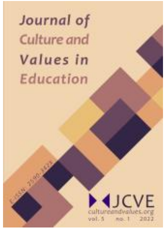

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Must know Grade 8 Technology Education Concepts and Vocabulary

Lucy Sibanda*[a], Jabulani Sibanda[a] & Theressa Madzingesu Zengeya[a]

* Corresponding author:
Email: Lucy.Sibanda@spu.ac.za
a. Faculty of Education, Sol Plaatje University, Kimberley, South Africa

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ABSTRACT

Explicit vocabulary instruction is key to building conceptual understanding as words carry domain concepts. The value of explicit vocabulary instruction is lost in the absence of a principled isolation of the right words to give focused attention. The key or 'must-know' vocabulary should find expression and resonance in all languages. The present study, a precursor to an empirical study on the extent to which African languages can handle concept vocabulary in the teaching of Technology, isolates the key must-know Grade 8 Technology Education vocabulary in English. Vygotsky's (1986) theory of scientific concept development informed the distinction between scientific and everyday concepts. Ha and Hyland's (2017) Technicality Analysis Model (TAM) and its five levels of technicality informed the judgment-based methods that were used to determine key Technology Education vocabulary at Grade 8 level. Over and above the model, some criteria emanated from the defining characteristics, the contextual clues, as well as Chung and Nation's (2004) four-step rating scale. The criteria applied yielded 80 key vocabulary, largely technical and substantive and bearing threshold concepts. The study recommends combining the words of the Tier 3 with the more general academic vocabulary of the Tier 2 to narrow the instructional focus and increase the conceptual understanding of the teaching of Grade 8 Technology.

KEYWORDS

Concept; technical words; technology subject; technology vocabulary; Tier 3.

INTRODUCTION

Acquisition of a sufficiently robust and relevant vocabulary is a password to textual comprehension. Understanding subject concepts and the vocabulary in which they are couched is highly correlated with textual comprehension. Rupley et al. (2012) observe that:

> Not having access to the meaning of words representative of the concepts and content of what they read causes difficulty in children's comprehension of texts, limits their ability to make a connection with their existing background knowledge, inhibits their ability to make coherent inferences, and impacts their ability to reason (p. 300).

What was challenging to the researchers was determining words to prioritise to unlock textual meaning. Successful understanding of texts depends on learners' repertoires crossing particular lexical thresholds. "Transcending vocabulary thresholds ensures reading with understanding and guarantees the derivation of meanings of the few unknown words from their contextual use" (Sibanda & Baxen, 2016, p. 58). The lexical thresholds that need to be crossed for textual comprehension are as high as 98% of words in the text. The sheer volume of words learners are exposed to, and which need to be taught and understood in a discipline, makes it imperative to prioritise some words over others because "in terms of usefulness, all words are not created equal" (Nation, 2007, p. 20). Tiering words is useful for narrowing the instructional focus because not all words can be given explicit attention.

In hierarchical vocabulary tiers, high-frequency words (HFWs) constitute Tier 1 words – the basic, familiar terms recycled much in ordinary conversation. Tier 2 vocabulary is also regarded as academic vocabulary on account of transcending different content areas and often having multiple meanings. These words are essentially used in academic circles. Tier 3 words are low-frequency, discipline or domain-specific vocabulary hardly heard outside the discipline discourse. Nation (2008) opines that Tier 3 words normally comprise 5%−20% of words in a text, compared to 80%-90% for HFWs or 8.5%−10% for academic words. This hierarchical clustering, credited to Beck et al. (2013), has widely been used to prioritise Tier 1 words because of their high frequency, with frequency deemed a proxy for general word utility.

This study departs from a universal focus on the high-frequency criterion in word isolation for explicit attention, to focus on vocabulary that carries the subject concepts. This is in line with Nation's (2012) call for the "common sense usefulness of the resulting lists". Words that carry subject content are generally low-frequency words learners hardly encounter in daily communication. They lack redundancy in the language, which reduces the multiplicity of their exposure to allow for incidental mastery. Tier 3 words typically do not have synonymic or antonymic relationships to aid the deduction of word meanings from related or converse concepts. Even their spelling often defies the phonetic rules of English syntax as they normally have foreign language roots modified with affixation. Technical vocabulary is essential for understanding subject matter and embodying domain concepts. These words constitute the subject matter and learners need to develop novel conceptual frameworks and understand increasingly more sophisticated ideas. This process explains the need for the isolation of Tier 3 words for explicit instruction because they cannot be acquired incidentally from repeated exposure or contextual word meaning derivation.

Literature Review

What concepts are

A concept is a major idea or generalisation that should embody the following:

- a bulletproof, uncontested, unalterable, watertight or incontestable definition or rule,
- potential to be disaggregated into examples and non-examples (where applicable) for clarification purposes,
- critical attributes (that are ever-present), non-critical attributes (that are sometimes present), and shared attributes (that are shared with other concepts). The third element leads to overgeneralisation when the concept is frequently applied beyond its confines.

