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CHALLENGES FACED BY STUDENTS IN ANSWERING BIOLOGY ESSAY QUESTIONS IN THE ENGLISH LANGUAGE

M. Jelani*[1], A. Abd Aziz[2], H. Hassan[3]

[1,2,3]Language Academy, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Malaysia

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ABSTRACT

Effective writing abilities are essential for science students to articulate their thoughts and critical thinking, enabling the assessment of their scientific knowledge progression. This study aims to uncover the challenges Malaysian Higher School Certificate (STPM) students face in answering Biology essay questions in English. Using a document analysis approach, examiners' feedback from 27 STPM Biology Candidate Reports of essay questions spanning 2013 to 2021 were inductively analyzed. Thematic analysis unveiled the challenges faced by students in answering Biology essay questions in English. The analysis reveals two primary hurdles faced by STPM Biology students. The most substantial challenge pertains to the 'content', followed by 'content and language'. Deficiencies in scientific comprehension and principles were evident within the 'content' category. In 'content and language', students needed help to compose English responses. Factors like 'technical term', content, language, and technical term', 'language', and 'technical term and language' held little significance. Intriguingly, 'content and technical term' posed the least difficulty; inaccuracies in specialized vocabulary usage caused confusion and point deductions. These findings highlight the substantive challenges STPM Biology students face in the domain of natural science education. The study underscores that prevalent issues addressing STPM Biology essay questions revolve around insufficient content coverage and limited English proficiency. Addressing these challenges and devising instructional strategies to bolster content comprehension and language skills within the natural science context proves pivotal. By tackling these issues, educators and policymakers can cultivate a more supportive and effective learning environment for STPM Biology students.

Keywords: Biology essay writing; candidate reports; English writing skills; ESL; STEM

INTRODUCTION

The industrial and business worlds are built on Science, Technology, Engineering, and Mathematics (STEM) principles. For a more adaptable and creative workforce, STEM fields seek to generate human resources with STEM-related knowledge, abilities, and values (RAE, 2015) in the global enterprise (Akaygun & Aslan-Tukak, 2016; Çevik & Özgünay, 2018) thus boosting the number of professionals assisting Malaysia's economic growth (KPM, 2018) and worldwide economic growth (Reider et al., 2016). Learning Mathematics and Science in English is crucial to allow students to develop their English language proficiency with science concepts (Motlagh et al., 2020). This is a two-pronged strategy since the future workforce will be equipped not only with STEM knowledge, which is the foundation for technological growth (Rothwell, 2013), but also with a strong command of the English language, which employers highly respect (Ting et al., 2017). Learners whose first language is not English, on the other hand, encounter difficulties in learning mathematics and science lessons in English. Students frequently struggle with writing

***Correspondence Address**
E-mail: cikgumisslina@gmail.com

scientific papers, according to Probosari (2015), since they do not comprehend the rules of good writing. In Malaysia, the problem is compounded by the fact that most learners are not competent English users since they did not learn the language successfully (Hamzah & Abdullah, 2009) and have poor or insufficient English literacy achievement (Musa et al., 2012).

Torres and Zeidler (2002) examine how students' knowledge of scientific subjects is impacted by their English language skills and status as "language learners". They find that the language learner variable (i.e., Hispanic English language learners or native English speakers) has no statistically significant effect. However, a considerable association exists between learners' English language competency and their scientific reasoning skills. This implies that learners' English language competency levels influence their science knowledge acquisition. In another study, Bruna et al. (2007) investigate the "didactic tension" that emerges between the development of conceptual understanding in the science of English language learners (ELLs) using a transcript of classroom discourse. According to the results of their study, ELLs should receive integrated education that balances teaching science topics and scientific language. In other words, ELLs learning STEM in English need much support with both language and subject. In addressing this concern, several scholars have advocated the implementation of content and language-integrated learning (CLIL) (Kong, 2014; Lo, 2014; Vázquez, 2014; van Kampen et al., 2017; Raitbauer et al., 2018; Yasuda, 2019; Lopes, 2020; Schneider, 2021; Freihofner, 2021). Nonetheless, language teachers are unprepared to integrate content-area resources into their English language curriculum, and content teachers believe they are incapable of assisting ELLs in understanding academic concepts through the English language (Crandall, 1998). Therefore, the onus of supporting ELLs in learning STEM subjects in English lies on the content subject teachers. Science teachers working with ELLs must use approaches that make science subjects more accessible as well as techniques that help students acquire academic language abilities (Short, 2017). This leads to two main concerns: what to support and how to support ELLs' STEM education.

