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From word recognition skills to reading for the meaning of a science text

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Background: Although the reading of science texts has been reported for high school learners, there is not much research on how younger learners engage with expository texts and how they develop academic language skills. In the instance of this study, the topic came from the curriculum content about animal reproduction.

Aim: The study from which this article emanated aimed to explore how a sample of learners engaged with a short text, which required cohesive reading and some background knowledge and vocabulary.

Setting: This study was conducted in a suburban school where the learners use English as a second language.

Methods: A sample (n = 25) was randomly selected from five Grade 4 classes. Their reading comprehension of a custom-designed test was assessed, along with their writing competence in their responses to content questions as well as their drawings. The data were analysed in a typical content analysis modality.

Results: This study showed that the learners do not apply inferencing skills and do not read cohesively across sentences and paragraphs and that their vocabulary and prior knowledge of animal reproduction is limited.

Conclusion: The urgent need for the development of academic language skills in the early grades is foregrounded in this article, arguing that it can be infused in subjects across the curriculum of the early grades.

Contribution: The task can be used by teachers and by researchers who may wish to replicate the study.

Keywords: middle school; reading comprehension; science texts; qualitative data; intermediate phase.

Introduction: Reading to learn

In their framework for the 'Cognitive Foundations of Learning to Read' (CFLR) (Tunmer & Hoover 2019:Title), the authors expand on the widely accepted 'Simple View of Reading' (SVR) (Hoover & Gough 1990) model by explicating how the building blocks for meaningful reading are put together. These building blocks propose that: (1) a reader must (visually) recognise words and (2) (semantically) know their meaning. On the surface this does sound 'simple' enough; but the route to accomplishing it is not 'simple' (Snow 2018). It takes systematic tuition and much practice to blend strings of letters with the sounds that they represent and to attend to the meaning of words and word parts at the same time. Unlike oral language, reading does not occur naturally – it is a cultural intervention (Dehaene 2009; Hoover & Gough 1990; Pan, Li & Lin 2022). We argue that reading 'for meaning' in the middle school years is a *sine qua non*. Reading without meaning is, in our view, not true reading, which requires much more from a reader than recognising words as 'pictures' of sounds. Frith and Snowling (1983:329) distinguished between 'reading for meaning' and 'reading for sound' in a comparative study. We have taken up these terms to distinguish between 'reading' without semantic cues and reading with understanding.

For the purpose of this article, we, therefore, distinguish between a person who is 'learning to read' in the early grades and someone who is an average reader according to the norm of an age group. If interaction with print text, such as a passage from a science textbook, does not yield

comprehension outcomes, it would mean that the reader has not truly *read* the text, although some psychomotor effort may have been put into engaging with it. For example, the authors of the present paper could, hypothetically, albeit clumsily, utter the sounds of Finnish words seen in print and even imitate some of the pauses and accentuation but cannot be said to 'read' the text orally. 'Not reading for meaning' has been one of the main comments by South African researchers and the news media about middle primary school learners' low reading proficiency, saying that a certain percentage of them cannot 'read for meaning'. We would argue that fourth graders who do not understand what they are decoding in a science text are not really reading.

The South African results of the Progress in International Reading Literacy Study (PIRLS) assessments had commentators and analysists repeatedly discussing the news that 78% of Grade 5 learners could not read (at all) (Howie et al. 2017; Spaull & Pretorius 2019). Following on the publication of such distressing outcomes, a more recent study to set benchmarks for Nguni languages beginner reader attainment, Ardington et al. (2020) concluded that young children who do not progress past the 'threshold' of decoding and grasping the alphabetic principle by the end of the second grade are likely to need remedial help in subsequent grades. Another study about learning loss during the first year of the coronavirus disease 2019 (COVID-19) pandemic shows how the school closures have exacerbated the already disturbing reality of weak reading. Ardington, Wills and Kotze (2021) found that the loss of education time is likely to predict further deterioration in the reading proficiency of primary school learners well into the future. Because science learning from workbooks and other textual sources are common in Grade 4, it is crucial that learners learn to read for meaning and learn how to do it in the expository and argumentative texts of school science books and e-material.

