



Can readability formulae adapt to the changing demographics of the UK school-aged population? A study on reading materials for school-age bilingual readers

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ABSTRACT

Background: Due to the increase bilingual population in the UK, it is imperative that reading materials are made accessible for them in and out of school. This study begins by reviewing literature on bilinguals reading comprehension competence, discussing findings and impact on limiting academic achievement. Much literature criticises readability formulae as a tool for grading reading materials. Readability formulae, for example, do not account for differences in reader's dialects and cultural backgrounds. Therefore, this study looks to identify those discrepancies and assess the effectiveness of two well-known readability formulae. It then compares these to a readability formula for bilinguals to identify any consistencies between outcomes, enabling identification of any categories or factors crucial in identifying the reading difficulty of texts for bilinguals not included in well-known readability formulae, specifically for school-aged children.

Method: 20 randomly selected eBooks available for children aged 7-9 y were quantitatively evaluated using three readability formulae: Spache, Flesch-Kincaid and McAlpine EFLAW.

Findings: Based on these results, it is inconclusive if the readability formulae are consistent with each other, as they did not appear to follow the same trend and assessed different criteria. Therefore, the findings suggest no readability formula used in this study can be confidently used on its own to successfully assess the readability of books to deem suitability for bilingual readers as it is paramount that non-text factors need to be incorporated when matching books for students.

Conclusions: This study concludes that a formula or a new set of criteria needs to be created which incorporates the salient factors affecting reading comprehension of bilinguals to best allow educators and authors to select and modify reading materials for this growing population, to increase accessibility academically, enabling best outcomes to be achieved.

1. Introduction

Approximately half the world's population is bilingual or multilingual (Ansaldo et al., 2008; Giovannoli et al., 2020), and the number of immigrant children not speaking the majority language of their place of residence is increasing (Giovannoli et al., 2020). The UK is becoming increasingly multilingual, with growing proportions of school-aged children being raised to speak languages other than English at home (Lamb, 2001). According to the Department for Education (Department of Education at the University of Bath, 2017), the proportion of primary school children speaking English as an Additional Language (EAL) has almost doubled from 11% in 2004 to 20.6% in 2017, accounting for one

in six primary school pupils, with over one million school children in England speaking minimum one language other than English.

Bilingualism, according to Wei (2020), is defined as the capacity to function in both languages in conversational interaction, at home and society regardless of proficiency (Royal College of Speech and Language Therapists, 2006). According to the department of education and skills (Department for Education and Skills, 2007), EAL is defined as children exposed to a first language, not English during early development, who use this language in their home or community settings. The terms EAL and bilingualism are often used interchangeably in literature (Silverman et al., 2014) and education (Office for Standards in Education (Ofsted), 2001) despite having different meanings, therefore different

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characteristics due for example to bilingualism not necessarily constituting to English being the first language. Therefore, interpretations of studies using this terminology needs to be handled with caution, as can reduce relevance to research on bilingualism, as bilingual studies may not incorporate English as one language.

Bilingualism benefits children, allowing them to grow-up with a better self-awareness of their heritage and culture, giving them pride, accomplishment, and diversity appreciations (Raguenaud, 2009), benefitting literacy development and academic achievement (Fox et al., 2019).

1.1. Relevance of reading

Dickinson et al. (2012) in a study of bilingual speakers with a regional language, Gaelic in Scotland, found out that it is developing reading skills during early childhood also in a language other than the dominant language spoken in the community can be beneficial for all reading skills, suggesting reading comprehension as the critical factor for long-term and overall academic success, (Mancilla-Martinez and Lesaux, 2010). Although a bilingual may be proficient in a language, it may not be the same language the book is written in, affecting readability in the educational context.

Book reading influences language learning, providing opportunities to hear new vocabulary embedded in different grammatical environments (Dickinson et al., 2012), and books contain broader ranges of words than in everyday conversation, ideal for vocabulary learning, promoting joint attention and interest. However, language levels development acquired through book reading are dependent e.g., on frequency of reading, early language abilities and onset age of book reading, as children benefit when regular reading routines begin around eight months (Dickinson et al., 2012). Aside from language development, reading brings pleasure, enabling escape from undesirable situations, developing imagination (Funk and Funk, 1992).

1.2. Different types of readability formulae

Readability is a property of a text and it refers to 'how easily written materials can be read and understood', incorporating language and non-language elements (Oakland and Lane, 2004). There are over 200 readability formulae using differing criteria to assess material readability for different ages and purposes, with varying success and accuracy (Begeny and Greene, 2014). Readability formulae look at average sentence length, number of words, word familiarity, syllable length and grammatical complexity (Begeny and Greene, 2014; Zamanian and Heydari, 2012), which has been regarded as best indicators of readability (Gray and Leary, 1935). These formulae determine text difficulty, generally in terms of educational years required to comprehend or cope with that text without frustration (Begeny and Greene, 2014; Compton et al., 2004). Therefore, formulae assist educators and authors in selecting and creating appropriate reading materials for students (Sangia, 2015), ensuring materials have same intended impacts on readers, ensuring individuals' reading abilities are not lower than the materials reading difficulty (Oakland and Lane, 2004).

