Roles of English for Specific Purposes (ESP) in STEM Education to Leverage Sustainable Education

Karmila Rafiqah M. Rafiq[1], Harwati Hashim[2*], Melor Md Yunus[3]

[1]Centre of Foundation Studies, Universiti Teknologi MARA, 43800, Dengkil, Selangor, Malaysia
karmilarafiqah@gmail.com
[2 3]Faculty of Education, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia
harwati@ukm.edu.my
melor@ukm.edu.my
[*]Corresponding Author

https://doi.org/10.24191/ajue.v20i3.27857

Received: 20 December 2023
Accepted: 8 October 2024
Date Published Online: 28 October 2024
Published: 28 October 2024

Abstract: The rise of technology in education has opened up more career opportunities in the Science, Technology, Engineering, and Mathematics (STEM) fields. However, one factor which causes the decline in STEM pursuers in higher education is the language barrier. This is because the English language learnt in school is not specified for the STEM field, so the term English for Specific Purposes (ESP) comes into view. This paper aims to discuss the roles of ESP in relation to STEM education in Malaysia. The major theme revolves around language issues in STEM education, the roles and characteristics of ESP for STEM and the first step in introducing English for STEM vocabulary in STEM education. This paper implied that knowing the vocabulary for STEM could ensure better teaching and learning opportunities. Future research could look into designing and developing courses for English for STEM to leverage quality education as aspired in SDG.

Keywords: Education, Engineering, English for Specific Purposes (ESP), Mathematics (STEM), Science, Technology, Teaching and Learning, Vocabulary

1. Introduction

English is a globally acknowledged international language due to its significance as a communication medium. However, learners of English as a Second Language (ESL) find it challenging to learn English (Deris & Shukor, 2019; Lingga et al., 2020). One reason is that ESL learners are not exposed to the language since birth, so they face difficulties using it (S. Krashen, 2006). Looking at this matter, one crucial aspect to look into in learning the English language is acquiring the vocabulary in the target language, which is to ensure that one can use the vocabulary in various skills, such as listening, reading, speaking, and writing (Ibnian, 2017; Misbah et al., 2017; Muhamad & Rahmat, 2015). Nevertheless, with the ever-expanding world, the English language learnt in school is used in the working field (Nikolaeva & Synekop, 2020; Rajprasit et al., 2015). It is essential to note that with the expansion of technology in the working field, the English language used for specific contexts is not similar to general English. This difference has brought the term English for Specific Purposes (ESP) into light, which is the English language used by a particular community for a specific context (Hutchinson & Waters, 1987).

English for Specific Purposes (ESP) undeniably is more challenging because it deals with the terms and jargon of the English language for a particular context (Dudley-Evans & St John, 1998). For instance, learning medical words in English requires specific vocabulary, which might not be covered

in ESL, but knowing the terms is crucial (Rajprasit et al., 2015). Despite learning ESL from a young age, most learners still face difficulties grasping the language (Otto, 2021; Rafiq et al., 2019), and what is more for ESP learners. However, ESP has been regarded as an essential branch in the teaching and learning of the English language because different contexts require different mastery of the language. Plus, the role of ESP started to emerge since the evolvement of science and technology, which requires specific use of language to suit their environment (Carver, 1983; Dudley-Evans & St John, 1998; Hutchinson & Waters, 1987).

Looking into the primary role of ESP, it is vital to leverage the English language for learners in the science and technology field of studies. With regard to field advancement, which requires the intervention of ESP, one expanding area is the Science, Technology, Engineering, and Mathematics (STEM) field. STEM was introduced by the United States (US) National Science Foundation in 1998 as the rapid growth of machines took place. Since then, STEM has grown worldwide, and STEM-related jobs are more in demand (Ministry of Education, 2013; Sheldrake, 2020; UNESCO, 2020). With the increasing number of STEM-related professions, the number of STEM graduates should be able to cater to the jobs for the country's economy. However, the language barrier has become an issue in the working environment, whereby many graduates are reported to have inadequate English language competency for their job scopes (Agus Budiharto & Amalia, 2019; Amutan et al., 2019; Hirsch, 2017). This has brought up the importance of learning English for specific purposes. Therefore, this paper aims to discuss the roles of ESP in relation to STEM education in Malaysia.

2. STEM Education in Malaysia

Relating the Malaysian educational situation to the current world, STEM has been paid more attention in the Malaysian education system as a vast and expanding field (Ministry of Education, 2013). In the Malaysian context, where English is learned as a second language, the demand for graduates with good English proficiency is irrefutable as the English language could bridge the language barrier between non-native countries (Arumugam et al., 2014; Nawal et al., 2017; Rasalingam & Embi, 2018). The notion that graduates are not up to par with their language abilities becomes an issue for education in Malaysia (Abidin & Hashim, 2021; Hirsch, 2017). According to the Malaysian Education Blueprint (2013-2025), the education system in Malaysia puts more emphasis on STEM (Ministry of Education, 2013). Since more STEM-related jobs are coming into view, there is also a need to look into the language issue these graduates have to enhance the quality of education, as recently announced in the Twelfth Malaysia Plan (RMK12) (Economic Planning Unit, 2021). The Twelfth Malaysia Plan has thirteen shifts to empower the nation's growth. Resonating with game-changer 10, which is developing future talent, the importance of leveraging education is highlighted. The quality of education to produce a labour market for sustainable nation growth becomes one of the strategies in this shift (Economic Planning Unit, 2021), which means that education should tackle specific issues first.

