbook was extraordinarily high for a lower secondary text. One reason for this is the quantity of detail included in the textbook, as exemplified by the 11-page long table with details of 16 diseases. Another example is the number of different examples of micro-organisms described in another chapter. The use of tables to 'warehouse' information was a familiar one for the research team, we had resorted to the same strategy in an early draft of the LSTT book (Barrett, Kajoro, et al., 2014). This raises questions around the level of descriptive or detailed content in the Biology syllabus and conceptual coherence.

Conceptual coherence in curriculum design has been defined by Schmidt et al. (2005:529) as progressive movement towards "the understanding of deeper structure". The notion of 'deeper structure' is derived from Bruner's argument that "to understand something is to sense the simpler structure that underlies a range of instances" (Bruner, 1960). In other words, a coherent curriculum is organised around core principles and concepts. Examples of specific instances play a role in moving students towards understanding of the discipline's structure. However, too many examples, particularly if they are unfamiliar to students and unrelated to their prior knowledge and experience, can distract from conceptual learning. A high density of specific examples also multiplies technical vocabulary, giving rise the large vocabulary range.

The very long tables used to present and compare information in some chapters represent an overburden of specific examples. This can create an expectation that students will memorise a large amount of information. This is reinforced by the revision exercises at the end of chapters, which had a large number multiple choice and short answer recall questions. These types of questions also make up the bulk of the Form Two National Examination (FTNE) papers. In the examination papers, consecutive questions are often on unrelated topics, so students have to quickly recall a miscellany of core conceptual and specific detailed information. A similar reliance on linguistically less demanding recall questions was found in lower secondary textbooks in Hong Kong (Lo & Fung, 2020). Whilst this reduces the linguistic demand of writing longer answers, it also reduces the opportunity for demonstrating understanding of scientific processes and relationships.

Attention to conceptual coherence would mean focusing time on understanding key scientific concepts, processes and relationships and associated vocabulary. So, for example, with respect to the topic disease, key vocabulary would include words such as infection, vector, symptoms, diagnosis and treatment. Learners might then be expected to apply these to write about a limited number of diseases, which are prevalent in the local context. This may be seen as reducing content but it would be developing depth of understanding. However, to demonstrate this understanding, students would also need to be able to write using scientific genres that are appropriate to their educational level and language competencies.

5.4 Pace and macro-scaffolding for language learning

Demonstrating understanding of the structure of a subject requires production of full sentences (Atnafu et al., 2023). Students cannot do this without explicit teaching of language within subject teaching (Christie, 2012; Lo et al., 2023). The majority of Form I learners in Tanzania struggle to produce single grammatically simple sentences (Barrett, Kajoro et al, 2014). The pace of subject learning, therefore, needs to be slowed down to create space and time for explicit teaching and learning of academic language within subjects as well as including general academic language skills in the English subject curriculum. Pace concerns the rate at which new content and skills are introduced and so relates to the concept of curriculum load (OECD, 2020). Pace has to be appropriate to age and grade, and also to the language learning challenge presented by transition.

The syllabus is the primary document that determines pace. It serves as a guide for the textbook authors and those designing national assessment, as well as for teachers. Integration of language learning objectives into subject curricula should follow Polias' (2016) advice on macro-scaffolding (see section 2.4). So, for example, in the first term of Form I students should be supported to produce genres that use simple grammar and vocabulary (e.g. a record of an experiment) and progress gradually over four years of lower secondary to producing more technical and grammatically complex genres (e.g. sequential explanation without human agency). There then needs to be alignment in the complexity of writing tasks expected of students across different the syllabus, textbook and national examinations.

The English primary school curriculum can also do more to support students with the development of productive skills. The English Language primary education syllabus was poorly specified, providing limited guidance on grammar, vocabulary or genre. Descriptions of specific competencies, highlight items which are not very relevant, e.g. writing using 'correlative conjunctions'. Previous research on the Tanzanian English language primary curriculum found that that the syllabus followed a ' "drop-and-reinstate" pattern, in which topics covered one year, are dropped in the subsequent year or two, and then reinstated at a higher level of cognitive demand' (Atuhurra & Kaffenberger, 2022:2). This makes it difficult for children to build competencies from one year to the next. Atuhurra and Kaffenberger

(*Ibid*.) also found poor alignment between the PSLE and the syllabus, due to an over-reliance on multiple choice questions that can be answered through memorization/ recall and less attention to the production of sentences. More detailed specification within the English syllabus and the formulation of specific competencies that develop skills at an incremental, steady and continuous pace is therefore another important step towards strengthening language learning coherence across the curriculum subjects.