Writing skills are one of the English language abilities that ELLs must acquire to succeed in STEM disciplines. Equipping learners with the necessary writing skills is important as articulating their thoughts in writing can assist learners in understanding ideas of science better (Sampson et al., 2013; Probosari, 2015). Most importantly, students' challenges while writing in science must be addressed. Omar (2019) demonstrates that ELLs experience difficulties in the academic writing setting owing to their poor understanding of grammar and advises that teachers establish techniques for teaching grammar that would assist students in improving their academic writing. However, content subject teachers who are not native English speakers may find it difficult to encourage and enhance their students' English writing skills. This is because writing is a complex skill (Hyland, 2003) and unique mode of learning (Emig, 1977) that involves not only language elements like organization, skills, spelling, punctuation, vocabulary, grammar, and sentence structure (Hedge, 2001; Shokrpour & Fallahzadeh, 2008; Amalia et al., 2021), with stages and a process (Miller & Paola, 2005) but also critical thinking skills (Quitadamo & Kurtz, 2007; Suwono et al., 2017; Bustami et al., 2018; Amalia et al., 2021), exhibiting different cognitive traits (Khasanah et al., 2017). Furthermore, according to Bustami et al. (2018), students' critical thinking skills must be more effectively developed, affecting their learning outcomes. One reason is that their teachers cannot regularly include critical thinking in their lesson plans (Choy & Oo, 2012). The writing process enables a deeper level of student thinking (Skolnick, 2000), achieved by giving sound arguments and judgments (Amalia et al., 2021). Learning to write in a second language, according to Zheng & Warschauer (2017), is more difficult than learning other language skills. Therefore, content subject teachers should explicitly try to teach their ELLs how to write science in English.

In Malaysia, content subject teachers, particularly those teaching Malaysian Higher School Certificate (STPM) students, can utilize written examiners' feedback from the Candidate Reports (CRs) to improve teaching and learning methods and help develop ELLs' writing skills. The CRs are published on the webpage of Majlis Peperiksaan Malaysia at https://www.mpm.edu.my/sumber/penerbitan/laporan-peperiksaan-stpm-dan-muet/ and can be accessed by both teachers and students. The purpose of CRs is to give teachers and students an overview of previous candidates' mistakes in answering essay questions, and CRs are available for all STPM subjects (MPM, 2012).

Examiners' feedback in the CRs is very useful because they provide assessment feedback for teachers to diagnose learning issues (Johnson & Jenkins, 2009; Tawafak et al., 2019) and improve

the teaching and learning process (Black, 2013). Kim and Kim (2021) argue that despite students' capacity to use scientific thinking abilities, understand scientific concepts and procedures, and apply knowledge to real-world situations, they still need help with writing. Therefore, giving students feedback on their writing can help them develop their writing skills and further clarify their knowledge (Issa et al., 2014; Probosari, 2015).

Any assessment feedback is a source of information that can be used to help with the teaching and learning process (Dixon, 2008; Dirksen, 2011; McMillan, 2013; Tawafak et al., 2019). Comment statements in the form of summative examination feedback can be used formatively to improve teaching and learning. Such feedback is thought to be beneficial in preventing mistakes from being made again (Wees, 2010; Winstone & Boud, 2022). It can also be used to determine previous candidates' strengths and weaknesses, which can then be used for developing more effective teaching and learning activities, as well as to identify problematic topics in the syllabus that require further improvement (Popham, 2008) and assist their future performance (Shafi et al., 2018). According to Rae and Cochrane (in Rand, 2017), feedback is one of the most potent influencers on student growth, development, learning, and achievement. Unfortunately, many teachers lack knowledge and information on analyzing and interpreting feedback from examiners' reports (Viljoen, 2011). Following this, many students report never reading or not paying attention to the feedback provided (Rand, 2017).