Specifically for this study, the Flesch-Kincaid grade level formula (Kincaid et al., 1975) has been included as it assesses upper elementary to secondary grade readability using average sentence length and number of syllables per word and has been tried with foreign languages in original and modified forms. The Spache formula (Spache, 1953) will also be adopted in the study as it assesses readability for students in lower elementary grades (Begeny and Greene, 2014) incorporating average sentence length and percentage of difficult words.

These are the two more traditional readability formulae adopted in the education setting and none of them account for differences in reader's dialect or cultural backgrounds (Bruce et al., 1981) failing to consider any criteria for bilinguals, known to have weaker reading comprehension (Berens et al., 2013). Hence, classic readability formulae

are considered inaccurate in predicting bilinguals' readability (Sangia, 2015), some of these factors are addressed by the McAlpine EFLAW formula (McAlpine EFLAW (McAlpine, 2005)). The McAlpine EFLAW assesses readability for EAL readers (Nafa, 2022). This formula includes intensity of mini words in its criterion, defined as words containing fewer than three letters e.g., beginning with or containing 'it', 'it is' etc, a vulnerability for bilinguals as these usually have no meaning (Sangia, 2015). Incorporating number of words, mini-words and sentences is said to be more suitable for assessing bilinguals' readability than traditional formulae (Sangia, 2015).

Readability assumptions cannot solely be based on formula outcomes for children as these formulae only rely on lexical, semantic and grammatical text variables, known to not be the only readability predictors (Schriver, 2000). These do not incorporate other variables, known to have significant impacts on readability, (Lenzner, 2013), especially for bilingual speakers, e. g. background knowledge, inferencing abilities, motivation and interest (Bruce et al., 1981), language differences, education and learning styles, among deeper syntactic and semantic structures of texts, genre and reader-reading material interactions (Zamanian and Heydari, 2012; Ismail et al., 2016). Further evidence criticises readability formulae for being weak readability indicators due to not closely aligning with cognitive processes involved in text comprehension (Crossley et al., 2011). Therefore, in classroom settings, it is unlikely readability formula information will be the singular measure used by teachers to suitably match books, as information making texts easier to understand is not given (McNamara et al., 2014a). Teachers know students more personally, accounting for other factors when matching books (Wray and Janan, 2013).

Readability formulae are also outdated; Flesch-Kincaid was created in 1975 and Spache in 1953. Since then, book difficulties and words deemed unfamiliar have changed, which largely determines readability in the Spache formula [23]. These word lists are usually a small set of outdated words [33], not accounting that many English words are derivatives and compounds, a critique supported by Lenzner [28].

When Lenzner (2013), applied readability formulae to survey questions, significant inconsistencies were found, implying formula choice strongly influences readability conclusions, deeming them useless. This finding is also verified by Heydari (2012) who found no correlation between formulae and readers evaluation of passage text-difficulty when compared by 118 undergraduate participants, suggesting inconsistencies. However, Heydari (2012) conducted this study on undergraduate participants who are different age ranges to this study and used readability formulae (SMOG and Gunning-Fog index) not in this study, weakening relevance. This mismatch was also discovered by Zheng and Yu (2017a), who compared users' perceptions of difficulty reading electronic health records to formula outcomes; however, this study's reading materials used, data collection methods via patient interviews and the participants age group do not align with this current study, decreasing relevance. However, findings of inconsistency between formulae are further supported by (Begeny and Greene, 2014; Schriver, 2000; Ardoin et al., 2005).

1.3. Factors related to reading comprehension

Current research suggests bilinguals' educational attainment is behind monolinguals (Strand et al., 2015). A reason being bilinguals reading is significantly behind monolinguals, with the gap increasing with age (Berens et al., 2013) as they receive less input from each language than monolinguals (Rispen and de Bree, 2015) or another reason could be that the variable considered in reading text are not favourable for them.

To comprehend written texts, readers need to be familiar with word and sentence meanings in relation to each other (Bayat, 2017), difficult for bilinguals due to weaker reading comprehension (Bayat, 2017). This is contradictory to early research by Mumtaz and Humphreys (2001) who found bilinguals had higher reading ages and comprehension

standards than monolinguals in a study comparing 120 7–8-year-olds, half being bilingual Urdu-English speakers, a finding supported by (Yeganeh and Malekzadeh, 2015) Yeganeh et al. However, later studies e.g., by Bayat (2017) comparing reading skills of bilingual and monolingual fourth grade primary school students in Turkey, found whilst monolinguals try mastering academic content in school, bilinguals need to master content and a new language in school, slowing down reading development (Bayat, 2017). This is due to negotiating two linguistic systems and needing to acquire reading skills in a language not spoken at home (Martohardjono et al., 2005).

Bilinguals' reading development can differ slightly as when Berens et al. (Spache, 1953) looked at optimal reading and language mastery in 213 young bilinguals, a dual-language learning context was found to lead to greatest reading and language mastery. This is when reading and learning occur in two languages during the same educational and developmental time with similar linguistic input amounts from both languages, supported by Pigulskaya (2007) who acknowledges home literacy learning experiences, influence literacy skills.