2.1 Language Issues in STEM Education

One factor associated with poor English competency among STEM graduates is that the schooling system, especially the Malaysian education system, separates STEM subjects from the English language. In Malaysia, the medium of instruction in teaching Science and Mathematics changes frequently. The different mediums of instruction cause a language barrier (Kamsi et al., 2019; Siti Nur Diyana et al., 2018). The language barrier has made it difficult for learners to suddenly change from Malay to English (Baharin & Kamarudin, 2018; Sabirin et al., 2020). This is because STEM-related subjects or courses are taught in English in higher education. Also, STEM-related fields tend to cooperate or compete globally, emphasising the importance of the English language (UNESCO, 2020). Considering that the inconsistency has caused language problems for STEM learners, it is crucial to start from the basics of acquiring the English language for STEM (Mohd Haniff et al., 2020). Thus, to curb the issue, vocabulary acquisition is the first step in language learning (Brown, 2000; Coady & Huckin, 1997). As Misbah et al., (2017) reported, one of the factors associated with difficulties in learning a second language is the lack of vocabulary. This shows that acquiring vocabulary should be emphasised first before developing other skills such as listening, reading, speaking, and writing (Kim,

2020; Lee & Stephens, 2020). However, a problem associated with English language learning in the Malaysian context is that the English language is too general (Ye, 2020). Hence, STEM-related vocabulary is not explicitly discussed, hindering their vocabulary acquisition, which brings light to ESP.

2.2 English for Specific Purposes (ESP)

Over the years, technological advancement has changed how people use English. The term English for Specific Purposes (ESP) has become a new form of language aimed to cater to the language of different fields of studies, such as business with technology and science. ESP's primary purpose is to involve only a particular community or group with common learning goals and needs (Hutchinson & Waters, 1987). ESP has been widely used as an approach in various research, which brought in some areas under the domain of ESP, such as English for Academic Purposes (EAP), English for Legal Purposes (ELP), English for Business Purposes (EBP), English for Vocational Purposes (EVP) and English for Occupational Purposes (EOP) (Paltridge & Starfield, 2013). On another note, Carver (Carver, 1983) categorised ESP into three categories: 1) English as a restricted language, 2) English for Academic and Occupational Purposes, and 3) English with specific topics. However, Hutchinson and Waters (Hutchinson & Waters, 1987) broke down ESP into three branches, which are 1) English for Science and Technology (EST), 2) English for Business and Economics (EBE), and 3) English for Social Studies (ESS). These three categories were further branched into two, known as a) English for Academic Purposes (EAP) and b) English for Occupational Purposes (EOP). Figure 1 below represents the "Tree of English Language Teaching (ELT)" by Hutchinson and Waters (Hutchinson & Waters, 1987).

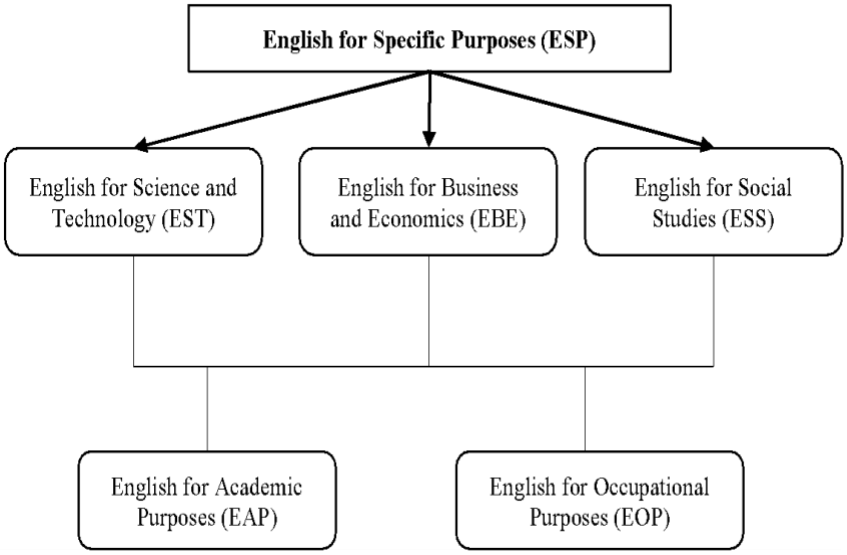

Fig. 1 The tree of ELT (Hutchinson & Waters, 1987)

The role and importance of ESP differ according to the context. In Hutchinson and Waters's (Hutchinson & Waters, 1987) definition of ESP, there is a visible gap between EAP and EOP. The EAP is mainly geared towards studying, while EOP is aimed at the workplace. However, it could be seen that Carver (1983) portrayed a similar categorisation of EAP and EOP because he implied that the end goal of these two categories is employment. Hutchinson and Waters (Hutchinson & Waters, 1987) noted that the end goal for EAP and EOP was the same, but the means to achieve it differs. Hence, they separated the two branches (Hutchinson & Waters, 1987).