Recently, a master's student in our research group, the first author, undertook a study to find out how a sample of Grade 4 learners responded to a reading task about a topic to which they had been introduced briefly in the Life Skills (Beginning Knowledge) curriculum in Grade 3, namely animal reproduction (Arends 2022). She was concerned that the general lack of reading skills that have been reported in large-scale literacy studies may be reflected even more pertinently in the reading of science textbooks. We present her study of Grade 4 learners' reading competence of a typical text in the science curriculum, arguing, from the results of the inquiry, that background knowledge and vocabulary, along with an overall strong sense of the structure of a language, are contributors to understanding a text about a specific topic.

In the Tunmer and Hoover (2019) model (Figure 1), learning to read is characterised by two intersecting streams of progress namely language knowledge and visual recognition of words. Pan et al. (2022) proposed that there 'may be some mutual promotion between vocabulary knowledge and word

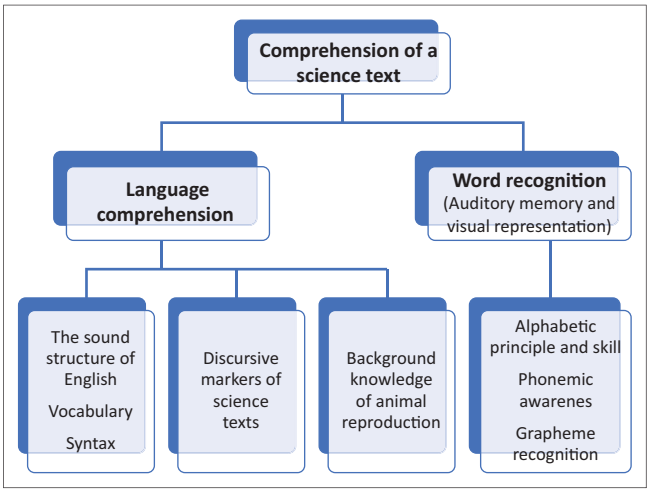

FIGURE 1: Cognitive foundations for reading a science text in Grade 4 (after Tunmer & Hoover 2019:77).

reading because the development of either of these leads to a stronger bonding of orthographic, phonological and semantic information' (Pan et al. 2022:59). We concur with this view and specifically with the authors' use of the term 'bonding' to describe the collation of language meaning in its written form and in its spoken form. Henning and Simelane (2022) refer to this cognitive and perceptual encounter as a 'meeting' that 'ignites' reading.

In this article, we apply the Tunmer and Hoover (2019) model to the construct of a specific print text about the reproduction of a giant lizard species. This model, although intended to represent the cognitive components of *learning to read* (CFLR), is applied/converted to show how the original building blocks of reading competence can culminate in understanding the meaning of a text about the reproduction habits of an animal that lays eggs and follows some unusual routines. We propose that to understand the text, the Grade 4 readers would, firstly, have learned to read by being instructed in the alphabetic principle and how to see the correspondence of letters with sounds. More specifically, they would have had to notice specific graphemes (individual, or clusters of letters) that represent a sound in the language of learning to become literate. They will, ultimately, automise the recognition of parts of words or whole words. With practice, they will increase their fluency as well. In addition to learning these skills of recognition, they also learn components of the language, ranging from its sounds, its words, its morphemes and its typical sentences. Regarding expository science texts, they will also need to see the cohesion of the typical discourse markers of such texts, such as argumentation and the building of expository networks of scientific information. They also have to adjust to the absence of narrative, which is the main genre for beginner readers.

In international and regional science education tests, such as the Trends in International Mathematics and Science Study (TIMSS)[1] and the Southern and Eastern Africa Consortium

1.http://www.hsrc.ac.za/en/media-briefs/general/timss-209-grade5-study#:~:text=The%20TIMSS%202019%20mathematics%20and,they%20acquired%20basic%20science%20.

for Monitoring Educational Quality (SACMEQ),[2] South African learners' results are a cause for concern as much as the PIRLS test results are. Reading the texts of mathematics and science requires not only alphabetical skills of reading, coupled with conceptual and procedural background/prior knowledge, but also some familiarity with the discourse of typical school science texts. It was with this understanding of 'reading as learning' (RAL) that the study was initiated with the research question, 'How do Grade 4 learners respond to a science text passage that they have read (and which was read to them)?'