Similarly, when Papastefanou et al. (2019a) tested forty Greek-English bilingual children on phonological awareness and vocabulary, they found bilinguals have strong decoding skills, but weaker linguistic comprehension skills than monolinguals (Papastefanou et al., 2021), impacting reading comprehension (Papastefanou et al., 2021). Although Droop and Verhoeven (2003), who investigated reading abilities of 302 children in the Netherlands, speaking Dutch, Turkish and Arabic, further agree bilinguals have well-developed metalinguistic knowledge influencing strong decoding skills. They suggest this depends on the other language as reading skills are highly dependent and strongly predicted by morphological structures and second language reading proficiency. Orthographic transparency also impacts this, as reading in languages with shallower orthographies corresponds to higher accuracy levels with regards to reading proficiency compared to bilinguals reading in deeper orthographies (Lallier et al., 2014).

However, there are not unanimous agreements between literature regarding bilingualisms impact on literacy due to the heterogeneous nature (De Bruin, 2019). This is due to factors such as age and context of acquisition, language use (De Bruin, 2019), properties of the other language itself (Papastefanou et al., 2021) e.g., high cognate frequencies (Kuo et al., 2017), orthographic depth (Lallier et al., 2014) and certain morphologies delaying language acquisition, affecting reading comprehension (Rispen and de Bree, 2015). These factors reduce some studies relevance to this study due to bilingualisms individualised nature. This makes results detailing bilingualisms impact on readability not entirely reliable, particularly those from different countries examining different languages with different properties.

For bilinguals, language and reading development in the second language is influenced by the first language's characteristics (Papastefanou et al., 2019b).

According to Ongun (2018), vocabulary is a pertinent aspect in language development and has significant impacts on and predicts bilinguals' reading comprehension (Garraffa et al., 2019; Bialystok et al., 2010). Vocabulary is a strong reading performance predictor and can predict bilinguals' intelligence (Ongun, 2018). It is said reading comprehension is jeopardised if over 3% of words in a text are unknown (Papastefanou et al., 2021), which can be the case for bilingual readers due to having smaller lexicons in each language than monolinguals (Bialystok et al., 2010), displaying lower medians of vocabulary in schoolyears (Ongun, 2018). Reading materials are typically written for monolinguals containing low-frequency vocabulary, difficult for bilinguals to understand (Ongun, 2018). This weakens their readability as different languages have different writing systems thus different syntactic knowledge around text structures, making understanding written texts by authors of different languages difficult (Bialystok et al., 2005).

Grammar is another factor influencing bilingual reading comprehension (Akbari, 2014). Grammatical structures of sentences impact readability (Bailin and Grafstein, 2016) as these aid text understanding,

said to account for greater variation in bilinguals than monolinguals reading comprehension over vocabulary.

Morphological awareness is another factor affecting bilinguals reading comprehension, playing substantial roles in predicting reading and comprehension development (Kuo and Anderson, 2006). Although Marsh et al. (2020) suggests bilinguals' morphological awareness exceeds monolinguals due to advanced metalinguistic skills, other findings disconfirm this, suggesting bilinguals have reduced morphological awareness and is largely language dependant (Saiegh-Haddad and Geva, 2008). Children with more developed morphological knowledge have advantages acquiring and retaining morphologically complex vocabulary which makes up 60–80% of new words acquired by school-aged children (Kuo and Anderson, 2006). This therefore affects bilinguals, said to have weaker morphological structure awareness (Papastefanou et al., 2019b) which Lam et al. (Papastefanou et al., 2019b) suggests is a strong vocabulary knowledge predictor, therefore influencing their reduced vocabulary medians (Ongun, 2018).

Level of exposure also plays a role in influencing bilinguals' reading comprehension. Language proficiency correlates to how much and how long children receive exposure to that language— those with higher intensities and longer exposures do better than those with lower exposures (Garraffa et al., 2019). If exposed to both languages for similar amounts of time, children are not expected to acquire two languages equally as acquiring a language is based on output quality not quantity (Bayat, 2017).

Socioeconomic status, parental education and gender are influencing factors on bilinguals' reading comprehension (Papastefanou et al., 2021). According to Vygotsky (1978), home environment influences reading comprehension abilities because better parent-child interactions, characterised by increased shared book reading increases reading and language abilities (Dickinson et al., 2012; Law et al., 2018) due to more stimulating literacy environments as parents act as scaffolders, assisting children's learning about topics. However, this is dependent on parent-child interaction styles as parents must optimise conversational opportunities using appropriate books (Dickinson et al., 2012) However, this evidence does not address differences in bilingual reading skill acquisition, known to be slightly delayed (Berens et al., 2013).

1.4. Current study

The purpose of this quantitative study is to explore the consistency between two 'standard' readability formulae (Flesch-Kincaid and Spache) (Kincaid et al., 1975; Spache, 1953) and one specifically for bilinguals (McAlpine EFLAW) (McAlpine EFLAW (McAlpine, 2005) and their appropriateness to assess readability of reading materials for school-aged children.

This study will further investigate findings from current research suggesting studies on bilingual reading comprehension and readability studies do not align (Schriver, 2000). The hypothesis is McAlpine EFLAW will be a more accurate indicator of readability for bilinguals than the other formulae due to the criteria. This study aims to identify factors crucial in identifying bilinguals' readability, not currently included in readability formulae. This will enable authors and educators to make modifications, adapting standardised processes when creating and selecting reading materials for school-aged children, increasing accessibility and book matching success, for growing bilingual demographics.