2.2.1 The Role and Characteristics of ESP

Despite having different categorisations, ESP has its characteristics, guiding practitioners, researchers, and teachers to develop an ESP course. Indeed, ESP branches out into many categories,

like EAP and EOP, the more common ones. Although famous theorists of ESP agreed that ESP is an approach specified for a particular context and learners (Carver, 1983; Dudley-Evans & St John, 1998; Hutchinson & Waters, 1987; Paltridge & Starfield, 2013), there are still differences in how they perceive the role of ESP in education. The two notable theorists who show different perceptions of the role of ESP are Hutchinson and Waters (Hutchinson & Waters, 1987) and Dudley-Evans and St John (Dudley-Evans & St John, 1998). First, Hutchinson and Waters (1987) drew a distinctive line between ESP and General English (GE). This showed that the methods of instruction differ in language teaching and learning. Second, they emphasised the role of ESP based on learners. They considered ESP a learner-centred approach where designs and delivery of the language should revolve around learners' needs. Though Dudley-Evans and St John (1998) did consider learners' needs, they emphasised that ESP is not to be broken down into various disciplines, as Hutchinson and Waters (1987) defined. Dudley-Evans and St John (1998) also ensured that ESP is focused on the language, skills, and functions aside from learners' needs.

Different researchers similarly described the characteristics of ESP. As mentioned, prominent theorists have their descriptions of ESP. The three ESP theorists who described ESP with similar characteristics were Carver (Carver, 1983), Hutchinson and Waters (Hutchinson & Waters, 1987), and Dudley-Evans and St John (Dudley-Evans & St John, 1998). Carver (1983) was one of the earliest theorists in the ESP field, who outlined three characteristics of ESP. He mentioned that ESP materials should be authentic, have specific purposes and be self-directed. The authenticity of materials is indeed a characteristic of ESP. Dudley-Evans and St John (1998) mentioned that ESP learning materials need not be newly created. They can also be modified; in some cases, modification is unnecessary, but the authenticity should remain. Authenticity in materials refers to originality, whereby ESP materials are specified for a particular context, rendering the authentic nature. This clearly shows that ESP materials, developed or adopted in language teaching, should be original because they refer to specific content for specific learners and contexts.

One notable feature of ESP that many have identified is the specific content for a particular target. Another characteristic of ESP is the end goal or purpose of the content. Carver (1983) stated that the end goal for ESP learners is to be able to use the language in the targeted context. Carver (1983) and Hutchinson and Waters (1987) mentioned that ESP learners are mostly adults because the end goal is to develop communicative abilities. However, Dudley-Evans and St John (1998) added to that by stating that ESP can also be designed for secondary school learners, which is a prominent key for this study. Also, the purpose mentioned by Dudley-Evans and St John (1998) also specifies adult learners in the occupational setting and includes school learners' General English (GE) knowledge, particularly grammar, discourse, and skills. This shows that the characteristic of ESP goes beyond the purpose of catering to occupational demands. This study looks into creating a supplementary mobile learning module to encourage learners to learn STEM-related vocabulary starting from secondary school.

Finally, the common characteristic of ESP is self-directed. In this sense, self-directed refers to learners' autonomy. Carver (1983) defined self-directed as giving freedom for learners to choose the time, place, and method of learning, which also means making them ESP users rather than learners. This definition provided by Carver (1983) is indeed a trait of ESP, as agreed by Hutchinson and Waters (1987), who described self-directed as analysing the learners' needs. Dudley-Evans and St John (1998) also mentioned that teaching specific content requires a particular methodology to cater to learners' learning needs. They also said that it is vital to analyse learners' needs. Analysing learners' needs and designing appropriate learning tasks are also known as needs analysis. Many ESP practitioners and designers conduct needs analysis as ESP requires specific content, which can only be identified through needs analysis.

The growing research on ESP has become a trend since the 1960s. ESP caters to various fields, including arts, business, and sciences. Some ESP courses are also designed by combining art and science disciplines. A study by Pollard and Olizko (2019) combined arts and ESP, involving tertiary-level chemical engineering learners. This study is unique as the integration of arts encourages creativity. Also, authentic materials were mentioned as well. Another recent study by Dolidze and Doghonadze (2020) includes technology in ESP teaching in tertiary education.

Similarly, a study on chemical engineering learners was carried out in the Ukrainian context, looking at ESP for technical competency (Fedorenko et al., 2020). This current trend of integrating

technology in ESP research sheds new light on the ESP field. Many studies in the ESP context were associated with adult learners, particularly learners at the tertiary level (Lavrysh & Saienko, 2020; Lou et al., 2020; Mostafavi et al., 2021; Nikolaeva & Synekop, 2020; Otto, 2021). This shows a gap in the research on ESP, particularly for secondary school learners.