Words are labels for frames of reference for particular concepts. They can express multiple concepts, and concepts can be represented by multiple words. The concepts of a discipline are captured within the discipline vocabulary. Concepts are, however, broader than words, because they provide mental representations of a class of things. This representation helps to make sense of our complex and diverse world. In the teaching of a discipline, concepts are indispensable to understanding. They facilitate the development of powerful knowledge and help connect learning. For Malt et al. (2014), concepts as units of knowledge have stability within long-term memory because they represent the world in meaningful entities, thus, allowing for more complex thoughts to be constructed. Concepts are not uniform and several designations have been used to distinguish one type of concept from the other. There are core concepts, substantive concepts, second-order concepts and threshold concepts.

Types of concepts

Core concepts encompass the ‘big ideas’ of the field or discipline, a prerequisite for learners to understand the diverse ideas in the field. These ideas build logically one upon the other. Substantive concepts embody the ‘substance’ or content of a particular discipline, that, while defining a discipline’s body of knowledge, can intersect with other disciplines. Second-order concepts determine what key questions to pose in a subject to organise its knowledge. Cause and effect (causation) is an example of a second-order concept. While substantive concepts are usually specific to the field, second-order concepts typically overlap and transcend disciplinary boundaries. Second-order concepts are essentially academic concepts and are sometimes defined as notional terms. The combination, however, gives the discipline its distinction and uniqueness.

Meyer and Land (2003, p. 412) state that a threshold concept is akin to a portal, opening a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, interpreting or viewing something, without which the learner cannot progress. The understanding of a threshold concept leads to a transformed internal view of a subject matter. Once understood, threshold concepts alter learners’ current and future understanding of the field (Meyer & Land, 2003). For Meyer and Land (2006) and Olaniy (2020), threshold concepts have five defining characteristics, namely:

- being transformative – leading to a shift in perspective,
- being integrative – uniting discrete concepts,
- being irreversible – once mastered they are difficult to unlearn or un-master,
- being bounded – potentially defining the boundaries of the field, and
- being troublesome – difficult to grasp and counterproductive.

To the researchers' knowledge, no study has been carried out to determine threshold concepts in Technology Education generally, and at the Grade 8 level, specifically. Although we acknowledge the empirical work that needs to go into determining what threshold concepts are for Grade 8 Technology Education, in this study, we rely on our expertise to subjectively isolate what we deem to be threshold concepts, using the defining features listed above.

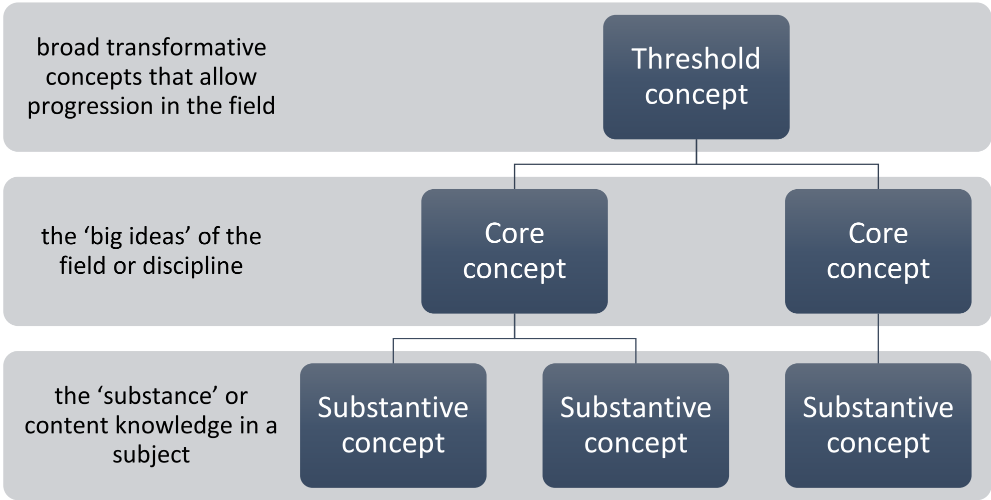
Threshold concepts connect subject knowledge in its breadth. They are recycled and explored in a wide range of topics. This process compels learners repeatedly to return to them, allowing the concepts' gradual entrenchment in learners' lexicon, thus, deepening their subject matter knowledge. Owing to their breadth, threshold concepts can be broken down into smaller disciplinary concepts. We envision the next broader division of threshold concepts as core concepts of the discipline that present themselves as focus areas or topics into which more specific and substantive concepts are developed.

Core concepts are captured within the academic and technical vocabulary. Second-order concepts resonate with the academic vocabulary category, and core and threshold concepts within the technical vocabulary category. This study considers must-know technical, not academic, vocabulary. The distinction between these two is instructive to the rationale for prioritising technical over academic vocabulary, despite the latter embodying concepts as well. Their distinction is not uniformly conceived, possibly due to the lack of uniformity in what constitutes academic context and academic use. Some academics have conceived technical words as part of academic words, together with general words for academic use, and non-general 'academic' words. However, for this study, academic vocabulary transcends subject or domain divides, whereas technical words are subject, or domain bound. Liu and Lei (2019, p. 2) see technical words as "…lexical items used with specialised meanings in a subject known mainly to a particular community of users" and that "...technical terms form the nomenclature of the respective branches of science". Technical vocabulary is subject-specific, therefore, it more closely represents the must-know vocabulary of a particular field – Technology Education in this case. This description coincides with the definition that "Technical vocabulary is subject-related, occurs in a specialist domain, and is part of a system of subject knowledge" (Chung & Nation, 2004, p. 252).