This comparison has been chosen as there has not been studies examining these readability formulae particularly for school-aged bilingual children. Therefore, this is a research gap that has been identified.

Due to lack of reading material accessibility for growing school-aged bilingual populations, they are frequently misdiagnosed with developmental language disorders, because of weaker linguistic abilities than monolinguals. This causes misidentification of underlying causes, with

risks of both under and over-diagnoses of language disorders in bilinguals (Garraffa et al., 2019). Therefore, identifying criteria crucial in determining readability for bilinguals will increase the identification success of whether children are presenting with literacy delays due to learning difficulties or language learning statuses (Fraser, 2017).

Therefore, the research questions are:

- i) How consistent and accurate are Spache and Flesch-Kincaid readability formulae compared to McAlpine EFLAW when determining reading materials' difficulty for school-aged bilinguals?
- ii) How accurate is McAlpine EFLAW in determining reading materials' difficulty for school-aged bilinguals?

2. Methodology

2.1. Sample

The study incorporated 20 eBooks produced by Oxford Owl and available for school-aged children aged 7–9. The books were selected from the online Oxford Owl website eBook library (<https://www.oxfordowl.co.uk/for-home/find-a-book/library-page/>) (Oxfordowl.co.uk, 2022), which covers a range of genres, giving a more representative sample. (See Table 6 for a list of books). This entailed making a free student account to enable electronic access to the eBooks. Samples of the first 200–300 words were selected from these 20 texts, calculated by typing these into a Microsoft Word document.

Using this selection of texts used in children's education from the Oxford Owl website, a series of statistical evaluations were conducted using the core readability formulae for this study. These extracts were then put through the: Flesch Kincaid Grade level, Spache revised formula, and the McAlpine EFLAW formula Kincaid et al. (1975); Spache (1953); McAlpine EFLAW (McAlpine, 2005).

2.2. Readability formulae

The two traditional readability formulae being assessed were specially selected for this research purpose. Firstly, the Spache formula is used to assess difficulty of reading materials for students in lower elementary grades (below year 4), making it suitable for this study as the age group is 7–9. As well as incorporating average sentence length, this formula includes the presence of unfamiliar, difficult words, a particular vulnerability affecting bilinguals reading comprehension due to having smaller lexicons in each language, affecting vocabulary knowledge (Bialystok et al., 2010).

The Flesch-Kincaid formula assesses comprehension difficulty of reading materials for upper elementary through to secondary grades (below year 6, equating to age 11 and below). This formula focuses on average syllable numbers per word and words per sentence, again increasing suitability for my question, focusing on morphology, a weakness experienced by bilinguals when reading (Clahsen and Jessen, 2021).

As well as these specifics, these formulae were chosen as both are readily and easily available with high popularity, looking at the linguistic elements of texts, and are free to access.

The McAlpine EFLAW formula was used in this study as it gives results based on evidence of what bilinguals find difficult in terms of reading comprehension, increasing suitability for my research question. However, this formula is not age specific, being intended for a 'global audience' (McAlpine EFLAW (McAlpine, 2005).

The texts were entered into the Spache and Flesch-Kincaid readability formulas provided from <https://readabilityformulas.com> by copying and pasting.

For the McAlpine EFLAW readability formula, the VBScript file was downloaded from <https://www.rlmuellet.net/Readability.htm>. Each book was then saved into a text file and then the script was run with each text file containing the text from the books in the command prompt

using the command `cscript Eflaw.vbs < filename.txt >`. This was then run to give results for the study.

2.3. Data

Data on a series of linguistic factors were collated, these included: Number of words (sum), Number of sentences (sum), Mean number of syllables in words, Mean number of words in sentences, Number (and percentage) of repeat words, Number (and percentage) of unfamiliar words, Percentage of double syllables (polysyllabic words), Number of mini words.

In terms of inclusion criteria, books selected were for children aged 7–9, as this provided the largest range of freely available eBooks from the Oxford Owl website. Texts also needed to be available as eBooks on the website.

The books also all had to be written in standard English and no older than 15 years old to give a more representative sample, because writing styles are everchanging ensuring they represented more modern, frequently used vocabulary.

It was also ensured these books included pictures, as these are known to contain a richer diversity of words (Readabilityformulas.com, 2022) and a greater incidence of grammatical constructions (Strouse et al., 2018), known to be a factor impacting the reading proficiency of bilinguals (Bailin and Grafstein, 2016), increasing suitability for my research question and this age group.

The eBooks chosen were both fiction and non-fiction, because at this age, the curriculum involves more concrete topics linking into non-fiction reading material, making it more representative of this age group.

Other inclusion criteria were that books had to have been published for schools and longer than 200 words to enable a representative sample to be extracted.

With regards to exclusion criteria, books were ensured to not contain too many pictures because children often rely on pictures rather than text to understand book meanings (Ismail et al., 2016). This would negate this study's purpose as even if the book had a high readability score (difficult to read), it may not be too challenging for the child due to becoming reliant on pictures, impacting findings.