2.3 ESP and STEM

Although the English language is taught in school as part of the curriculum, the English language subject is too general, and it is not contextualised for STEM learners (Fang & Liu, 2020). Despite learning English from a young age, learners still find it challenging to master English. One difficult area for ESL learners is mastering English vocabulary (Aravind & Rajasekaran, 2020; Mohd Haniff et al., 2020). Undeniably, vocabulary is indeed crucial in ensuring the success of language learning (Lee & Stephens, 2020). Despite having other skills in the English language, such as grammar, reading, writing, listening, and speaking, the mastery of vocabulary is more vital (Kim, 2020; Solikhah, 2020). This is because, without proper vocabulary in the language, learners would be unable to use the language in terms of accuracy and fluency (Solikhah, 2020).

The importance of vocabulary acquisition has been deemed vital by many researchers (Fernández et al., 2019; Kim, 2020; Kocabas et al., 2019; Lacosse et al., 2020; Lee & Stephens, 2020; Maarouf, 2019). In this study, the lack of vocabulary related to the STEM field has become a barrier for learners. In secondary schools, STEM subjects are taught separately from the English language. This resulted in inadequate vocabulary comprehension for STEM learners (Fang & Liu, 2020). Based on the textbook analysis in the Malaysian English syllabus, particularly for secondary school learners, it can be seen that there are limited topics related to STEM. This shows that learners are not given ample opportunity to learn the jargon, terms, and vocabulary related to STEM in the English subject (Junaini et al., 2019). This indicates that English is too general for secondary school Malaysian learners (Fang & Liu, 2020). Table 1 below shows the topics for the secondary school English textbooks, starting from Form 1 to Form 5.

Table 1. Summary of English Topics Related to STEM

Form	Topics	Related to STEM	Reference
1	1: What Do You Like?		Pulse 2 Student's Book
	2: Fact or Fiction?		by Michele Crawford
	3: Wild Weather	/	
	4: Life on Earth	/	
	5: Let's Experiment5	/	
2	6: Money		
	7: Journeys		
	8: Good Luck, Bad Luck		
	9: Take Care	/	
3	1: Family Ties		Close Up B1 Student's
	2: Food, Food, Food!		Book by Angela Healan
	3: The Wonders of Nature	/	and Katrina Gormley
	4: Special Relationships		
	5: A Place to Call Home		
	6: Ready, Steady, Go!		
	7: Extreme Situations		
	8: Time to Spare		
	9: High-Tech World	/	
	10: That's Entertainment		
	11: Lessons to Learn		
	12: The Body Beautiful	/	

Form	Topics	Related to STEM	Reference
4	1: Let's Chat		Full Blast! Plus 4 Student's Book by Mitchell
	2: Ready for Anything		
	3: Buy It!		
	4: Being a Teen		
	5: Globetrotting	/	
	6: Time Out		
	7: Mother Nature	/	
	8: Image		
5	1: It's Personal!		English Download B1+ Form 5 by Elizabeth Gordon, Liz Hammond, Phillip James, Liz Stolls
	2: Life's Great Mysteries		
	3: The World of Sport		
	4: Shopping Therapy		
	5: The Environment	/	
	6: Crime		
	7: The Media		
	8: A Hard Day's Work		
	9: Getting Away		
	10: Where on Earth?		
	11: High-Tech World	/	
	12: Happy to Help!		

As can be seen, the STEM topics are limited in the Malaysian English syllabus in secondary school. Form 1 English has three topics related to STEM out of five, but Form 2 has no related topics among the four mentioned topics. Form 3 has three topics related to STEM out of twelve, whereas Form 4 and 5 have two STEM topics out of eight and twelve topics, respectively. This shows that there are indeed limited STEM-related topics in the Malaysian English syllabus in secondary school. With this, learners have little opportunity to learn and grasp the terms and jargon related to STEM, which becomes a barrier (Baharin & Kamarudin, 2018; Fang & Liu, 2020; Junaini et al., 2019; Sabirin et al., 2020). Since Form 4 and 5 learners can choose either STEM or arts stream (Ministry of Education, 2013), the terms and jargon related to STEM should be introduced in the upper secondary school. Introducing English vocabulary for STEM could be the initial step in preparing STEM learners for higher institutions (De Meester et al., 2020; Lacosse et al., 2020; Ye, 2020).

With regards to acquiring English vocabulary for STEM learners, the role of ESP comes into view. ESP focuses primarily on the functions of a language, as mentioned by Dudley-Evans and St John (Dudley-Evans & St John, 1998). Learning ESP differs from learning ESL, as ESP emphasises awareness of the context to create authentic language learning for specific situations (Hutchinson & Waters, 1987). Looking into the syllabus of general English in secondary schools, there is a need to adopt ESP to learn specific vocabulary for STEM, and undeniably, vocabulary acquisition is the first step in mastering a language (Fernández et al., 2019; Gayathree & Harwati, 2021; Kim, 2020; Kocabas et al., 2019; Lacosse et al., 2020; Lee & Stephens, 2020; Maarouf, 2019). Since ESP is discipline-specific (Carver, 1983; Dudley-Evans & St John, 1998; Hutchinson & Waters, 1987), there is a need to look into upper-secondary learners. In Malaysia, upper secondary (referring to Form 4 and Form 5) learners can choose their paths and streams, which are discipline-specific (De Meester et al., 2020). Introducing discipline-specific vocabulary could bridge the language gap between secondary and higher institutions.