The figure below represents our schematisation of the relationship between and among the three concept categories.

Figure 1.

Schematisation of concept types



The present study does not address the nuances of the broader and narrower view of technical vocabulary given by Liu and Lei (2019), whereby the narrower view conceives of technical vocabulary as a feature of the 'hard' sciences, with its equivalent being a specialised vocabulary in the arts, humanities and social sciences; a view we, in common with Liu and Lei (2019), consider problematic. Nation (2013) uses specialised vocabulary as an umbrella term for what we define as academic and technical vocabulary in this study. The nuanced differentiation of the technical vocabulary potentially leads to semi- or sub-technical terms. For this study, the technicality of a technical term depends on its representation of the intended concepts.

Criteria that can be helpful in determining technical vocabulary include:

- a word's criticality to the meaning of academic text,
- not typically used by learners without explicit instruction,
- less likelihood of appearing in other texts outside the discipline, and
- words not likely to have multiple meanings.

Why Technology in Grade 9?

In South Africa, as in many contexts, the subject Technology is a relatively new entrant to the curriculum. Technology's use in schools or educational technology predates Technology Education as an independent discipline. Technology as a school subject is relatively new and does not have a considerable research base and a well-recognised classroom pedagogy (Maja, 2023; Makeresemese & Mahlomaholo, 2023; Rauscher, 2011). The subject was first introduced in South Africa in 1998 for Grades 7-9 (senior phase). Its amalgamation of particular disciplines merits considering what concepts and attendant vocabulary are uniquely Technology education-specific. Grade 9 learners are required to make important decisions about subject combinations to pursue through to their final Matric exams, that is an important milestone toward career building.

Domain or discipline concepts are cumulative and determining the key vocabulary in the early years of a discipline is instructive. In South Africa, Grade 9 marks the transition to high school and inequalities in conceptual understanding at the outset of secondary school tend to persist to the matric level (Grade 12). Grade 9 achievement indexes matric performance and conceptual understanding at the beginning of secondary schooling is deterministic, not only for matric performance, but also for the ultimate educational attainment of learners.

THEORETICAL FRAMEWORK

Vygotsky's (1986) theory of the development of scientific concepts, that distinguishes between spontaneous (everyday) concepts and non-spontaneous (scientific) concepts, provides the theoretical basis for this study. On the one hand, spontaneous concepts emanate from daily experiences that are generalised and abstracted. Spontaneous concepts have neither explicit teaching nor explicit connection with other concepts, and intuitive ad-hoc understandings are relied upon. On the other hand, non-spontaneous concepts exist as a unified system of interrelated ideas accessed through explicit classroom instruction and explicit connections. These latter concepts are related to a specific field of study and occasionally extend the meaning and use of spontaneous concepts. Vygotsky (1986) sees generality, systemic organisation, conscious awareness, and voluntary control as attributes of nonspontaneous concepts that are distinct from spontaneous concepts.

Despite their apparent dissimilarities, there is a dialectical relationship between spontaneous and nonspontaneous concepts. Vygostsky (1986, p. 157) underscores their interrelatedness and 'reciprocal dependence', seeing them as 'parts of a single process… not a conflict of antagonistic, mutually exclusive forms of thinking'. In this vein, John-Steiner et al. (1998, p. 128) cites Luria's 'interfunctional organisation' concept of 'interfunctional organisation' drawn from Vygotsky's scientific and everyday concepts, 'in which scientific concepts rise on the foundation of everyday concepts and, in the process, fundamentally change everyday concepts by drawing them into systemic relations'. For Vygostsky, "Once the child has achieved consciousness and control in one kind of concept, all of the previously formed concepts are reconstructed accordingly" (Vygotsky, 1986, p. 192). Technology thrives as a field of study of non-spontaneous concepts, that need to be properly isolated and judiciously and explicitly developed.

METHODS

Determination of Tier 3 (Technical) words

Liu and Lei (2019, p. 9) note that "research has also demonstrated that knowing technical vocabulary is indispensable for developing subject knowledge". Ha and Hyland (2017) see it as central to disciplinary teaching and learning, rendering sound identification of technical vocabulary a prerequisite to discipline-specific subject matter instruction and, thus, indispensable to course and material design. The level of technicality of words determines the pedagogic decisions needed to develop the concepts.