The inquiry

Participant sampling and research setting

The population for this study was selected purposively; we opted for Grade 4 learners at a school where English is the medium of instruction, although very few of the children use it as a primary language at home. One of the aims of the study was to specifically find out how second/additional (L2) users of English read a science text. The random sample from the population of Grade 4 learners ($n = 148$) was selected to get optimally varied data for the topic of the study, while the population itself was selected purposively at the outset. The school is in a high poverty area of suburban Johannesburg, bordering on what was, historically, racially segregated areas of the metropolis. Merriam (2009:77) argues, in terms of purposive/purposeful sampling: 'Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry, thus the term purposeful inquiry'. The participants ($n = 25$), 10 of whom were girls, with the mean age 10.4 years at the time of the research, came from five different Grade 4 classes in this big primary school.

The adult population in the community of the school work in low income and casual labour employment. Most families receive social development grants from government for children under 18 and the school is a non-fee school in Quintile 1 of the categories of public schools in the country; this means that the school requires additional resources from the local education department. The community consists of people speaking a variety of languages, although the *lingua franca* is a mix of Afrikaans, interspersed with 'township' slang and some 'street' English. The medium of instruction in the school is English.

The first author (K) was granted permission by the Gauteng Department of Education and the school's governing body to conduct the research and consent letters were sent to the parents, all of whom consented. The learners were also asked if they would agree to participate over the 2 days scheduled for the research. The Ethics Committee of the Faculty of Education of the University of Johannesburg granted permission for the study to be conducted.

2.http://www.sacmeq.org/sites/default/files/sacmeq/reports/sacmeq-iv/national-reports/sacmeq_iv_project_in_south_africa_report.pdf.

Design and methods

The research was designed as a qualitative case study, keeping in mind that the research construct itself was the main conceptual parameter of the inquiry and that the participants, in their school, formed the boundary of the *bounded system*, which Merriam (1998), Stake (2005) and Yin (2013) regard as a characteristic of a case study. K spent 2 days at the school and administered a reading assessment instrument with 11 items, much as a teacher would do in a classroom setting. She also asked the learners to write a short passage as a summary of what had been read and to draw a Komodo dragon as they had imagined it. The procedure on the 2 days was different; although the reading assessment was repeated on the second day, photographs of the dragon were then shown to the children. In the first assessment round, they had no pictorial stimulus.

The 'design type' (Henning, Van Rensburg & Smit 2004) of the study was a qualitative case study (Merriam 1998, 2009) of learners' reading comprehension, coupled with their writing of a short passage and their drawings.

Data collection

The same test was completed in pencil-and-paper on two consecutive days and the responses were captured verbatim as language utterances, while the drawings on the first day were considered as artefact data. The rationale for the repetition of the questionnaire/test was that the participants may have retained some of the information and the vocabulary that they had encountered on the first day, thereby showing some memory retention and thus some evidence of learning. Another reason for a second day of research activity was that they would be able to express their understanding by writing a short passage about what they had read, giving them the opportunity of expressing themselves freely and imaginatively.

On the first day, K read the text orally and then the learners read it on their own. She gathered data by way of the test questionnaire that the learners completed in writing, and she also gave them time to make a drawing of what they had imagined about the content. On the second day, she repeated the administering of the questionnaire, with one addition: Included in the text were images of real Komodo dragons as they live on an island in Indonesia (Figure 2). In addition to

The life cycle of a Komodo dragon

The Komodo dragon looks like a giant lizard, but they are deadly and far stronger than a lizard. The scientific name for the Komodo dragon is, *Varanus komodoensis*, They weigh approximately 150 kg and are considered endangered. Komodo dragons are carnivores and it is predicted to live to the age of 30 in the wild. Let's read more on the life cycle of a Komodo dragon.

Source: JustFunFacts, 2017, *Interesting facts about Komodo dragons*, viewed n.d., from http://justfunfacts.com/interesting-facts-about-komodo-dragons/

FIGURE 2: Introduction to the text in the Grade 4 science class.

their responses to the items, she asked the learners to write a brief passage about the topic. The participants were given 15 min to read the text again and then time to write a short summary. Questionnaires were then again handed out to the learners. The four data sets were then collated.