It was also ensured to not choose books older than 15 years as the curriculum has changed since, making this study more representative of current books on offer in schools and reading for pleasure. It was also ensured to not use non-books e.g., newsletters and any books not suitable for children aged 7–9 in British Schools.

A statistical analysis involving the mean, median, mode and standard deviation for all the results was then calculated for readability formula outcomes. The data was then examined to assess the consistency and reliability of these formulae to successfully facilitate matching of reading materials to school-aged bilinguals.

3. Results

3.1. Linguistic and lexical attributes

In this study, Flesch-Kincaid grade level, Spache and McAlpine EFLAW formulae were used to statistically analyse data extracted from 20 texts to identify consistencies between formulae when applied to school-aged children's books. In Table 1, linguistic factors are reported for all texts. Lexical variables including number of words, repeat words, sentences, words in sentences, syllables in words and percent of double syllables were calculated.

In Table 2, lexical property factors are reported for all texts including number of unfamiliar words, percentage of unfamiliar and repeat words.

3.2. Grade and score comparisons

Table 3 compares grade and scores from Spache, Flesch-Kincaid, and

Table 1
Summary of means, standard deviation (SD) and range of Linguistic attributes from Spache and Flesch-Kincaid readability formulae.

	Number of words (sum)	Number of repeat words	Number repeat words (%)	Number of sentences (sum)	Words in sentences	Syllables in words	Percent of double syllables
Mean	256.9	99	38.3%	31.7	8.45	1	18.6%
Mode	228	85, 71	41%	31	8	1	17%
Median	262.5	98	38.5%	31	8	1	18%
SD	34.6	22.8	5.4%	34.6	1.50	1	3.8%
Range (Min-max)	204–312	67–144	28%–47%	204–312	6–11	1	11%–25%

Table 2
Summary of means, standard deviations, and ranges of Lexical properties results from Spache and Flesch-Kincaid readability formulas.

	Number of unfamiliar words	Number of unfamiliar words (%)	Number of repeat words (%)
Mean	157.8	61.7%	38.3%
Mode	179	59%	41%
Median	157.5	61.5%	38.5%
SD	20.7	5.4	5.4
Range (min-max)	124–198	53%–72%	28%–47%

Table 3
Summary of grade levels for Flesch-Kincaid, Spache and McAlpine EFLAW formula score.

	Flesch-Kincaid grade level	Spache (Grade)	McAlpine EFLAW
Mean	2.8	4.2	11.7
Mode	3	5	9.1, 11, 11.5
Median	2.8	4	11.3
SD	1	0.8	2.2
Range (min-max)	1–5	3–5	8.5–16.5

McAlpine EFLAW formulae when applied to selected texts.

The Flesch-Kincaid and Spache formulae give grade estimates according to US education systems, convertible to UK systems, depicted in [Table 4](#). For consistency purposes, the term ‘Grade’ is used in this study.

3.3. Overall results interpretation

The Flesch-Kincaid formula assesses text readability examining average sentence length and syllable numbers with better scores for texts containing shorter words and sentences. The mean for all texts was 2.8 suggesting an average readability grade of 2 or 3, indicating age seven suitability. The standard deviation of 1 is small. This suggests data points are closer to the mean, with less variation and data skewness, as points are closer together. This is also shown by equal median and means, demonstrating a unimodal distribution with fewer anomalies.

The Spache formula analyses texts using ‘familiar’ words list. Any words not on this list are deemed ‘unfamiliar’. The formula gives a readability grade from average sentence lengths and unfamiliar word percentages. This formula’s mean was 4.2, suggesting, on average, the books sampled are readable for 4th graders, aged nine. The standard deviation is small at 0.8. This shows data points are closer to the mean

Table 4
US grade to UK year and age conversions.

Grade (US)	Year (UK)	Age
2	3	7
3	4	8
4	5	9
5	6	10

with less variation and data skewness. The mean and median are equal, suggesting a unimodal distribution as fewer anomalies.

The McAlpine EFLAW formula does not provide a text grade level (as is not children specific), instead, it provides a numerical score intended to assess readability for a ‘global audience’. This formula considers number of words, mini words (three letters or less), and sentences to determine readability. A score lower than 20.49 corresponds to ‘very easy to understand’ while a score higher than 29.49 equates to ‘very confusing’. The McAlpine EFLAW mean was 11.7 indicating texts were ‘very easy to understand’ on average. However, because this was designed with a ‘global audience’ in mind rather than specific age group, texts may be easily understood by older rather than school-aged bilinguals.

The results differed when the three readability formulae were applied. When determining readability, the Flesch-Kincaid and Spache formulae provide a grade estimate. The Flesch-Kincaid formula has a 2.8 mean grade and a mode of 3, suggesting grade 3/year 4 is the most common grade for these books. However, the Spache formula had a 4.2 grade mean, suggesting texts correlated to grade 4. The mode of 5 suggests the most common grade for these books is grade 5/year 6. Although both readability formulae are for the same ages, they produced two different mean grades, suggesting inconsistencies between formulae. However, their standard deviations overlap, suggesting there is not a significant difference between results, increasing result reliability. The McAlpine EFLAW formula does not estimate grades, instead giving a numerical number corresponding to a category ranging from ‘very easy to understand’ to ‘very confusing’. This formula’s data suggests all books are ‘very easy to understand’. [Table 5](#) displaying readability formula results for all texts, allowing for more individual data analysis to identify specific trends and variations between results.