After reviewing the existing literature, we discovered a need for an in-depth investigation into particular challenges science students encounter when answering biology essay questions in English. Even though there were studies on challenges faced by non-native English-speaking students in STEM subjects, there needs to be more research specifically on the challenges encountered in the context of biology essay questions. For instance, although some studies have discussed the language and content integration needs of English language learners in science education (Bruna et al., 2007; van Kampen et al., 2017), the studies do not specifically address the challenges faced by science students when composing coherent and well-structured essay responses in English. In addition, while studies have emphasized the significance of writing abilities for students' comprehension of scientific concepts (Sampson et al., 2013; Probosari, 2015), there is little research that specifically examines the writing challenges that science students face when responding to biology essay questions. This clearly shows a need for more research specifically addressing the challenges science students face when writing essay responses in English in the context of biology. Therefore, this study aims to close this gap and add to the existing body of knowledge by providing valuable insights and recommendations for improving science education practices.

It is crucial to draw attention to the implications this research has for science education and students' academic success to emphasize its importance and urgency. By recognizing and addressing the challenges that science students encounter when responding to biology essay questions, their understanding of the contents encourages more effective communication of scientific ideas in English. Additionally, this improvement will advance science education as a whole for the benefit of the students. Thus, this paper focuses on the analysis findings conducted on the examiners' feedback found in the STPM Biology CRs. The research aims to identify the types of challenges faced by candidates in answering STPM Biology essay questions as signaled in the Candidates' Reports and to determine the frequency of those challenges. The research questions of the study are as stated below: 1) What are the types of challenges faced by candidates in answering STPM Biology essay questions as signaled in the Candidates' Reports? 2) What is the frequency of the different types of challenges faced by candidates in answering STPM Biology essay questions as signaled in the Candidates' Reports?

It is important to recognize the limitations of this research even though it aims to shed light on the challenges that science students face when responding to biology essay questions. Our study may only be completely generalizable to some science disciplines or educational contexts because it primarily focused on a particular cohort of science students from 2013 to 2021. Furthermore, the research does not address the additional variables affecting English proficiency. However, this study is significant in identifying and addressing science students' unique challenges in answering biology essay questions.

METHODS

As stated previously, this study aimed to investigate the challenges faced by Malaysian Higher School Certificate (STPM) students when answering Biology essay questions in English. This study employed a qualitative research met-

hod, in which document analysis was carried out inductively on examiners' written feedback. The feedback was taken from 27 Candidate Reports (CRs) of STPM Biology essays published from 2013 to 2021.

This study was underpinned by the constructivist theory based on observation and scientific study on how people learn (Bada & Olusegun, 2015). Constructivism acts as a basis of theory that encourages critical thinking. Constructivist theory proposes that people construct knowledge and understanding through experiences and self-reflection. New information is fitted together with prior knowledge. This could be done by asking questions and exploring and assessing things that are already known. Through constructivism, teachers could encourage students to continuously assess how the teaching and learning activities help to gain knowledge. Teachers act as facilitators who train, facilitate, prompt, and guide students to develop and assess their understanding and, thereby, their learning. The teacher's role is to ask good questions and help students to get the answers.

The data for this study were the STPM Candidate Reports, which were taken from 2013 to 2021. The selection was made based on two main factors: i) 2013 was the start of the modular system, which is the current STPM system being implemented, and ii) STPM Biology CRs in 2013-2021 were available on the MPM website during the data collection period. It is important to note that biology STPM exams are conducted three times a year, and each exam contains three essay questions that need to be answered in section C. This means nine CRs were published a year, and the total amount of CRs analyzed in this study was [three feedback a year multiplied by nine] 27, even though the data were collected only for nine consecutive years. The CRs were written in English, reflecting the main language used by STPM Biology candidates in answering the STPM Biology paper.

This study employed an inductive approach guided by thematic analysis. Thematic analysis enables a deep, rich, detailed description of the data (Braun & Clarke, 2006). It was appropriate for the nature of the data, which aimed to investigate STPM Biology CRs regarding the challenges ELLs face in the STPM Biology essay assignment. The thematic analysis also entails organizing raw data into manageable and interpretable descriptions based on themes and pertinent illustrative examples (Boyatziz, 1998). Thus, employing the thematic analysis as the analytical framework for analyzing qualitative data was justified. The activities involved, according to Braun & Clarke (2006), were: i) familiarizing with the data, ii) generating initial codes, iii) looking for themes, iv) reviewing themes, v) defining and labeling themes, and vi) providing reports. The examiners' comments in the CRs were evaluated thematically in the current study, as proposed by Braun & Clarke (2006). Thematic analysis was used to identify patterns, categories, and themes, and it should be noted that thematic analysis was a laborious process in which the data analysis process was back and forth until a comprehensive set of themes was established (Creswell, 2014).