To generate a list of words potentially crucial for learners' understanding of Technology concepts, we drew Tier 3 words from the Technology Department of Education Curriculum and Assessment Policy Statement (CAPS) (2011) document. Tier 3 words are those that are predetermined in course books and syllabi because they are critical carriers of domain content. The technical word generation process had its challenges, some of which are documented in the extant literature. For Chung and Nation (2004, p. 251), "the major difficulty is that technicalness is a functional aspect of a word and thus the particular use of a word must be taken into account when deciding whether it is a technical term or not". This problem is compounded by the fact that the meanings of some technical words overlap because they carry diverse specialised meanings in different topics. An appropriate example of a word characterised by polysemous meanings given by Liu and Lei (2019) is the word 'tension' which assumes different meanings in physics, psychology and physiology. The technical meanings of such words are largely opaque (Todd, 2017). The challenge with such polysemous words is whether they then become academic words by transcending subject or disciplinary boundaries. In our view, polysemous words would, by having different meanings in different disciplines, become different technical terms in the domains in which they exist. In the present study, the above example of the term 'tension' would be considered three technical terms in the three fields, rather than one academic word transcending the three domains. Some terms may originate and belong to a specific field but are extended metaphorically to other fields, in which case, we classified such words as technical terms for the field of their core use, but not technical terms for the field of their extended use. Although the study is located at the lexical or word level, it realises the existence of technical vocabulary in multiword units.

Ha and Hyland's (2017) Technicality Analysis Model (TAM) with five levels of technicality from least technical, slightly technical, moderately technical, very technical, and most technical; evinces the challenges that accompany the determination of technical vocabulary with precision. An appreciation of the levels of lexical technicality helped us to determine, even within the technical words isolated from the curriculum document, the must-know technical terms to prioritise. Ha and Hyland (2017, pp. 6-7) identify characteristics of the technicality of a word saying a word is more technical...

- the more its specialised sense departs from its general sense, where "the more semantically the word's specialised sense departs from its general sense, the more technical the word's specialised sense is.",
- the less frequently the word occurs, where "the degree of technicality increases as the chance of the word being understood decreases.",
- if the word is monosemous, where a "specialised sense is the only sense that a word has.".

Liu and Lei (2019) identify two methods for determining technical words, namely: judgement-based and corpus-based. We employed the former in this study.

Judgement-based Methods

Intuitions of disciplinary experts have been accepted as a valid way of generating technical vocabulary. According to Liu and Lei (2019, p. 4), "judgment-based methods require subjective decisions based on subject domain knowledge". However, judgement-based methods are not arbitrary or baseless. Chen and Lei (2019) identify rating scales, technical dictionaries, context clues, computer-based methods and hybrid methods as instruments employed in judgment-based methods. They note from other studies that the rating scale is "the most accurate but time-consuming". Chen and Lei (2019, p. 132) also identify steps from Chung and Nation's (2004) four-step rating scale for identifying technical words that are experts' identifying words:

- that have no specific relationship with a specialised field (Step 1) – all function words would fall into this category,
- minimally related to a specialised field (Step 2),
- closely related to a specialised field (Step 3), and
- specific to a specialised field (Step 4).

In the absence of a Technology Education Technical Vocabulary Dictionary compiled by subject specialists, we used a combination of the rating scale and contextual clues. To avoid the variability of intuitive judgement, we took a cue from Chung and Nation (2004, p. 253), who used a carefully designed rating scale, classifying how closely related a potential technical word was to the particular subject area (in our case Technology) on a scale from least related to most related. Owing to the fact that technicality is not binary and there is a line of technicality (Ha & Hyland, 2017) where words exist on a continuum with varying degrees of technicality, a rating scale was deemed appropriate to classify technical words from the curriculum documents. Words surviving elimination at stage 1 but being eliminated at stage 2 could, therefore, represent the least technical and those surviving all elimination phases would be the most technical.

Initially, we compiled a list of all the terms written in bold in the curriculum document because this bold print was meant to identify these words as important. We employed our domain knowledge from domain information within the context, and our knowledge of related STEM areas (some of whose technical vocabularies are well documented unlike Technology Education), to effect word eliminations. We based our eliminations on the four-step rating scale developed and adapted by Chung & Nation (2004) and employed by Todd (2017).

We used our subjective judgement cognisant that "technical terms should either occur only in a specialist area or occur with much greater frequency in that area than other areas" (Chung & Nation, 2004, p. 252). In step 1 function words and words such as 'scenario' were eliminated on account of their not being remotely field-specific. In step 2, words such as 'calculate' and 'case study' were eliminated because they were minimally related to specialised fields. In step 3, words such as 'recycle' and 'budget' were eliminated. The resultant list was then subjected to further elimination based, not just on their specificity to a specialised field, but specifically to Technology Education.

After the third step of the rating scale, we also used the textual and contextual clues provided by the text to determine the technical nature of the words. These clues included aspects such as explicit definitions of words, typographical clues such as bolding, italicisation and bracketing, as well as labelling in diagrams or illustrations (Chung & Nation, 2004). It was assumed that the words with the most contextual clues would signal their importance to the field and be likely to have a degree of technicality.