The adoption of ESP in the teaching and learning of English for STEM is crucial in this case. One feature of ESP is the authenticity of the materials (Dudley-Evans & St John, 1998; Hutchinson & Waters, 1987; Paltridge & Starfield, 2013). The learning strategies in using authentic materials for ESP include using audio and visual, allowing language to be functionally used in contextualised settings, which is more vital in the current era (Kuchkarova, 2020; Sitepu et al., 2020; Vora, 2020). This is because the objectives of learning ESP are closely related to the learners' needs (Dudley-Evans & St John, 1998). Hence, acquiring English for STEM vocabulary could assist learners in their future endeavours as the nature of it is authentic and contextualised.

2.4 Vocabulary Learning

Vocabulary learning in STEM contexts requires a different range of words and should have specificity. Vocabulary is essential in language learning; without proper vocabulary, learners could not produce speech (Krashen, 2009). Due to that, vocabulary acquisition should be emphasised. In second language acquisition, vocabulary learning involves direct instruction, in which learners learn words in formal education. This means that, for a learner to perform well in a particular language, they need to possess a specific range of words. Before looking at the vocabulary size, the nature of vocabulary learning should be looked into. In vocabulary learning, there are three tiers to be looked into: 1) Tier 1, 2) Tier 2, and 3) Tier 3 (Beck et al., 2013). Figure 2 below shows the three tiers of vocabulary learning.

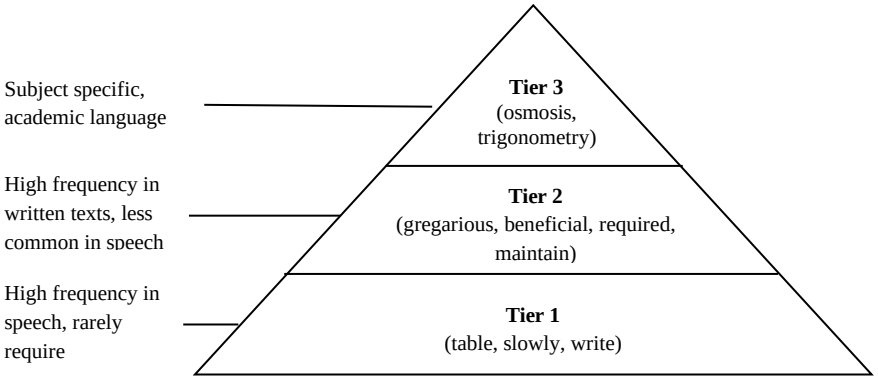

Fig. 2 Three tiers of vocabulary (Beck et al., 2013)

According to Beck et al. (2013), the three tiers of vocabulary show which vocabulary teaching should be emphasised. In tier 1, the vocabulary comprises essential words acquired through informal learning, usually at an earlier age of language acquisition. On the other hand, tier 2 vocabulary plays a more significant role for English language learners because the words in tier 2 are generalisable to most contexts. In tier 3, the vocabulary is precise, focusing on particular fields, which only need proper instructions when there is a need. Not everyone needs to master tier 3 vocabulary; hence, Beck et al. [56] emphasised vocabulary teaching tier 2. Though tier 2 vocabulary is generalisable, it was further emphasised that the main element in teaching vocabulary is to ensure that it is specific for students to learn in their contexts (Beck et al., 2013; Herman & Dole, 1988; Sternberg, 1987). This shows that there is a need to look at specific-context vocabulary in tier 2 to suit the needs of learners to function well in society. Hence, to identify how many words a learner should know, it is essential to look into the vocabulary size of English language learners.

2.4.1 Vocabulary Size

The vocabulary size differs for each learner. Native learners, 17 years old, were required to have between 14000 and 15000 words; however, non-native speakers of a similar age group must have between 8000 and 9000 words (Kurniawan, 2017). However, Nation and Waring (1997) mentioned that ESL learners need to master words at 3000 and 5000 levels to comprehend texts and speeches effectively. This was supported by Ng et al., (2020), who mentioned that it is too challenging for ESL higher education students, particularly in engineering, to learn 14000 words. A study by Wong et al., (2019) examined the vocabulary size of Malaysian ESL learners in secondary education. It was reported that most students did not pass the 2000-word level test, meaning they have not mastered a threshold level of words required for higher education.

In enhancement, 61 studied ESL learners pursuing engineering in higher education. They found that the learners need 11000 words to perform efficiently in their field. This vast difference showed that learners in Malaysia are still less proficient in English, which requires a novel solution. English language learners should learn eight to ten words per week, be taught via direct instructions, and be introduced during formal learning. However, Graves (2016) mentioned that English language learners need to learn

between 3000 to 4000 words per year, meaning they need to know at least 20 words daily. Regardless, these words must also come from context, as it is the nature of effective vocabulary instruction (Sternberg, 1987). Thus, there is a need for teachers and educators to look into introducing specific vocabulary in secondary school properly (Ng et al., 2020) precisely because STEM learners have the specific vocabulary to master.