Data analysis procedure

The process for analysing the information of the four data sets was in the modality of typical qualitative content analysis (QCA) with elements of open coding in grounded theory mode (Charmaz 2006). The responses for the open-ended items and the passage writing were transcribed. The drawings were coded according to our joint description of the pictures (Table 1). Although there were five multiple-choice items in the questionnaire, the responses for these were awarded a qualitative value. The learners' responses were coded as 'correct/incorrect word recognition'. The correct answers were coded according to one of three difficulty levels of an item.

Although there are several definitions of QCA, one that summarises its essence is from Roller and Lavrakas (2015:232), who state that QCA is 'the systematic reduction of content, analysed with special attention to the context in which it was created, to identify themes and extract meaningful interpretations of the data'. Mayring (2014), importantly, warns against rigidity and rule-bound analysis:

> The establishing of a concrete procedural model of analysis is of central importance. Content analysis is not a standardized instrument that always remains the same; it must be fitted to suit the particular object or material in question and constructed especially for the issue at. (p. 39)

Qualitative content analysis specialists do, however, agree that the initial task of awarding codes to units of meaning is the first step after having become familiar with the data: Charmaz (2006:43) defines qualitative coding as 'naming segments of data with a label that simultaneously categorises, summarises, and accounts for each piece of data'.

As a result of the different types of data sources, each data set was coded according to separate procedures. Inductive coding for the responses of the open-ended questionnaire items differed from deductive coding of the written passages and the drawings, where the analysis had an element of interpretation plus some evaluation according to criteria. Once the raw data of the study had been organised according to codes, these codes were then grouped into categories that were relevant to the interpretation of the content of the first coding phase. The categories were later assembled in themes that were formulated according to data across the four data sets.

Open-ended questions

The first author, K, started to develop the primary codes from the 'raw' data (Table 1). From these primary codes, she derived categories by clustering codes with related content. The process of naming the categories was somewhat more challenging than the naming of the codes because she now started interpreting the data by deciding which codes belong together conceptually and how they were aligned with the research question. The co-authors' views were incorporated in this step and the categories were refined once consensus had been reached. Table 1 shows the responses from three participant exemplars, who were given code names: *Se*, *Ga* and *Mo*. Such two-letter 'names' were given to all participants.

The task of deciding whether the learner had not read well, did not know the meaning of a word or just extracted information haphazardly was challenging. In the end, the 25 participants' responses were considered individually. For example, in Table 1, Participant *Se* appears to have had a good grasp of the content and could infer meaning to some extent, while Participant *Ga* likely selected parts of the text randomly for answers. Participant *Mo* did not read across sentences. Only five participants read cohesively – linking the meaning of individual sentences across sections of the text – thus being able to infer meaning.

Having awarded 73 codes altogether for all four sets of data in this way, the codes were then collapsed into 17 categories. Table 2 shows an example of how the codes of the same participants from Table 1 were clustered in two of the 17 categories that emanated from the whole corpus of data codes.

Some of the codes that were assigned in the first round were almost the same. Recognising that, they were left as they were and collapsed into a suitable category.

Written passage

In the coding of the passage content, the analysis had an additional layer, namely the interpretation (and evaluative/

TABLE 1: Example excerpts from the transcriptions of open-ended item responses.

How much does the Komodo dragon weigh?	Why does the female Komodo dragon dig holes when she is ready to lay its eggs?	How many months does it take for the eggs to hatch?	How long does a Komodo dragon live?	Where does the young dragon live in the first 5 years of its life?	How does the Komodo dragon protect itself while living on the ground?
Participant *Ga*					
They weigh is 150 kg	So that the eggs can keep warm enough	It takes April–July to hatch	They live from September–December	Young dragons live for five years in the trees	They can live on ground for their protection
Participant *Mo*					
It weigh's 150 kg	To confuse who might try eat her eggs	It takes eight to nine months to hatch	It lives about four to five years	In a tree	They dig sleeping burrows about 1 metre long on the side of the hill
Participant *Se*					
The Komodo dragon weight's 150 kg	To confuse predators who might try to eat her eggs she lays the egg in only one of the holes but closes all of the holes	It takes eight – nine months to hatch	For years	They young dragons that climb trees and will live in them for about four-five ys	The climb the trees

TABLE 2: Example of codes leading to categories.