In line with best practices, the three researchers separately identified and classified the technical vocabulary and measured interrater reliability to determine the extent to which there was reasonable consistency and agreement regarding where a lexical item fell within the scale. Prior to the classification, the researchers had perused the classification criteria and piloted the criteria with five terms to establish a common understanding of what determines the technicality of words. These terms needed to meet at least four of the six criteria to qualify (see Table 1 below for the criteria). If there was inconsistency in ticking off any one of the five terms against particular criterion/criteria, provision was made for a discussion among researchers to achieve consensus and consistency. In the pilot, there was no need for such a discussion because the ‘ticking-off’ of the five terms was uniform across criteria. Such unanimity allowed for confident acceptance of the five test terms as technical terms.

The researchers individually identified the technical words in the curriculum document following the steps and criteria outlined. A comparison was made, first on the resultant list in which all the words identified by the three researchers appeared on the three researcher lists. The terms identified across the four lists were shaded green to signify their provisional acceptance into the word list. Those appearing on only one of the two lists were coloured red to signify their exclusion. The terms appearing on two or three lists were deliberated upon by all three researchers, with whoever had identified them justifying their inclusion in their lists. It was only then that they were either shaded green or red based on the collective judgement. In only a few instances were discussions needed to reach consensus on particular terms. The resulting list, therefore, reflected the consensus of researchers.

After having established what terms were technical, it was important to determine their level of technicality. Nation's (2007) observation that ‘no words are created equal’ applies to the generality of lexical terms, as it does to technical vocabulary specifically. In the present study, it was important to subjectively determine the degree of technicality of a word. The assumption was that the high-level technical words were more deterministic of textual understanding than their low-level counterparts. The technical degree of the technical terms was determined using an adapted Chung and Nation (2004) rating scale. The four researchers rated the technicality of a term based on the following categories: Not related to Technology (NRT), Minimally related to Technology (MRT), Closely related to Technology (CRT), and Meaning and use restricted to Technology (RTT).

The placement of particular terms on specific levels of the rating scale in the four researchers' lists was analysed for consistency in five randomly selected terms (not used previously in the pilot terms), and a high average inter-rater reliability agreement (88%).

FINDINGS

Table 1 below (see appendix) presents the data of the key Technology vocabulary after applying the first two stages of the rating scale to eliminate terms that were not technical.

The resultant 127-word list represented the must-know terms in Technology for Grade 9. However, the list needed trimming and categorisating for two reasons. First, a subsequent empirical study by the same authors sought to determine the words' equivalence in, and relatability to, African languages. Too long a list would overwhelm informants. Second, the understanding that words are never equal in their precision, utility, potency and in the reaction they elicit, necessitated the reduction of the word list using some principled criteria.

On the criterion of typographical enhancements, all 127 terms qualified as must-know terms because they were all typographically enhanced. Typographical cues draw attention to word forms and Sibanda and Baxen (2018, p. 546) attest that "Explicit attention to word form is foundational to long-term retention". In an experimental study, Sohbati et al. (2021, p. 8) found that "…lexical elaboration and typographical enhancement have an interactive and reciprocal influence on vocabulary learning". They went further to determine the relative individual effect of lexical elaboration and typographical enhancement on incidental vocabulary acquisition and found that "...lexical elaboration alone did not have a statistically significant effect on incidental vocabulary learning through reading" (p.1), testimony to the power of typographical enhancement in instigating incidental vocabulary acquisition. This statement then qualified the terms for which typographical enhancements were considered to be key terms.

The second criterion dealt with whether the terms on the list were ones that could be explicitly defined. We learn languages by using words, some of which we know but cannot define. Examples that come to mind are colours, which we can easily use and make reference to but can hardly define. However, must-know terms are those that carry the concepts and content of the discipline and should, therefore, be definable in explicit terms. Definitions provide clarity, accuracy and specificity to the concepts and standardise terms for consistency and coherence in their use. With regard to definitions, all the terms in the 127-word list qualified as must-know terms.

The next criterion related to the criticality of the word to the global or local understanding of the major concepts. Siew (2021, p. 1) notes that "a word's global feature distinctiveness is measured with respect to all other words in the network and a word's local feature distinctiveness is measured relative to words in sub-networks derived from clustering analyses". We did not perform a clustering analysis in this study. However, we considered local or global distinctiveness from our subjective estimation of how much of the specific topic and the section would be rendered incomprehensible if the specific term was not understood, whether a term was specific to a particular context or field (local distinctiveness) or had wide recognition and use across multiple domains (global distinctiveness). Technical terms that exhibit local distinctiveness are typically specialised vocabulary unique to a specific industry, discipline or area of expertise. Some terms such as disc brake, bicycle brake, drying and salting, while important terms, were deemed as engendering local rather than global understanding and, thus, were eliminated from the list. Since the idea was for words to index concepts, some of the names of objects/concepts were deemed not facilitative of global textual understanding. Such terms included ratchet and pawl, cleat and spur gears. Other terms such as resistors and rack-and-pinion gear were seen as dependent on a particular concept for their naming, and were thus, retained.