3. Conclusion

In conclusion, this paper aims to discuss the roles of ESP in relation to STEM education in Malaysia. ESP is a fundamental approach in designing instructions, particularly for the fields of Science, Technology, Engineering, and Mathematics (STEM) in Malaysian secondary schools. Although English for Science and Technology (EST) is a branch under ESP, the context is more towards adult learners. However, ESP can also be designed for secondary school learners and emphasises that the learning needs of the learners should be identified based on their end goal. The end goal of ESP for STEM is to start with the fundamental language component, vocabulary acquisition, particularly for STEM. Knowing the vocabulary size for an ESP course provides enlightenment in a course's design and development. Hence, the importance of vocabulary size is undeniable. English language learners need to learn between eight to ten words per week, but it was also suggested that at least 20 words per day are needed to achieve the number of words learned in a year. This paper implied that knowing the vocabulary size is to ensure that the number of words introduced in English for STEM is sufficient. Future research could look into designing and developing courses for English for STEM to leverage quality education as aspired in SDG.

4. Co-Author Contribution

The authors affirmed that there is no conflict of interest in this article. Karmila Rafiqah M. Rafiq, Harwati Hashim and Melor Md Yunus prepared the literature review and overlooked the whole article's writeup.

5. Acknowledgements

Universiti Kebangsaan Malaysia funded this research with grant no. GG-2021-003.

6. References

Abidin, N. Z., & Hashim, H. (2021). Common European Framework of Reference (CEFR): A Review on Teachers' Perception & Plurilingualism. *Creative Education, 12*(04), 727–736. https://doi.org/10.4236/ce.2021.124051

Agus Budiharto, R., & Amalia, L. (2019). Motivation behind Indonesian Undergraduates Learning English as a Target Language. *Journal of Language Teaching and Learning, Linguistics and Literature, 7*(1), 1–15.

Amutan, K. I., Ching, H. S., Ramalingam, S., & Maruthai, E. (2019). An Investigation of Communication Skills Required by Employers from the Fresh Graduates. *Pertanika J. Soc. Sci. & Hum, 27*(3), 1507–1524.

Aravind, B. R., & Rajasekaran, V. (2020). A Qualitative Research through an Emerging Technique to Improve Vocabulary for ESL Learners. *International Journal on Emerging Technologies, 11*(2), 441–446.

Arumugam, N., Xavier, T., Dass, L. C., & Maniam, M. (2014). Unemployment among Graduate Nurses in Malaysia : A Case Study. *Asian Social Science, 10*(9), 227–233. https://doi.org/10.5539/ass.v10n9p227

Baharin, N., & Kamarudin, N. (2018). STEM ASEAN Project to Promote 21st Century Teaching and Learning. *Learning Science and Mathematics, 13*.

Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing Words to Life: Robust Vocabulary Instruction*. Guilford Press.

Brown, H. D. (2000). Teaching by principles: An interactive approach to language pedagogy. Pearson Education.

Carver, D. (1983). Some propositions about ESP. *The ESP Journal, 2*(2). https://doi.org/10.1016/0272-2380(93)90003-P

Coady, J., & Huckin, T. (1997). Second language vocabulary acquisition: A rationale for pedagogy. In Second language vocabulary acquisition: A rationale for pedagogy. Cambridge University Press.

De Meester, J., Boeve-De Pauw, J., Buyse, M.-P., Ceuppens, S., De Cock, M., De Loof, H., Goovaerts, L., Hellinckx, L., Knipprath, H., Struyf, A., Van Petegem, P., & Dehaene, W. (2020). Bridging the Gap between Secondary and Higher STEM Education - The Case of STEM@school. *European Review, 28*(S1), S135–S157. https://doi.org/10.1017/S1062798720000964

Deris, F. D., & Shukor, N. S. A. (2019). Vocabulary learning through mobile apps: A phenomenological inquiry of student acceptance and desired apps features. *International Journal of Interactive Mobile Technologies, 13*(7), 129–140. https://doi.org/10.3991/ijim.v13i07.10845

Dolidze, T., & Doghonadze, N. (2020). Incorporating ICT for Authentic Materials Application in English for Specific Purposes Classroom at Higher Education Institutions. *International Journal of Management, Knowledge and Learning, 9*(2), 207–221.

Dudley-Evans, T., & St John, M.-J. (1998). *Developments in English for Specific Purposes: A Multi-Disciplinary Approach (Cambridge Language Teaching Library)*. Cambridge University Press.

Economic Planning Unit. (2021). Twelfth Malaysia Plan (2021-2025): A Prosperous, Inclusive, Sustainable Malaysia.

Fang, F., & Liu, Y. (2020). 'Using all English is not always meaningful': Stakeholders' perspectives on the use of and attitudes towards translanguaging at a Chinese university. *Lingua, 247*. https://doi.org/10.1016/j.lingua.2020.102959

Fedorenko, S., Kolomiiets, S., Tikan, Y., & Tsepkalo, O. (2020). Interdisciplinary Approach to Modeling in Teaching English for Specific Purposes in the Ukrainian Context. *Arab World English Journal: Special Issue on English in Ukrainian Context, 3*, 124–131. https://doi.org/10.24093/awej/elt3.11

Fernández, L. M., Tharayil, S. A., & Callahan, R. M. (2019). Beyond the Spoken Word: Examining the Nature of Teacher Gesturing in the Context of an Elementary Engineering Curriculum for English-Learner Students. *Journal Homepage: Texas Education Review Texas Education Review, 8*(1), 40–64. https://doi.org/10.26153/tsw/7052

Gayathree, C., & Harwati, H. (2021). Self-Paced Formative Assessment: Concept and Applications in Learning ESL Vocabulary. *Creative Education, 12*(01), 140–150. https://doi.org/10.4236/ce.2021.121010

Graves, M. F. (2016). *Teaching Individual Words. In The Vocabulary Book: Learning and Instruction* (Second Edition, pp. 89–116).