Final codes for three participants	Categories		
	Category 1 Limited understanding of the written text and the questions	Category 2 Unable to formulate reasonably clear responses	Category 3 Struggle with the grammar and syntax of English
Participant 1: Limited understanding of the question Responding haphazardly Confusion about number words in the sentences	XXXX	XXX	XXX
Participant 2: Many grammar errors Almost no understanding of the question Haphazard response Did not understand the question Not able to write relevant reponses the participant does not understand the question Does not recognise number words in sentence form	XXXXXXX	XXXX	XX
Participant 3: Confusion between questions Does not understand the question Randomly picks answers Misinterpreting the information in the text	XXXXXX	XXX	XXX

X, the number of times the group of codes appeared for three participants.

TABLE 3: Examples of coding of the written passage.

Passage content	Notes	Content and writing competence	Codes
Participant 1: Firstly what I heard exiting about a Komodo Dragon is that it hatches many eggs like the amount of 30. Komodo dragons are always on their own except when they look for a partner to mate with. And I am pretty sure that its heavy, because it weighs 150 kg. And there's only one thing that is the same as female human. It reproduces only after 8–9 months.	Shows understanding and ability to link new information to existing information.	Imaginative addition to content of original text. Syntax and vocabulary good.	Good writing proficiency Syntax, grammar cohesion Assumptions based on read information Imaginative inference
Participant 2: I learned that a Komodo weighs 150 kg. And the Komodo dragon digs holes to protect itself from preditors. The Komodo dragon is carnivorers. I like Komodo dragons. They are very dangerous.	Spelling error and fails to begin sentences with a capital letter. Does not attempt to provide more information that they learned. Rushing through the writing. Penmanship is an issue as well.	Misinterpreting the information in the text. Basic writing skills.	Misinterpretation of information Limited writing skill
Participant 3: There was once a komodo dragon. He weighted about 200 kg. He was the highest gragon. He also had sharp teeth. He was green and black. He had hard and priky skin. He looed very scary. On day he went hunting for his children. He had about 8 or 9 children. But one day he went hunting but a bunch of big lion came to him and ate hime up and that was the end.	Turn passage writing into a story. Provides incorrect information of the Komodo dragon – look at the weight.	Grammar errors Creative writing on some passage information Grammar and spelling errors	Creative, imaginary writing Grammar errors

criterial judgement) of the researchers who were reading the content of this data set. A typical rubric for assessing learner writing contains three to four levels of achievement and includes sections about formulation, vocabulary, cohesion and spelling and grammar.

In the analysis of the learners' passage writing, K aimed to find out how the participants could express their understanding of the text they had read and how they used the information to compose their own writing. She summarised the comments as 'codes', which were to feature in subsequent categorising and thematising *Drawings*. The codes for the drawings were awarded in a similar way to the coding of the passage writing.

.The coding of this data set was, however, a challenge. K decided to create codes that reflected creativity and imaginative quality. Interestingly, in one of the drawings, the learner personified the dragon and her future offspring as humans (Figure 3).

In another drawing the learner created an artwork of fantasy.

There was one drawing that came close to what the text had contained. The learner drew a lizard-like figure, which showed that the content had been read in a specific way, with no indication of the theme about reproduction in the text, though.

The analysis progressed from here to the forming of categories across the various data sets and culminated in 17 categories/clusters:

1. Writing proficiency – large variance
2. Imaginative inference
3. Misinterpretation of information
4. Low word recognition
5. Some creative, imaginary written expression
6. Grammar and spelling reasonable
7. Limited understanding when listening
8. Limited understanding when reading
9. Written responses vague
10. Drawings are imaginary
11. Limited vocabulary for the text
12. Background knowledge vague
13. Limited reference to detail of the text in drawings
14. Limited reference to detail of the text in passage composition
15. Unsure of answers. Circled two possible answers
16. Guesses multiple-choice question (MCQ) answers
17. Incomplete answers

FIGURE 3: The dragon as human.

FIGURE 4: Fantasy dragon sky.