McAlpine was hypothesised to be more accurate, producing higher scores, depicting harder readability. This was therefore hypothesised to

Table 5
Summarising Flesch-Kincaid, Spache, and McAlpine EFLAW readability formula grade, levels and scores for all texts.

Sample	Flesch-Kincaid grade level	Spache grade level	McAlpine EFLAW
1	3	3.5	14.4
2	3	4.1	10.9
3	5	4.4	14.1
4	1.9	3.3	9.1
5	5	4.8	14.6
6	1.6	4.5	14.2
7	3.2	4.5	11.6
8	2.1	4.4	11
9	2.8	4.2	11.5
10	1	3	8.5
11	2.1	5.2	11.1
12	2	5	9
13	2.3	3.2	11
14	2.8	4.9	10
15	3.1	5	9.1
16	3	5.1	11.5
17	2.2	4.9	10.2
18	3.2	3.7	16.5
19	4.4	4.4	13
20	2.6	3.4	12.4

Table 6
List of the 20 books used in this study.

Book title	Author	Year of publication
Fables from Africa	Elizabeth Laird, Michaela Morgan, Timothy Knapman, Brian Gray, Fiona MacDonald	2010
Journey to Mars	Tony Bradman	2014
Animal Conflicts	Steve Parker	2014
Stinky Street	Helena Pielichaty	2006
Downhill Racers	Jonny Zucker	2014
Cool Clive	Michaela Morgan	2014
Kelly the rescue Dog	Tessa Krailing	2003
Cornflake Coin	Jonny Zucker	2008
Here comes trouble	Corinne Demas	2013
Oh, Otto!	Michaela Morgan	2008
The personality potion	Alan MacDonald	2014
Grace the Pirate	James Riordan	2014
Big game Adventure	Alison Hawes	2014
Animal tricksters	Candy Gourlay	2010
Doohickey and the robot	Jonathan Emmett	2014
The Rust Monster	Steve Cole	2014
Waiting for Goldie	Susan Gates	2005
Why the sea is salty	Rosie Dickins	2009
The Destroyer	Tony Broadman	2014
Team X	Tony Broadman	2009

constitute lower Flesch-Kincaid and Spache formula grades, implying books are more easily read, due to not including bilinguals' difficulties.

Book 18 had the highest McAlpine score at 16.5, but grade 3 in other formulas, some of the lowest. Whereas book 12 had one of the lowest McAlpine scores, 9, but a Spache grade 5 and 2 in Flesch-Kincaid suggesting a large, 3-grade/age variation between formulae ranging from ages 7–10, wider than the website suggests. Although the hypothesised trend is sometimes apparent, this is not a reliable cross-comparison because not all formulae produce grade estimates.

4. Discussion

This study compares general reading formulae to a bilingual-specific formula to determine how accurately and consistently reading comprehension of school-aged bilinguals can be assessed. The hypothesis was that the McAlpine EFLAW formula (McAlpine EFLAW (McAlpine, 2005) would provide a more accurate picture of book readability for bilinguals than the others (Spache and Flesch-Kincaid) (Spache, 1953; Bruce et al., 1981) because these do not specifically account for difficulties faced by bilingual readers, such as 'mini words' and syntax, areas of difficulty for bilinguals (Bailin and Grafstein, 2016).

After statistical analysis, it can be concluded, for the 20 samples studied, there is no overall consistency between results presented by readability formulae when applied to all texts.

The McAlpine EFLAW formula's mean of 11.7 suggests all books were 'very easy to understand'. The Flesch-Kincaid formula's mean concludes on average, all books were suitable for grade 2/3. The Spache formula's mean concludes, on average, books were suitable for grade 4. These readability formulae findings demonstrate inconsistencies between formulae, at times with a 3-grade variation from grade 2 to 5, between Spache and Flesch-Kincaid formulae e.g. in book 12. This is further shown by the uneven distributions of grades between the two formulae. Although after evaluating and analysing outcomes from the Flesch-Kincaid and Spache formulae, 30% of books were deemed grade 3 from both formulae, the same grade was not appointed to both books e.g. for book 10 which achieved grade 3 on Spache but grade 1 on the Flesch-Kincaid. This uneven distribution is further proven by 50% of

books from the Spache formula being deemed suitable for grade 4, but only 5% being considered grade 4 using the Flesch-Kincaid formula. Again, in the Flesch-Kincaid formula, 55% of books are deemed suitable for grade 1/2 but according to the Spache formula, no books are deemed this grade. The findings from this study conclude these formulae cannot be used to accurately deem text suitability for bilinguals due to inconsistencies between formulae.

Inconsistencies between formulae is commonly found in studies examining results obtained by different reading formulae, looking at reading materials for school-aged children (Begeny and Greene, 2014; Ardoin et al., 2005) but also health information materials (Wang et al., 2013). When readability formulas were applied to a sample of 15 health information documents, Wang et al. (2013) discovered inconsistencies of up to five reading grades. Although Wang et al.'s (Wang et al., 2013) findings were for health-related documents, Begeny and Greene (2014) discovered readability formula outcomes were inconsistent when applied to 12 passages for school-aged children in the US (including Spache and Flesch-Kincaid formulae) and not valid indicators of grade-levels in children's writing and did not follow expected patterns.