Any challenging issues stated in the feedback of candidates' essay answers were listed during the data analysis. Based on the list, the challenges faced by the candidates in answering the essay questions in English were categorized into themes and followed by the labeling process. The overview of the data analysis procedure of the current study is shown in Figure 1.

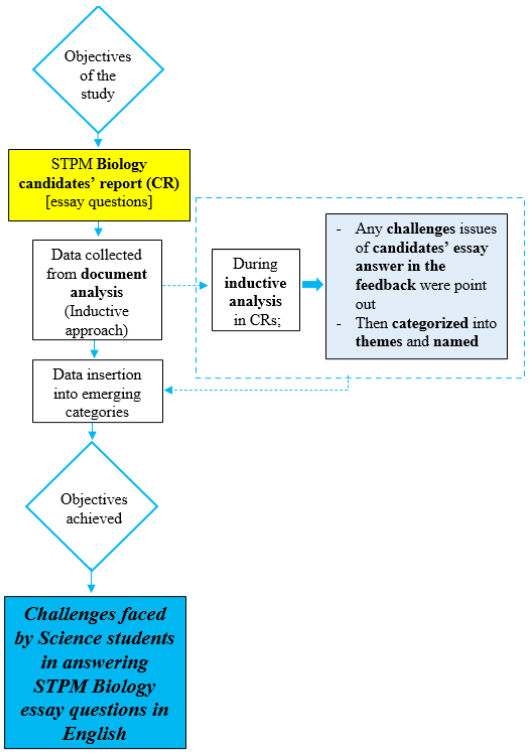

Figure 1. Overview of Data Analysis Procedure

RESULTS AND DISCUSSION

The findings of the thematic analysis show that STPM learners face two major challenges in answering Biology exam questions in English. The main challenges are related to content and language, besides the challenges on technical terms, which are not very significant. Further analysis has revealed the occurrence of overlap-

ping within the three issues, which are 'content and language,' 'content and technical term,' 'content, language and the technical term,' and 'technical term and language.' The subsequent sections discuss the challenges identified in turn.

In the context of Biology, 'content' is the knowledge and understanding in the study of living things and their vital processes (MPM, 2012). According to the syllabus, candidates should be able to comprehend biological facts, concepts, and theories, as well as their implications for social, technological, and environmental challenges in biology. Candidates must master the content knowledge required to critically analyze biological information and deduce logical conclusions, organize and carry out experiments scientifically and make deductions, and cultivate abilities and skills in correctly and safely handling materials and devices in the laboratory (MPM, 2012). The STPM examination evaluates and measures the candidates' understanding of the knowledge and their abilities to apply it in the real world. The Biology STPM syllabus, according to MPM (2012), is designed to strengthen candidates' knowledge and understanding of biology and biological issues, to prepare and empower candidates for tertiary education, to explore careers in related fields, and to foster ongoing awareness of the importance of biology in life. Despite the importance of content, lacking content knowledge in Biology is the major issue faced by candidates, which hinders their ability to answer the STPM Biology exam as stated in the CRs. The following examples show content issues faced by candidates.

Example 1. Question item prompt: *Upon returning from a vacation, you noticed that your potted plant had wilted. Explain this observation by relating it to the cohesion-tension theory of water movement in plants. [10 marks]* (*Question 18(a)STPM Term 2 2015*).

Feedback in CR: *Most candidates scored low marks for this section, even when the candidates explained well the movement of water from the soil into the root via the symplast, apoplast, and vacuolar pathways to the cortex, and how the cohesive and adhesive forces, the capillarity, and also the transpirational pull, the candidates just failed to relate it as to how the potted plant wilted after being without water supply for a while.*

Example 2. Question item prompt: *Describe the formation of the placenta during human fetal development. [6 marks]* (*Question 19(a)STPM Term 2 2014*).