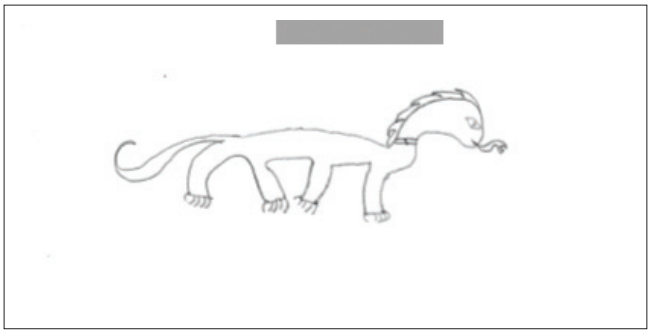

FIGURE 5: The lizard.

Table 4 shows examples of two categories/clusters, with some of the codes from which they had been constructed.

In the procedure discussed about coding and categorising, with 73 codes from the combined data, K had constructed the 17 categories. Thereafter she searched for connections between the categories, aiming to 'thematise' the data. She identified six themes, emanating from the various categories (Table 5). One co-author followed the thematising procedure independently and their consensus led to the following themes:

TABLE 4: Examples of coding for two categories.

Notes	Compilation of codes from notes
Category 3: Misinterpretation/misunderstanding of text information	
Did not understand the question, as it takes 8–9 months for eggs to hatch. Did not understand the question, as the Komodo dragon can live up to 30 years in the wild. The participant did not understand the question. The question asks where the Komodo dragon lives in the first stages of its life.	• Question was not answered • Random interpretation of text • Not understanding the text • Misinterpretation • Question and answer not matching
Category 14: Limited reference to detail of the passage	
These dates are not provided in the text. This answer is incorrect. This participant likely rushed through the text so that they can finish answering the questions. The participant is making assumptions. They are not answering the question with the information provided in the text.	• Answers are not from the text • Unable to identify facts from the text • Scanning text for answers • Providing information that is not from the text • Unable to retrieve information

TABLE 5: Categories that formed themes.

Categories	Themes
Writing proficiency – large variance	4
Imaginative inference	1, 2
Misinterpretation of information	1, 2, 4
Low decoding competence	1, 2, 3
Some creative, imaginary expression	5
Grammar and spelling reasonable	6
Limited understanding when listening	4
Limited understanding of the questions asked	1, 4
Limited understanding of the text when reading	1, 2, 4
Written responses not precise	5, 4
Drawings are imaginary	5
Vocabulary of the text is a challenge	4, 3
Background knowledge vague	4
Limited reference to detail of the story text in drawings	4
Limited reference to detail of the story text in passage composition	4
Unsure of answers. Circled two possible answers	2, 3, 4
Guesses MCQ answers	3, 4
Incomplete answers	1, 2, 3, 4

MCQ, multiple-choice question.

Theme 1: Basic word recognition skills in English for Grade 4 level have not been secured

Theme 2: Reading cohesively – not yet secured

Theme 3: Low-level inferencing

Theme 4: Background knowledge and vocabulary not sufficient

Theme 5: Imaginative writing composition and drawing

Theme 6: Minor grammar and spelling errors

Table 5 shows the number of times a category was aligned with a theme, indicating the strength of each theme.

It is evident that several categories could be aligned with Theme 4: 'The learners did not have sufficient background knowledge and vocabulary to read the text with understanding'.

Discussion

Considering the collage of four different data sources and the individual methods of interpretation and analysis for the various data sets, it was no mean feat to bring such a variety of processes together for discussion. The strength of

qualitative data analysis is that its very structure gives some evidential warrant for conclusions to be drawn. Neither data sources nor their analyses were by any means equal in their individual importance. However, as an amalgam they produced worthwhile findings. The amalgam gives a sense of a 'collage' of findings; we argue that the detail of the data and of the analysis shows a *pattern* in this collage, reflecting the patchwork nature of the design of the study. This detail also makes it possible to replicate the study, which is a qualitative measure for replicability (reliability). By the very nature of the study as one case, findings cannot be generalised, though. Nevertheless, when the research question had to be 'answered', there was sufficient information to 'validate' the findings or to propose that the findings are worthy of trust.

With regard to the theoretical lens of the study, namely how sense/meaning can be made from text, the evidence from the analysed data suggests that Theme 4 is pertinent. As a main finding, this fits the 'background knowledge and vocabulary' building block of reading comprehension (Figure 1). With that, the skill of reading intersententially, making cohesive links between various parts of the text, is a second important finding. Knowledge of how syntax works in a language is a skill that readers in Grade 4 should ordinarily have achieved so that they can read for cohesion across sentences and for inferential deductions from the text.