The Spache and Flesch-Kincaid formulae are not consistent with their results, possibly because they look at different criteria. The Flesch-Kincaid looks at average sentence length and syllables per word (Begeny and Greene, 2014). Whereas, as well as average sentence length, the Spache formula assesses readability using word familiarity.

The McAlpine formula looks at number of sentences, words and mini-words (McAlpine EFLAW (McAlpine, 2005), ignoring other bilingual vulnerabilities. As this produces scores relating to categories, not grade estimates, this increases difficulty comparing to other formulae outcomes, making it unclear if this constitutes to higher grades than other formulae. Also, as this formula is intended for 'global audiences', not children-specific, texts may be 'very easy to understand' for adults rather than children, making this an unreliable readability outcome measure for school-aged bilinguals.

In the Flesch-Kincaid grade level formula, inflectional morphemes (-es, -ed and -e) endings are ignored (Alas et al., 2013). This decreases reliability for bilinguals who are said to struggle with morphological awareness characterised by tense markers (Kuo et al., 2017), particularly inflectional morphemes (Clahsen and Jessen, 2021), increasing unreliability as is a critical reading comprehension predictor, particularly of bilinguals (Kuo et al., 2017).

According to Ongun (2018), vocabulary is the best readability determinant of bilinguals' children's books as is a predominant factor impacting this populations readability. Although the Spache formula incorporates vocabulary in its criteria, how the 'unfamiliar' word list is created is unspecified, therefore words on this list may be unknown to bilinguals and it is already known vocabulary impacts bilinguals reading comprehension, due to their smaller lexicons (Bialystok et al., 2010). This is further supported by (Schrivier, 2000) Janan, who states vocabulary variations are apparent between subjects, cultures and time, diminishing reliability of word lists as an assessment tool with another issue being homonyms, derivatives and compounds are unaccounted for (Lenzner, 2013), making word lists a weak text difficulty indicator (Schrivier, 2000). The mean of unfamiliar words from this study is 61.7%, over half the book, significantly impacting book readability, implying half the book contains words not understood by the reader, which may be higher percentages for bilinguals. Also, the mean percentage of repeated words is 38.3%. If these repeat words are unfamiliar, this could further increase reading difficulty for bilinguals. With some non-fictional books containing place names and people's names that may be unfamiliar to the reader, the grade level increases, increasing reading difficulty.

Although readability formulae have their advantages, being easy to use by authors and educators, enabling quick matching and modifications of reading materials to be made, to increase student suitability (Sangia, 2015). These results conclude they are not a flawless and suitable method to assess reading material suitability for bilingual

students due to their various limitations and inconsistencies. Findings show Spache and Flesch-Kincaid formulae are inconsistent with each other, let alone in comparison to the McAlpine EFLAW formula due to not following the same trends, perhaps due to assessing different criteria. Therefore, it is unclear if these books are suitable for bilingual readers as data is too inconsistent to make a definitive conclusion.

These findings are correlated to those of [Crossley et al. \(2017\)](#) who found that traditional readability formulas e.g., Flesch-Kincaid, provide weaker classifications of reading text level than the Coh-Metrix L2 reading index, providing unreliable results. However, the index proposed had limitations to its success, only classifying 59% of the books accurately. The findings from this study suggest that more research is needed to develop new formulas which include additional linguistic features to allow for better text readability matching for different genres, readers and levels. Formulation of this criteria crucially needs to include factors affecting L2 readers, from various first language backgrounds ([Crossley et al., 2008](#)).

In another study, by [Nahatame \(2021\)](#), eye tracking was used to examine text readability and processing effort in correlation to results from various readability formulas. In this study, the Coh-Metrix L2 reading index predicted skipping and eye fixation rates better than traditional readability formulas which relates to processing effort for reading L2 texts.

This study suggests newer readability formulas are more valid for giving accurate measures of readability, highlighting the importance of including additional linguistic variables in criteria when assessing reading ease which incorporates the cognitive processes of reading such as word recognition.

Although newer formulas outperformed the traditional formulas, these still failed to predict all measures of eye tracking and not one formula gave the best outcomes across this study suggesting new investigations into producing new readability formulas should take place to provide more consistency with regards to predicting readability incorporating reading effort as this is a variable crucial in determining readability of a text.

Moreover, in terms of formulae limitations, although according to [Ongun \(2018\)](#), vocabulary is the best readability determinant of children's books for bilinguals, this is not agreed amongst researchers. This differs from findings by [Lenzner \(2013\)](#) who examined 71 question pairs using four readability formulas and found only a 50% success rate of the formulae in successfully identifying difficulty, apparent alongside significant variations between formulae outcomes, concluding other variables, not just syntactic and semantic features, need to be included. This finding is corroborated by [Zamanian and Heydari, 2012](#); [Ismail et al., 2016](#)), suggesting limitations of readability formulae is their absence in incorporating other factors within outcome measurements, deemed imperative to determining readability ([Crossley et al., 2011](#)).