Herman, P. A., & Dole, J. (1988). Theory and Practice in Vocabulary Learning and Instruction. *The Elementary School Journal, 89*(1), 43–54. https://doi.org/10.1086/461561

Hirsch, B. J. (2017). Wanted : Soft skills for today's jobs. Phi Kappan, 98(5), 12–17.

Hutchinson, T., & Waters, A. (1987). English for Specific Purposes: A Learning-Centred Approach. In *Handbook of Research in Second Language Teaching and Learning*. Cambridge University Press. https://doi.org/10.4324/9781315716893

Ibnian, S. S. K. (2017). Writing Difficulties Encountered by Jordanian EFL Learners. *Asian Journal of Humanities and Social Studies, 5*(3), 2321–2799.

Junaini, K., Harshita, A. H., Nor Suhaila, C. P., Zuhairah, I., & Mohamed Roshimi, M. S. (2019). MatchApp Innovation to Assist in the Learning of Science, Technology and Engineering. *International Journal of the Malay World and Civilisation, 7*(2), 25–35.

Kamsi, N. S., Radin Firdaus, R. B., Abdul Razak, F. D., & Ridha Siregar, M. (2019). Realizing Industry 4.0 Through STEM Education: But Why STEM Is Not Preferred? IOP Conference Series: Materials Science and Engineering, 506(1). https://doi.org/10.1088/1757-899X/506/1/012005

Kim, C. E. (2020). STEM Teachers' Beliefs and ESOL Professional Development. *ORTESOL Journal, pp. 37*, 63–70.

Kocabas, S., Ozfidan, B., & Burlbaw, L. M. (2019). American STEM Education in Its Global, National, and Linguistic Contexts. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(1). https://doi.org/10.29333/ejmste/108618

Krashen, S. (2006). Second Language Acquisition Theory, Applications, and Some Conjectures. In TESOL Asia. TESOL Asia.

Krashen, S. D. (2009). Principles and Practice in Second Language Acquisition. Pergamon Press Inc.

Kuchkarova, M. (2020). The Role of the Authentic Materials in Improving Communicative Competence of ESP Learners. *Journal of Intangible Languages and Linguistics, 2*(2).

Kurniawan, I. (2017). Assessing English Students' Vocabulary Size of Lampung State Islamic University. *HUMANIORA, 8*(4), 381–390.

Lacosse, J., Canning, E. A., Bowman, N. A., Murphy, M. C., & Logel, C. (2020). A social-belonging intervention improves STEM outcomes for students who speak English as a second language. *Sci. Adv, 6*, 1–10.

Lavrysh, Y., & Saienko, N. (2020). Teaching mediation skills at technology-enhanced ESP classes at technical universities. *XLinguae, 13*(4), 20–29. https://doi.org/10.18355/XL.2020.13.04.02

Lee, O., & Stephens, A. (2020). English Learners in STEM Subjects: Contemporary Views on STEM Subjects and Language With English Learners. *Educational Researcher, 20*(10), 1–7. https://doi.org/10.3102/0013189X20923708

Lingga, L. M., Simanjuntak, R. M., & Sembiring, Y. (2020). Students' Strategies in Learning Speaking Skills at SMP Nasrani 3 Medan. *Journal of Languages and Language Teaching, 8*(1), 91. https://doi.org/10.33394/jollt.v8i1.2238

Lou, Y., Li, H., & Zhao, Z. (2020). A Study on Needs Analysis of Chinese Vocational Non-English-Majored Undergraduates in English for Specific Purposes. *Open Access Library Journal, 07*(05), 1–15. https://doi.org/10.4236/oalib.1105694

Maarouf, S. A. (2019). Supporting Academic Growth of English Language Learners: Integrating Reading into STEM Curriculum. *World Journal of Education, 9*(4), 83. https://doi.org/10.5430/wje.v9n4p83

Ministry of Education. (2013). Malaysia Education Blueprint 2013-2025 (Preschool to Post-Secondary Education).