Feedback in CR: *Most candidates could not describe the formation of the placenta during human fetal development, as they tended to explain what happened to the zygotes after XXXertilization, i.e., the candidates were inclined to write about organogenesis or embryogenesis. Many candidates described the process and role of amnion, allantois, yolk sac, and chorion, which were not the right answers.*

Similarly, the feedback found in the CR, in Example 2, is clearly related to the content issue. The question requires candidates to demonstrate their understanding of placenta formation. Nonetheless, the CR feedback indicates that candidates cannot accomplish the task given successfully. In contrast, the candidates provide the incorrect answer by explaining what happened to the zygotes after fertilization and have a tendency to write about organogenesis, embryogenesis, the process of and role of amnion, allantois, yolk sac, and chorion, which are obviously unrelated to placenta formation. The candidates clearly do not understand or do not have sufficient knowledge of the formation of the placenta during human fetal development, which results in them being unable to describe the formation process. As mentioned above, the feedback given in the CRs can be used to alert candidates to the importance of understanding the placenta's formation process during human fetal development.

The arguments for Example 1 and Example 2 are discussed according to Darling-Hammond (2020). The content knowledge involves students' deep understanding of a subject matter that needs to be developed in relating ideas to one another and addressing common misconceptions. Therefore, teachers must master their content knowledge and skills to help students understand and organize many science concepts, facts, theories, and principles. In addition, Shulman (1986) proposes that to teach content such as science in a way that truly promotes student understanding, teachers need to integrate both content and pedagogical knowledge. The feedback for Example 1 and Example 2 is a good example that teachers can use to identify the strengths and weaknesses of students in a particular topic, enabling teachers to plan better teaching and learning activities as well as to recognize topics that students find challenging (Popham, 2008) and guide them accordingly as recommended by the examiners.

In the context of Biology, 'language' is the crucial tool needed for articulating and forwarding ideas in biology content. According to Asoulin (2016), language acts as an instrument of thought. Besides the knowledge content, Biology learning requires effective language mastery, particularly in the written form. Language is necessary for candidates to explain and express their

knowledge content in forming and developing concepts during the examination to be evaluated and measured. The following example illustrates the knowledge content and language issues candidates face in answering the STPM Biology essay questions.

Example 3. Question item prompt: *ATP and NADPH are two main molecules that are required for the production of carbohydrates in plants. Describe how these molecules are generated during photosynthesis. [9 marks] (Question 19(a)STPM Term 1 2014)*

Feedback in CR: *Some candidates misunderstood the question, and hence, they described both PSI and PSII. Some weak candidates could not give the correct flow with the correct term in this process. There are many mistakes in using specific terms, such as, 'light excites PSI and PSII,' 'PSI and PSII accepted/receive electron,' 'light trapped/reached/strikes/receive/bombarded PSI and PSII' instead of 'PSI and PSII absorb light energy/photon.' They also like to use 'electron is liberated to primary electron' and 'electron is photoactivated' instead of 'the electron is excited and captured by primary electron acceptor', 'pheophytin' instead of 'primary electron acceptor' and wrongly spelled the term ferredoxin. Some of them stated the name of the electron carrier incompletely. For example, they mentioned 'cytochrome' instead of 'cytochrome complex/cytochrome b6-f'. Some of the good candidates lost marks in describing 'the energy released in the form of ATP//energy is used for photophosphorylation for production of ATP' without naming the process that is chemiosmosis. Some candidates drew a diagram of the flow process, which was not mentioned in the question, and no mark was given to them.*

As illustrated in Example 3, the issue highlighted in the CR feedback pertains to the content and language. In the feedback given, it is indicated that candidates *'like to use electron is liberated to primary electron' and electron is photoactivated' instead of 'the electron is excited and captured by primary electron acceptor'*. This clearly shows a problem with both the content and language. One of the examples of language errors highlighted in the feedback is the term 'liberated', which was wrongly used to mean 'excited'. In science, the phrase 'electron is excited' indicates that the electron has received energy, causing it to become excited, resulting in the electron moving forward. In contrast, the term 'liberated' shows that the electron is dispersed without any indication of it receiving any energy.