There was, thus, no evidence in the data that the children 'cannot read' (at all) because their decoding and other basic skills were not assessed. Although they did not recognise several words and did not read across sentences for cohesion, it does not necessarily mean that they could not decode these words. However, if they did not know the meaning of the word, they are unlikely to have been able to 'recognise' the word. This brings another important finding to the surface. As with most science texts for school use, the text used in this inquiry is dense, and several new terms are introduced. The discursive style of science textbooks, like the text about the Komodo dragon, is often overly expository and often 'cluttered' with several modalities such as font style, colours, 'boxes', drawings and instructions on one (busy) page. In the end, though, the text that was used in this study is not necessarily too difficult for the Grade 4 readers in terms of its content. For 'deep comprehension' (Best et al. 2005; Ozuru, Dempsey & McNamara 2009), however, it was not optimal, because of its style. Arya, Hiebert and Pearson (2011) argue the value of cohesive texts:

> Given that text cohesion influences readers' maintenance of text coherence, readers' prior knowledge and reading skill should interact with text cohesion in different ways in influencing comprehension. With respect to readers' prior knowledge level, the benefit of text cohesion should be more pronounced for readers with less knowledge. That is, whereas maintenance of text coherence in a less cohesive text demands contribution of specific knowledge, a highly cohesive text is more self-contained; hence, it requires less contribution of topic-specific knowledge for maintenance of text coherence. (p. 106)

With regard to the drawings, the findings are encouraging. To personalise the dragon, one learner drew a human and four smaller humans in what is presumably a 'hole'. This type of drawing begs for further analysis and an interview with the learner. Another drawing created a fantasy image of flying figures. Like Vygotsky, we propose that imagination is a source of scientific creativity (Vygotsky 2004).

In summary, notwithstanding the main limitation of the study – namely the absence of individual learners' process of making meaning – this study has shown that science reading tasks require preparation. Such preparation could include not only vocabulary and syntax but also the structure of the text and its style. We argue that reading in science and other content areas in the early grades can alleviate some of the challenges of background knowledge, vocabulary and text structure that learners typically experience in the intermediate phase. Several studies have suggested literacy learning and content subjects could be combined during the time when children are learning to read in the early grades. We would concur with this view of early reading across the curriculum, such as the study by Williams et al. (2009) about embedding reading comprehension in Grade 2 and Kim et al. (2021) and Cervetti et al. (2012) who have, respectively, argued for improving knowledge depth of early grade learners and for the expansion of science vocabulary and discourse in the early grades. Kim et al. (2021:1940) suggest: 'Content literacy instruction may provide an ideal context for helping young children mentally instantiate and leverage networks of academic vocabulary words to further develop their domain knowledge'. Williams et al. (2009) emphasise the importance of teaching text structure and deliberately targeting comprehension skills in science text reading once children have grasped the alphabetic principle and have achieved sufficient reading fluency. We would add to that the need to teach young readers to read critically and to form their own view of text content, much as some of the participants showed in their drawings. Lastly, as Snow (2010) has explained, the academic language of school science has to be mastered – and it is no mean feat to do so. The collage of data comprised a pattern that indicates the academic language proficiency is crucial for learning.

Although many teachers may think that 'simple language' is important for children to learn, it also holds true (Tunmer & Hoover 2019) that knowledge and vocabulary are crucial building blocks for reading in subject area.

In collating the five themes, it is evident that the learners' struggles are not only related to fluency in decoding, but especially with reading across sentences and being able to meaning by inferring. These are skills that are not taught very well in the classrooms that I have observed. With that comes the need to know not only the meaning of individual words, but also how to fund meaning across words, which means that the meaning of words must be known.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

K.A. conducted the research and composed 80% of the article. K.F. conducted supervision and composed 20% of the article. K.F. also reviewed and edited the article

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg Faculty of Education Research Ethics Committee (No. Sem 1-2021-049).

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Data availability

Derived data supporting the findings of this study are available from the corresponding author K.J.A. on reasonable request or the University of Johannesburg Library Repository.

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