We believed that all 127 listed words were ones that learners would neither acquire nor use conversationally and inter-personally, but were restricted to formal academic use and would require explicit instruction for their learning. We also considered the likelihood of a listed word appearing in other disciplines. The idea was to eliminate such words for not being exclusively Technology terms. They were also not strictly must-know Technology terms because even if students did not master them in Technology, they could acquire an understanding of them in the other subject areas. After identifying the words that also belonged to other subjects or disciplines, we determined two things before eliminating them. First, we established whether the word appeared in the other discipline with the same meaning or different nuanced meaning(s). Words in other disciplines that took on new meanings in Technology were retained. An example of such a word was 'relay'. In cases in which the meaning was the same, the assumption was that the meaning would be transferred from the other discipline to Technology, so the word was eliminated. Examples included words are problem and flow chart. Second, if a word was shared between Physical Science and Technology, for instance, we determined from the curriculum documents (CAPS) for Physics Senior Phase if that word appeared. If it only appeared much later at Grade 10 for instance, we retained it in the Technology list. The rational for this practice being that the learner would then need to learn and master it in Technology not in Physics where it appeared much later. Examples of words in other disciplines that were retained are prototype and force multiplication. Some words appeared in disciplines that were not taught at the school system e.g., triangulation (typical in the research field) and syringe mechanism (in the medical field). These terms were also retained despite them being inter-disciplinary.

An aspect of the dynamism of language is how, in the evolution of language, some words shift in the meanings and others take on new meanings, as diverse disciplines blend. This process results in lexical polysemy. In the subsequent study that interrogates the African languages equivalents of the key Technology vocabulary, the words would not be presented in context, and so respondents would not be able to disambiguate the word senses. Rather, they would risk providing translations or equivalents divorced from the intended Technology meaning. The technical polysemous words were, therefore, removed from the list. These included words such as problem and tension that related more to the academic words or Tier 2 words discussed earlier.

Some words were deemed closely related to each other and, in some cases, derivatives. In those cases, only one of the words, the base form, was retained. Examples of such words were two sets: compressed, incompressible and compressed air, as well as corrosion resistance and corrosion. In the latter set, knowledge of corrosion resistance subsumes that of corrosion. Similarly, knowledge of force multiplication was assumed to imply knowledge of force division. In one case, rather than having cells in series and cells in parallel, as well as switches in series and switches in parallel; cells in series were retained, switches in parallel were retained, and the other terms were eliminated. Preserving metals and preserving food was represented by the term preserving. Owing to the fact that the subsequent empirical study for which the word list was generated sought to establish the presence of African language equivalents for any of the named gears, the assumption was that the same African language would have equivalents for the other gears, therefore, only one gear name was retained in the list.

The Department of Education Curriculum and Assessment Policy Statement (CAPS) (2011, p.12) stipulates that the "Design Process (Investigate, Design, Make, Evaluate, Communicate – IDMEC) forms the backbone of the subject and should be used to structure the delivery of all learning aims" thus, the IDMEC terms were retained even if they qualified for elimination using any of the criteria used.

Table 2 below (see appendix) depicts the resultant list after the eliminations discussed above were effected.

The final list had 80 terms (words and phrases) most of which were nouns that named entities or processes. The terms represented the vocabulary learners of Technology needed to understand and use in the field of Technology education. We deemed these terms building blocks for comprehension and communication within the field. They provide a solid foundation of Technology terminology for engaging with course materials, discussions and practical applications, as well as master fundamental concepts, theories and principles in the field. They represent the language skills of the discipline.

CONCLUSION

The final list of must-know vocabulary generated in this study largely confirms the features of Tier 3 technical vocabulary on account of not having synonymic or antonymic relationships, their low frequency in use, and their general restriction to context-specific Technology domains, among others. This statement does not discount the general overlap between Tier 2 and Tier 3 words and their loose tier classification. Unlike Tier 2 vocabulary with high-utility academic words, the generated list is characterised by low-utility words. Beck et al. (2013) classified words into tiers based on their utility, relationship with others and contribution to textual meaning, that was applied to determine the must-know technology vocabulary in this study. Some terms are phrasal but have meanings akin to those of single words. The words isolated in this study are entwined with concepts and qualify as either threshold or substantive concepts words rather than second-order concepts. The words also conform to the features of concepts identified earlier. Although the present study focused on Tier 3 technical words, the retained IDMEC words are part of the Tier 2 academic words. The recommendation is to combine Tier 3 words with the more general academic Tier 2 terms to narrow instructional focus and increase conceptual understanding of a field of study – Technology Grade 8.

Disclosure statement

No potential conflict of interest was reported by the authors.

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APPENDIX

Table 1.