Example 4. Question item prompt: *Describe, with the aid of a labeled diagram, the structure of the plasma membrane according to the model proposed by Singer and Nicolson. [15marks]* (*Question 18STPM Term 1 2013*)

Feedback in CR: *Some candidates showed a misconception of the terms 'glycoprotein' and 'glycolipid'. They wrote that the carbohydrate chain attached to protein is glycoprotein, and the carbohydrate chain attached to phospholipid is glycolipid. This concept was wrong as the term 'glycoprotein' referred to the whole structure formed when the carbohydrate chain is attached to a protein (both carbohydrate and protein) and glycolipid. The fluidity of the membrane was not well described. Most candidates only mentioned that the plasma membrane was not static and that the phospholipid molecules moved freely. Some candidates even said the whole phospholipid bilayer could move freely. They should state that the phospholipid molecules were free to move laterally. Most candidates did not accurately describe the integral and peripheral proteins' positions. Some wrote that peripheral protein was located outside the membrane, which needed to be more precise. The correct description should be "bound or attached on the membrane". Very few candidates described the membrane proteins as amphipathic with hydrophilic and hydrophobic regions. The position of cholesterol should be between the phospholipid molecules, not between the phospholipid bilayer.*

Example 4 also shows the challenges related to the content and language issues. The statement *'The fluidity of the membrane was not well described'* signifies the problems with the content and language. In terms of content, candidates might not have sufficient content knowledge of what entails *'the structure of plasma membrane according to the model proposed by Singer and Nicolson'*. However, in terms of language, the term *'not well described'* might indicate that candidates might have the content knowledge but were unable to articulate their ideas due to a low level of language proficiency. In addition, the statements '*Most candidates only mentioned that the plasma membrane was not static, and the phospholipid molecules moved freely. Some candidates even said the whole phospholipid bilayer could move freely'* and *'They should state that the phospholipid molecules were free to move laterally',* showing that candidates have the content knowledge about the movement of phospholipid molecules but did not have the language ability to describe the movement well as required by the marking scheme, that is, the phospholipid molecules are free to move laterally.

Most candidates struggle to express their thoughts clearly because of their English language inability. The term *'not well described'* might indicate that candidates might have the content knowledge but could not articulate their ideas due to language problems. As stated in the feedback, '*Most candidates did not accurately describe the position of the integral protein and peripheral protein.*

Some wrote that peripheral protein was located outside the membrane, which was not precise. The correct description should be "bound or attached on the membrane". This shows that the candidates use imprecise terms in their answers. The statement '*The peripheral protein was located outside the membrane',* was not an accurate answer in the CR, while the expected answer is *'the peripheral protein was bound or attached to the membrane'*. The comment given in the CR is that '*located outside the membrane'* is not the same as *'bound or attached on the membrane'*. Apparently, the candidates' language inability hinders them from articulating the idea to write the correct answer as required by the rubric.

Biology learners are expected to master the richness of its terminology besides its vast contents. The English language words used in learning biology can be divided into technical and non-technical. Biology students must understand that certain phrases or terminology may have one or more meanings in ordinary English but have a specific and sometimes contradictory meaning in a scientific context (Ali & Ismail, 2006). Furthermore, Biology students must have adequate writing skills as well as the ability to employ non-technical words such as 'if' and 'therefore' as conjunctions between sentences or concepts and a proposition. Some terms, such as 'define' and 'explain,' are substituted for 'say,' while 'compute' and 'predict' are substituted for 'think' (Oyoo, 2015). Thus, Biology students must be equipped with technical and non-technical writing skills. Technical mistakes include errors in using words specific to a science discipline, as well as mistakes arising from candidates' carelessness in following rules in writing the answers (Oyoo, 2015). Example 5 and Example 6 illustrate the content and technical term issues faced by the candidates in answering STPM Biology essay questions.

Example 5. Question item prompt: *Name the infectious agent for cholera. [1 mark]* (*Question 20(b)(ii) STPM Term 2 2014*)

Feedback in CR: *Most candidates could not name the causative agent correctly or did not follow the rule in writing scientific names. They wrote Vibrio cholera or Vibrio cholerae or Vibrio cholerae instead of Vibrio cholera. Many candidates ignored the advice and comments made in examiners' reports on previous occasions.*

The question in Example 5 requires the candidates to state the name of the infectious agent for cholera to test their understanding and knowledge of the disease. The feedback in the CR clearly indicates there are content and technical challenges in answering the question. The candidates do not follow the rules in writing the scientific names and thus cannot correctly spell the causative agent's name. This shows that the candidates were not sure of how to spell the technical terms, and having said that, the error is categorized as a mistake in using words or terms that are specific to the biology discipline (Oyoo, 2015).