5.5 Section conclusion

Discussion in this section has made a connection between science and language learning. We designed analysis in this study to probe planning for language learning across English Language and a science subject. However, we have found ourselves making connections to wider issues of curriculum design that relate to how subject disciplines are introduced to students. In section 2.1, we cited Halliday (1993:94), saying 'language is the essential condition of knowing, the process by which experience becomes knowledge'. We therefore should not be surprised to find that continuity in language learning in the curriculum is linked to conceptual coherence of the curriculum. This leads us to argue for a joined up approach to curriculum design that pays attention to conceptual learning within subject disciplines as well as development of the language practices within those disciplines. It is this insight that underpins the recommendations set out in the following section.

6. Conclusion

We conclude by distilling the discussion above into four principles to guide curriculum design in education systems, where a new LoLT is introduced in upper primary or lower secondary. This is followed by a set of recommendations for strengthening curriculum coherence specifically in Tanzania Mainland. The final sub-section identifies priorities for further research.

6.1 General principles of coherent curriculum design

From the literature review and analysis three key principles emerge for designing a curriculum that is coherent across subjects and grades with respect to academic language learning.

1. **Curriculum should be organised around the structure and logic of a discipline.**
   Curriculum documents should centre foundational principles, key concepts and relationships that together make up the logic or structure of a subject. This requires specifying limits to the number of specific examples students are expected to be able to write or talk about. Assessment should be designed to allow students to demonstrate understanding of foundational principles, key concepts and relationships.

2. **Curriculum load and pace should be appropriate to age, grade and take account of linguistic challenge of introducing a new LoLT**
   There is a pay-off between linguistic demand and pace of content learning. The exclusive use of a new L2 in the late primary or lower secondary phase requires slowing the pace and allowing more time for explicit teaching of academic language skills within other subjects.

3. **Academic language learning needs to be planned coherently across and within educational phases and grades**
   A planned approach to subject language learning would involve gradual and explicit introduction to different genres. Such planning would address the following questions:
   - At what rate should new vocabulary and the associated concepts be introduced for different grades?
   - What genres should learners be expected to read and produce in each grade? How should these be sequenced?
   - What multimodal literacies should learners develop in each grade? How should these be sequenced?

4. **Subject learning should use and develop scientific language skills in a familiar language**
   Learners would more quickly master academic language skills in English if they are also introduced to the same language skills in a familiar language.

6.2 Recommendations for curriculum design in Tanzania

Revising the Tanzanian curriculum that was being used in 2022 to make it coherent with respect to language learning across the primary and secondary phases and across subjects requires changes to processes of curriculum design as well as to syllabi and textbooks.

6.2.1 Cross-curriculum planning of language learning

Planning a curriculum that is coherent with respect to language learning is a process that will require close collaboration between language educators and educators in other subjects. Language educators should be involved in designing and reviewing subject curriculum materials to ensure that they are appropriate to the language abilities of learners. However, language advisors should not be allowed to displace subject learning objectives with general language learning objectives. Curriculum design needs to be underpinned by an understanding of the interdependence and embeddedness of subject and language learning.

Cross-curricular guidance for textbook authors and those who write national examinations is needed to control pace across the subjects. This may include guides on general academic vocabulary, the length of sentences and reading passages in textbooks and the genres of writing and talking that learners in different grades can be expected to produce. At the lower secondary level, most guidance, such as that on genres of writing, will be specific to related sets of disciplines (e.g. the natural sciences, humanities and arts). Guidance might extend to suggestions for activities that develop language skills, such as learning and reinforcing vocabulary, writing passages or creating tables and charts.

6.2.2 Support the use of Kiswahili in teaching and learning

Extending the use of Kiswahili in teaching and learning of subjects will accelerate subject learning, including the learning of academic English. Guidance on multilingual and translanguaging practices, such as that provided in the front matter of the LSTT textbooks (LSTT, 2015), can be provided at the cross-curricular level and elaborated for groups of related subjects. It should be clearly communicated to all stakeholders that the benefits of allowing learners to use familiar languages in the classroom is strongly evidenced by over 40 years of research in Tanzania and diverse contexts worldwide.