Key Technology Education Vocabulary in Grade 8

Term	typographical clues in the curriculum document (Brackets, Bolding, italics)	Explicit Definitions-does the term have a specific definition in Technology?	Word's criticality to textual meaning. global meaning affected ✓ not affected x	Word having specialised sense and not typically used by learners without explicit instruction	Word's less likelihood of appearing in other texts outside the discipline (Indicate discipline if it intersects with any.)	Word meaning not likely to have multiple meanings
design	✓	✓	✓	✓	✓ [applied arts, Geography]	likely
investigate	✓	✓	✓	✓	✓ [law, English, research]	likely
make	✓	✓	✓	✓	✓ [English,]	likely
evaluate	✓	✓	✓	✓	✓ [English, research]	likely
communicate	✓	✓	✓	✓	✓ [Communication	likely
problem	✓	✓	✓	✓	✓ [social sciences]	likely
structures	✓	✓	✓	✓	✓	

7. first angle orthographic projection	✓	✓	✓	✓	✓ [Geography]	not likely
front view	✓	✓	x	✓	✓[maths]	likely
top view	✓	✓	x	✓	✓[maths]	likely
side view	✓	✓	x	✓	✓[maths]	likely
scale and dimensions	✓	✓	✓	✓	✓[Geogra-phy and maths]	likely
design brief	✓	✓	✓	✓	[accounts. Project management]	likely
isometric projection	✓	✓	✓	✓	✓[maths]	likely
forces [static, dynamic]	✓	✓	✓	✓	✓[geogra-phy, social science]	likely
load	✓	✓	✓	✓	✓[science, geology, gambling]	likely
tension	✓	✓	✓	✓	✓[physics, social sciences]	likely
metal cross-section	✓	✓	✓	✓	✓[geology, geography]	unlikely
compression	✓	✓	✓	✓	✓[data science, physics]	likely
bending of beams	✓	✓	✓	✓	X	unlikely
torsion force	✓	✓	✓	✓	X	unlikely
cross bracing	✓	✓	✓	✓	X	unlikely
corrosion resistance	✓	✓	✓	✓	X	unlikely

corrosion	✓	✓	✓	✓	✓[science s, chemistry]	unlikely
flow chart	✓	✓	✓	✓	✓[science , business studies, maths]	unlikely
sketch	✓	✓	✓	✓	✓[English, drawing	likely
mechanical systems & control	✓	✓	✓	✓		
syringe mechanisms	✓	✓	✓	✓	✓[medica l]	likely
force transfer	✓	✓	✓	✓	✓[physics]	unlikely
compressed air [pneumatic system]	✓	✓	✓	✓	X	likely
hydraulic system	✓	✓	✓	✓	X	unlikely
force multiplicatio n	✓	✓	✓	✓	✓ [military science]	likely
force division	✓	✓	✓	✓	✓[military science]	likely
liquids	✓	✓	✓	✓	✓[science , English]	unlikely
incompressi ble	✓	✓	✓	✓	✓[physics]	unlikely
pascal’s principle	✓	✓	✓	✓	✓[physics]	unlikely
hydraulic press	✓	✓	✓	✓	✓[physics]	unlikely

hydraulic jack	✓	✓	✓	✓	X	unlikely
fixed pulley	✓	✓	✓	✓	X	unlikely
ratchet and pawl	✓	✓	x	✓	X	unlikely
disc brake	✓	✓	x	✓	X	unlikely
bicycle brake	✓	✓	x	✓	X	unlikely
cleat	✓	✓	x	✓	✓[sporting, farming, shoe making]	likely
spur gears	✓	✓	x	✓	X	unlikely
counter rotating	✓	✓	✓	✓	X	unlikely
velocity	✓	✓	✓	✓	✓[physics, maths]	unlikely
idler	✓	✓	✓	✓	✓[social sciences]	likely
bevel gears	✓	✓	x	✓	X	unlikely
axis of rotation	✓	✓	✓	✓	✓[geography, physics, maths]	unlikely
rack-and-pinion gear	✓	✓	✓	✓	X	unlikely
worm gear	✓	✓	x	✓	X	unlikely
single vp perspective	✓	✓	✓	✓	X	unlikely
electrical/elec-tronic systems	✓	✓	✓	✓		
cells in series	✓	✓	✓	✓	X	unlikely
cells in parallel	✓	✓	✓	✓	X	unlikely
switches in series	✓	✓	✓	✓	X	unlikely

switches in parallel	✓	✓	✓	✓	X	unlikely
current in the circuit	✓	✓	✓	✓	✓ [physics]	unlikely
ohm's law	✓	✓	✓	✓	✓ [physics]	unlikely
voltage	✓	✓	✓	✓	✓[physics]	unlikely
current	✓	✓	✓	✓	✓[physics, English, geography]	likely
voltmeter	✓	✓	✓	✓	✓[physics]	unlikely
ammeter	✓	✓	✓	✓	✓[physics]	unlikely
resistor	✓	✓	✓	✓	✓[physics]	unlikely
led (light emitting diode)	✓	✓	✓	✓	X	unlikely
diode	✓	✓	✓	✓	✓[physics]	unlikely
transistors	✓	✓	✓	✓	✓[physics]	unlikely
sensors	✓	✓	✓	✓	✓[physics]	unlikely
simple transistor circuit	✓	✓	✓	✓	X	unlikely
ldr (light dependent resistor)	✓	✓	✓	✓	X	unlikely
thermistor	✓	✓	✓	✓	X	unlikely
touch detector	✓	✓	✓	✓	X	unlikely