Example 6. Question item prompt: *Explain how curare causes paralysis and death to the victim. [5 marks]* (*Question 18(b) STPM Term 2 2015*)

Feedback in CR: *Some candidates lost marks because they did not relate the failure of muscle to contract that resulted in paralysis and death if the diaphragm or the intercostal muscles were affected. Weak candidates wrongly spelled scientific terms.*

The feedback, as shown in Example 6, illustrates the challenges regarding the learners' content knowledge and technical terms. This question requires candidates to recall their memory about the mechanism of action of curare. Nonetheless, the feedback indicates that candidates lack content knowledge since they fail to link their responses to muscle contraction failure, which results in paralysis and death if the diaphragm or intercostal muscles are impacted. This causes them to lose their marks. Candidates also state the scientific terms wrongly. Even though the examples of the scientific terms that are wrongly spelled are not stated in the CR, *'wrongly spelled'* for scientific terms indicates a technical mistake in stating the terms, which falls under technical mistakes in using words that are specific to a science discipline (Oyoo, 2015) because terms that are wrongly spelled give wrong terminology and give no meaning for the scientific terms**.** This feedback shows that, apart from content issues, answers provided by candidates also have technical term issues.

The findings of the thematic analysis also suggest that candidates experience overlapping mistakes in content, language, and technical terms while answering STPM biology essay questions. The following examples show the challenges on content, language, and technical terms faced by candidates in answering STPM Biology as stated in the CRs.

Example 7. Question item prompt: *Describe postzygotic isolating mechanisms. [7 marks] (Question 18(b)STPM Term 3 2016)*

Feedback in CR: *Some candidates could not differentiate between hybrid sterility and hybrid breakdown. However, facts such as hybrid viability, hybrid variability, hybrid sterile, and hybrid infertility were unacceptable.*

The phrase '*could not differentiate*' in Example 7 indicates the challenges related to the content, language, and technical terms. The examiners explicitly commented that the candidates *could not differentiate between hybrid sterility*

and hybrid breakdown. The answers such as *hybrid viability, hybrid variability, hybrid sterile, and hybrid infertility* were not accepted because the words or terminologies were incorrect (Oyoo, 2015). The candidates should have an in-depth understanding of postzygotic mechanisms that happened *after fertilization* to enable them to answer the question correctly. The right terminology that should be written is *hybrid sterility* and not *hybrid sterile*, *hybrid viability*, *hybrid variability,* or *hybrid infertility*. The postzygotic isolating mechanism is the mechanism that reduces the fertility of hybrid zygotes. This mechanism includes hybrid inviability, hybrid sterility, and hybrid breakdown. In hybrid inviability, fertilization occurs, but the offspring die early in life because it fail to develop. In hybrid sterility, mating between two individuals creates the first-generation hybrids that are sterile and unable to reproduce offspring of their own. Hybrid breakdown is a type of reproductive failure after the second generation of crosses between different species because of incompatibility between interacting genes. The candidates should have shown the difference between the first-generation failure, which occurs in hybrid sterility, and the second show the difference between first-generation failure, which occurs in hybrid sterility, and the second-generation hybrid failure in hybrid breakdown. This suggests that candidates may have a problem differentiating not only the content but also experience a problem with the English language, resulting in an unacceptable answer.

Example 8. Question item prompt: *Explain two ultrastructures of the xylem concerning its functions in transport and mechanical support. [6 marks]* (*Question 19(a)STPM Term 1 2016*)

Feedback in CR: *For its function, 95% of the candidates lost marks for mentioning allowing water and mineral flow instead of allowing water and mineral ions to flow continuously.*

Similarly, in Example 8, the feedback given in the CR indicates the errors regarding content, language, and technical terms. The general terms *'lost marks'* and *'instead of'* are categorized into content, language, and technical term categories because the examiners' comment in the CRs stated that the candidates miss the term 'ions', which is used to complete the term 'mineral' and is related with the content knowledge of biology. Whereas the term '*continuously'* that they miss shows the mistakes in the language usage. The sentence is incomplete as it does not state '…flow continuously' to show that the water and mineral ions move non-stop. The word 'flow' without the word 'continuously' is not accepted, and, in addition, the technical term 'ion' is missing.

The challenges categorized under the technical term are technical mistakes made by the candidates. As mentioned earlier, technical mistakes are word choice errors specific to the Biology discipline (Oyoo, 2015). Example 9 shows the feedback given on the error related to the technical term.