Misbah, N. H., Mohamad, M., Yunus, M. M., & Ya'acob, A. (2017). Identifying the Factors Contributing to Students ' Difficulties in the English Language Learning. *Creative Education, 8*, 1999–2008. https://doi.org/10.4236/ce.2017.813136

Mohd Haniff, M. T., Intan Safinas, M. A. A., Airil Haimi, M. A., Mohamad Syafiq, Y. S., & Dianna Suzieanna, M. S. (2020). The Application of Visual Vocabulary for ESL Students' Vocabulary Learning. *Arab World English Journal, 11*(2), 323–338. https://doi.org/10.24093/awej/vol11no2.23

Mostafavi, S., Mohseni, A., & Abbasian, G. R. (2021). The pedagogical efficacy of ESP courses for Iranian students of engineering from students' and instructors' perspectives. *Asian-Pacific Journal of Second and Foreign Language Education, 6*(6), 1–20. https://doi.org/10.1186/s40862-021-00109-2

Muhamad, N., & Rahmat, H. (2015). Investigating Challenges for Learning English through Songs. *European Journal of English Language Teaching, 6*(1), 1–15. https://doi.org/10.46827/ejel.v6i1.3270

Nation, P., & Waring, R. (1997). Vocabulary size, text coverage, and word lists. In N. Schmitt & M. McCarthy (Eds.), Vocabulary: Description, Acquisition, and Pedagogy. Cambridge University Press.

Nawal, M., Norazah, N., & Mohamed Amin, E. (2017). A Need Analysis for a Communicative English Mobile Learning Module for Healthcare Professionals. *International Journal on E-Learning and Higher Education, pp. 6*, 13–24.

Ng, Y. J., Chong, S. T., Thiruchelvam, S., Chow, M. F., & Karthikeyan, J. (2020). Vocabulary Threshold for the Comprehension of Malaysian Secondary Engineering Texts as Compared to the Non-Engineering Genres. *International Journal of Innovation, Creativity and Change, 14*(1).

Nikolaeva, S., & Synekop, O. (2020). Social Aspect of Student's Language Learning Style in Differentiated ESP Instruction. *Universal Journal of Educational Research, 8*(9), 4224–4233. https://doi.org/10.13189/ujer.2020.080949

Otto, P. (2021). Choosing specialized vocabulary to teach with data-driven learning: An example from civil engineering. *English for Specific Purposes, pp. 61*, 32–46. https://doi.org/10.1016/j.esp.2020.08.003

Paltridge, B., & Starfield, S. (2013). *The handbook of English for specific purposes*. John Wiley & Sons, Inc.

Pollard, D., & Olizko, Y. (2019). ART AND ESP INTEGRATION IN TEACHING UKRAINIAN ENGINEERS. *Advanced Education, 6*(11), 68–75. https://doi.org/10.20535/2410-8286.147539

Rafiq, K. R. M., Pazilah, F. N., Tong, G. Y., Yunus, M.M. & Hashim, H. (2019). Be a Hero through Gamified-learning : A PowerPoint Revolution in Leading Towards Creativity & Innovation Series 2, pp. 204–211.

Rajprasit, K., Pratoomrat, P., & Wang, T. (2015). Perceptions and problems of English language and communication abilities: A final check on Thai engineering undergraduates. *English Language Teaching, 8*(3), 111–120. https://doi.org/10.5539/elt.v8n3p111

Rasalingam, R. R., & Embi, M. A. (2018). The Use of Communicative Language Teaching (CLT) in the Teaching of English Courses among Malaysian Polytechnics Lecturers. *International Journal of Social Science and Humanities Research, 6*(2), 254–264.

Sabirin, A., Roslinda, R., Gan, K. B., Mardina, A., Lilia, H., & Norisza, D. I. (2020). STEM Outreach Program of Smart Control Helicopter Competition in Malaysia: A Descriptive Analysis. *Jurnal Kejuruteraan (SI), 3*(1), 29–34. https://doi.org/10.17576/jkukm-2020-si3(1)-05

Sheldrake, R. (2020). Changes in Children's Science-Related Career Aspirations from Age 11 to Age 14. *Research in Science Education, 50*(4), 1435–1464. https://doi.org/10.1007/s11165-018-9739-2

Sitepu, S., Masela, M., & Kurniawati, L. A. (2020). Designing Technology-assisted Lesson Materials for ESP Nursing Students by using TPACK. *Journal of Language, Literature, and Linguistics, 1*(1).

Siti Nur Diyana, M., Nurfaradilla, M. N., Mohd Ali, S., & Lilia, H. (2018). Science teacher education in Malaysia: challenges and way forward. *Asia-Pacific Science Education, 4*(1). https://doi.org/10.1186/s41029-018-0026-3

Solikhah, N. A. (2020). Improving Students' Motivation In English Vocabulary Mastery Through Mobile Learning. *Wanastra: Jurnal Bahasa Dan Sastra, 12*(1). https://doi.org/10.31294/w.v12i1

Sternberg, R. J. (1987). Most Vocabulary Is Learned from Context. In M. McKeown & M. E. Curtis (Eds.), The Nature of Vocabulary Acquisition (pp. 89–106). Lawrence Erlbaum.

UNESCO. (2020). World Teachers' Day 2020 Fact Sheet.

Vora, R. (2020). Integrating Authentic Materials and Language Skills in Teaching English for Specific Purposes (ESP). InterConf.

Wong, A. S. C., Lee, J. Y. V., Fung, M., & Willibrord, O. (2019). Vocabulary Size of Malaysian Secondary School Students. *International Journal of Modern Languages And Applied Linguistics, 3*(4), 27. https://doi.org/10.24191/ijmal.v3i2.7364

Ye, Y. (2020). EAP for undergraduate science and engineering students in an EFL context: What should we teach? *Ampersand, 7*. https://doi.org/10.1016/j.amper.2020.100065