moisture detector	✓	✓	✓	✓	X	unlikely
capacitors	✓	✓	✓	✓	X	unlikely
electronics	✓	✓	✓	✓	✓[physics]	unlikely
circuit	✓	✓	✓	✓	✓[English]	likely
prototype	✓	✓	✓	✓	✓[English, Biology]	unlikely
processing	✓	✓	✓	✓		
preserving metals	✓	✓	✓	✓	X	unlikely
painting	✓	✓	✓	✓	✓[art]	unlikely
galvanising	✓	✓	✓	✓	X	unlikely
electroplatin g	✓	✓	✓	✓	X	unlikely
preserving food	✓	✓	✓	✓	X	unlikely
storing grain	✓	✓	x	✓	X	unlikely
pickling	✓	✓	✓	✓	X	unlikely
salting	✓	✓	x	✓	✓[data science]	likely
drying	✓	✓	x	✓	✓[English]	likely
properties of plastic	✓	✓	✓	✓	X	unlikely
types of plastics	✓	✓	x	✓	X	unlikely
coding	✓	✓	✓	✓	✓[IT, traffic]	likely
reduce	✓	✓	✓	✓	✓[photog raphing, chemistry]	unlikely
reuse	✓	✓	✓	✓	✓[English]	unlikely
recycle	✓	✓	✓	✓	✓[English]	unlikely
thermal conductor	✓	✓	✓	✓	✓[physics]	unlikely

aerodynamics	✓	✓	✓	✓	X	unlikely
stability	✓	✓	✓	✓	✓[politics, English]	likely
texture	✓	✓	✓	✓	✓[visual arts]	unlikely
asymmetrical	✓	✓	✓	✓	✓[maths, photographing, arts]	unlikely
symmetrical	✓	✓	✓	✓	[maths, photographing, arts]	unlikely
tower crane	✓	✓	x	✓	X	Unlikely
frame structures	✓	✓	✓	✓	X	Unlikely
shell structures	✓	✓	✓	✓	X	Unlikely
triangulation	✓	✓	✓	✓	✓[research, psychology, maths]	Likely
centre of gravity	✓	✓	✓	✓	✓[physics, geography]	Unlikely
structural members	✓	✓	✓	✓	X	Unlikely
beam	✓	✓	✓	✓	✓[English, physics]	Likely
equilibrium	✓	✓	✓	✓	✓[physics, maths, chemistry]	Unlikely
systems approach	✓	✓	✓	✓	✓[health, psycholog	Likely

					y, education]	
pulleys	✓	✓	✓	✓	X	Unlikely
speed ratio	✓	✓	✓	✓	X	Unlikely
gear train	✓	✓	✓	✓	X	Unlikely
compound gear train	✓	✓	✓	✓	X	Unlikely
gear ratio	✓	✓	✓	✓	X	Unlikely
velocity ratio	✓	✓	✓	✓	X	Unlikely
crank mechanism	✓	✓	✓	✓	X	Unlikely
cam and follower	✓	✓	✓	✓	X	Unlikely
Fulcrum	✓	✓	✓	✓	✓[English, program ming]	Likely
mechanical advantage	✓	✓	✓	✓	X	Unlikely
mechanical disadvantag e	✓	✓	✓	✓	X	Unlikely
Torque	✓	✓	✓	✓	✓[physics]	Unlikely
Insulators	✓	✓	✓	✓	X	Unlikely
conductors of heat	✓	✓	✓	✓	X	Unlikely
gravitational potential energy	✓	✓	✓	✓	X	Unlikely
Amps	✓	✓	✓	✓	X	Unlikely
carbon resistor	✓	✓	✓	✓	X	Unlikely
resistor colour codes	✓	✓	✓	✓	X	Unlikely
Relay	✓	✓	✓	✓	✓[sports, English]	Likely

Table 2.

Final must-know Grade 8 Technology Education terms

aerodynamics	counter-rotating	fulcrum	metal cross-section	switches in parallel
ammeter	crank mechanism	galvanising	moisture detector	symmetrical
amps	cross bracing	gear ratio	ohm's law	syringe mechanisms
asymmetrical	current	gear train	pickling	systems approach
axis of rotation	design	gravitational potential energy	pneumatic system	tension
capacitors	design brief	hydraulic press	preserving	texture
carbon resistor	electrical/electronic systems	hydraulic system	prototype	thermal conductor
cells in series	electronics	insulators	pulleys	thermistor
centre of gravity	electroplating	investigate	relay	torque
circuit	equilibrium	isometric projection	resistor	torsion force
coding	evaluate	ldr (light dependent resistor)	resistor colour codes	touch detector
communicate	first angle orthographic projection	led (light emitting diode)	sensors	transistors
compound gear train	fixed pulley	load	shell structures	velocity
compressed air	force multiplication	mechanical advantage	simple transistor circuit	velocity ratio
conductors of heat	force transfer	mechanical disadvantage	speed ratio	voltage
corrosion resistance	frame structures	mechanical systems & control	structural members	voltmeter