Furthermore, [Begeny and Greene \(2014\)](#) discovered readability formulae appeared more accurate in determining text difficulty for children considered 'better readers', further undermining reliability of Spache and Flesch-Kincaid formulae for assessing bilinguals' readability who are already said to have weaker reading skills ([Bayat, 2017](#)).

Therefore, it cannot be concluded that solely using readily available readability formulae to confidently assess book readability to deem suitability for school-aged bilinguals is appropriate. Incorrectly matched books can reduce children's reading interest because books which are too difficult or easy to understand, negatively impact reading development and academic attainment ([Dickinson et al., 2012](#)). These results are like those found by ([Nahatame, 2021](#)) [Rahmawati and \(Sangia, 2015\)](#) [Sangia](#), the latter whereby readability of English texts were assessed using two formulae, specifically curated for bilinguals, including McAlpine EFLAW.

4.1. Limitations

One limitation of the present study was the McAlpine EFLAW formula produced results as a score corresponding to categories ranging from 'very easy to understand' to 'very confusing', whereas Spache and Flesch-Kincaid produced actual grade levels based on passage readability. This made comparing the three formulae difficult because they do not all provide grades, therefore difficult to assess the hypothesis.

Another study limitation was reading material grade-levels were not over an equal range. The Flesch-Kincaid formula range was 1–5 whereas the range of the Spache formula was only 3 to 5. Therefore, there was no equal representation of the grades. These ranges suggest not all grades are represented by the Spache formula, possibly limiting comparisons between the two formulae. This finding is commonly found in readability research, e.g., by [Begeny and Greene \(2014\)](#), [Compton et al. \(2004\)](#), and [Ardoin et al. \(2005\)](#).

A further study limitation is that there was only a selection of 20 books for this study. This impacts the generalisability of the study as this is not representative of all books available for school-aged children.

4.2. Future directions

In terms of future directions, if this study was to be replicated with a larger sample, this may curate a larger range of grade representations of both the readability formulas, allowing increased reliability and results consistency, also suggested by [Begeny and Greene \(2014\)](#). A larger sample should include other reading materials, not just limited to books but also textbooks and assessments to increase generalisation for school-aged children, also suggested by [Sangia \(2015\)](#).

Only using text features can wrongly probe educators and authors to create reading materials with shorter sentences, minimising cohesion, increasing reading comprehension difficulty ([McNamara et al., 2014b](#)). Therefore, it is well researched that interactions between readers and reading materials impacts text readability as well as other external factors e.g. motivation and interest impacting the text comprehensibility for readers ([Papastefanou et al., 2021](#)). Therefore, in terms of future directions, taking these factors into consideration e.g., readers perspective of reading difficulty may better inform this study as performed in other studies e.g. by [Zheng et al. \(Zheng and Yu, 2017b\)](#), when cross-examining user perceptions and readability formula outcomes of electronic health records. This will incorporate other factors influencing text difficulty, not measured by formulae, allowing better readability examination to be noted as would incorporate measures of comprehensibility and other influential factors alongside syntactic and semantic text structures. This would lead to greater understandings and smaller differences between readers perceived text difficulty and readability formula outcomes.

Therefore, for future implications, this study's limitations pose a vital need for a formula or set of criteria to be created incorporating salient factors affecting bilinguals' readability, matching this to a proposed school-grade. A formula of this calibre to measure bilinguals' readability would be useful, allowing authors, educators and other relevant personnel to create, select, modify and adapt better suited study materials for their target audience e.g. worksheets and assessments to match student's ability ([Sangia, 2015](#)).

As already curated formulae do not consider specific factors known to impact school-aged bilinguals' readability e.g., linguistic differences between languages, culture, inflectional morphology, interest and motivation ([Zamanian and Heydari, 2012](#); [Bruce et al., 1981](#); [Ismail et al., 2016](#)), these would need including in criteria when devising a better methodology, also suggested by [Rahmawati \(2014\)](#). This will increase reading material accessibility, decreasing misdiagnoses of language disorders in this population ([Garraffa et al., 2019](#)). This is crucial in current times due to the growing bilingual UK-demographic, specifically school-aged ([Department of Education at the University of Bath, 2017](#)).

However, a readability formula should not be the sole method determining readability. Although formulae enable generation of quick, simple judgements regarding book readability, particularly in classrooms, teachers know children more personally, specifically, what can be handled in terms of reading e.g., children's specific knowledge of topics, increasing reading ease of certain books, which readability formulas may regard unsuitable.

In accordance with Janan and Wray's (Wray and Janan, 2013) findings, teacher selection of appropriate reading materials for children should include individualised information to match books appropriately. This is also relevant because bilingual children's performance is individualised and there are many factors influencing their unique functioning (De Bruin, 2019). It is becoming increasingly important for these unique factors and educators' knowledge about the child to be incorporated when determining appropriate reading materials, making this more person specific, as interactions between reading materials and readers are essential when determining text suitability.

Overall, this study provides insight into the limitations of existing methods assessing reading material readability for bilinguals, emphasising the necessity for the creations of a new formula or set of criteria to better assess this. Therefore, establishing a pivotal foundation for further research into developing new methods to assess readability of reading materials for school-aged bilinguals.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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