6.2.3 English subject - syllabus

Provide more detailed and consistent specification of learning objectives for learning of grammar, vocabulary and genres. Some examples of carefully specified curriculum documents for second language English learners are Pearson's Global Scale of English (GSE) for Young Learners (Pearson, 2022b), South Africa's National Curriculum Statement for English First Additional Language (DBE, 2011) or the WIDA English Language Development Standards Framework (WIDA, 2020). Once a language skill is introduced, develop it incrementally across grades.

6.2.4 English subject - textbook

Include more tasks that develop writing skills, which gradually increase in complexity so that, in the last year of primary education, students are supported to write in simple academic genres.

Reduce the vocabulary range in reading comprehensions.

6.2.5 Biology - syllabus

More carefully specify content to include limits on the number of examples and the amount of detail that students are expected to learn.

Include specific objectives for learning the language practices associated with Biology. E.g. understand how nouns are derived from verbs in English through use of '-ion'; how to record

steps take in a laboratory experiment; how to write a simple description. This should extend to multimodal literacies, e.g. report of an investigation that includes a table, description of the structure of an organism that includes a labelled diagram.

6.2.6 Biology – textbook

Reduce the range of general, academic and subject specific vocabulary in the TIE textbook as an absolute priority for making the book usable by Form I students.

Add Kiswahili translations for words that appear in the glossary and preferably on the page where words appear. English to Kiswahili glossaries on the first page of a new chapter support students to make connections to relevant previous learning in primary school.

Reduce the length of continuous passages that students are expected to read, whilst continuing to use subheadings and images to support interpretation of the text.

Include a larger number of activities that provide scaffolding for reading, writing, and talking activities by breaking tasks down into steps and providing support such as sentence starters, vocabulary lists, examples of how to construct a sentence. Scaffolding for talking activities should give explicit permission for exploratory talk using familiar languages and structured support for summarising conversations in simple sentences in English.

6.3 Further research

As with any research, findings and discussions have highlighted some concerns that this research was not designed to address, which warrant further investigations.

6.3.1 Macro-scaffolding for secondary school science

In section 6.2.1, we recommended that guidance be created for textbooks in Tanzania that sets the pace for introducing different genres, the grammar and the general academic vocabulary that it is appropriate to introduce in different grade levels. Creating such guidance, will involve careful detailed research within or influenced by the SFL tradition that is conducted and led from within Tanzania.

6.3.2 Assessment design

One aspect of curriculum coherence, not explored in this research is the coherence between assessment and specified learning objectives. We did not in this research conduct close analysis of the FTNE or the PSLE. Assessment can have a powerful 'washback' effect on how teachers implement the curriculum (see for example, contributions to Smith, 2016). When assessment is high stakes, teachers are under pressure to teach to the test and learning objectives not addressed in the assessment are neglected. In the discussion, we touched upon the implications this has for the development of academic language skills. We therefore recommend that further research on language coherence in the Tanzanian or other national curricula, include analysis of national examinations.

6.3.3 Language practices across curriculum subjects

In this study, we have focused on one non-language subject, Biology. However, the preliminary analysis that we did conduct of textbooks for two other subjects, Geography and History, suggested that there is a need for research to extend to other subject disciplines.

6.3.4 Processes of curriculum design

We have argued for wide-ranging changes to the Tanzanian curriculum, including extending the use of Kiswahili in teaching and learning through the lower secondary phase and integrating explicit teaching of subject specific language practices within subject curricula. We have suggested that this would be aided by collaboration between subject and language teachers. However, we have not in this research, explored the process of curriculum and

design. Designing a curriculum or textbook that is very different from existing textbooks, requires time, including time for piloting. The same applies to the curriculum design. In Tanzania, a government department is responsible for developing both syllabi and textbooks. This may make it easier to control the quality of textbooks as a government department accountable to political leaders. It can also create vulnerability to short-term political agendas. It would be instructive to conduct research that looks into questions such as:

- Who writes syllabi and textbooks? How are they selected?
- What knowledge is available to textbook authors and curriculum designers regarding the role of language in learning? How do they access this information?
- What are the spaces for innovating textbook design, within a system where a government department has a monopoly on authorised textbooks? What are the benefits of this system?

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