Example 9. Question item prompt: *Describe the formation of the placenta during human fetal development. [6 marks]* (*Question 19(a)STPM Term 2 2014*)

Feedback in CR: *In addition, they also wrongly spelled blastocyst as blastocyte.*

In Example 9, the feedback in the CR indicates a technical term issue. The phrase '*wrongly spelled'* is categorized into a technical category (Oyoo, 2015) because the examiners' comment in the CRs stated that the candidates '*wrongly spelled blastocyst as blastocyte'*. The spelling of terminologies in answering Biology essay questions is very important. Simple mistakes or carelessness in writing the correct terms will result in the wrong answer, which is considered a technical mistake. In this example, 'blastocyst' and 'blastocyte' are different. 'Blastocyst' means the modified blastula of a placental mammal, whereas 'blastocyte' means an undifferentiated embryonic cell. It is important to note that marks would not be awarded if the candidates did not spell the required terminology correctly.

Example 10. Question item prompt: *Differentiate aerobic respiration and fermentation in cells. [8marks]* (*Question 20(a)STPM Term 1 2015*)

Feedback in CR: *The main problem with this question was that many candidates from many centers still answered this question in table form.*

Interestingly, in Example 10, the error is due to a technical problem, by which the candidates do not follow the rules given. If something is technically the case, it is the case according to a strict of facts or rules (Oyoo, 2015). As mentioned earlier, the section analyzed is an essay exam part, meaning the candidates must write their answers in the essay format. However, some candidates do not answer in the essay form and use a table form instead. Essay questions need to be answered in complete sentences in essay form (MPM, 2023). As stated in the CRs, candidates answer the differences between aerobic respiration and cell fermentation using the table form. It is, therefore, crucial for the candidates to follow the rules; otherwise, they will lose marks.

Language is necessary for presenting and communicating ideas in biology. Candidates must be able to express their written answers well to be understood and accepted by the examiners. Despite the importance of content, language is

another major difficulty candidates face in answering STPM Biology, as stated in CRs. Example 11 illustrates the language challenges faced by the candidates.

Example 11. Question item prompt: *Differentiate the characteristics of r-selected and K-selected species. [6 marks] (Question 18(b)STPM Term 3 2014)*

Feedback in CR: *Marks were only given if the candidates used "conjunction," and 'marks were only awarded if candidates used complete sentences'.*

Feedback in Example 11 clearly states that the candidates must apply relevant conjunctions and complete sentences in differentiating the characteristics of r-selected and K-selected species. The comments given by the examiners are *'marks were only given if the candidates used "conjunction" and 'marks were only awarded if candidates used complete sentences'*. These comments are categorized under the language category.

Example 12. Question item prompt: *The characteristic of the plasma membrane is selectively permeable. Discuss the significance of this characteristic to the living cells. [9 marks]* (*Question 18(a)STPM Term 1 2014*)

Feedback in CR: *Some candidates could not interpret the question correctly, thereby obtaining low marks. Many of the candidates drew the diagram of the plasma membrane, which was not required by the question, and received no mark for it. Weak candidates seemed to misunderstand the idea of describing the structure of the plasma membrane instead of the significance of selectively permeable characteristics. Only a few candidates mentioned vague terms such as 'move into plasma membrane' instead of 'pass through plasma membrane' in explaining the movement in and out of substances through the plasma membrane. They also lost marks as they thought that the plasma membrane was equivalent to the phospholipid bilayer and stated 'the plasma membrane' instead of 'phospholipid bilayer' in allowing very small uncharged molecules/hydrophobic/lipid soluble/non-polar molecules/oxygen/water to pass through. Some candidates mentioned only that 'the plasma membrane consists of phospholipid and protein', but they had to mention 'transmembrane / transport protein' in answering the question.*

In Example 12, the CR states a few general terms that are categorized into language, such as 'not able to interpret the question correctly,' 'misunderstand,' and the use of 'vague terms.' These comments are grouped under the language category. The comment *'some candidates were not able to interpret the question correctly, thereby obtaining low marks'* obviously connotes that the candidates misunderstand the questions and fail to comply with the requirement. They also draw the diagram that is not asked in the question, indicating that candidates do not fully understand how to answer this type of question correctly due to their language problems.

The examiners also mention that '*Weak candidates seemed to misunderstand the idea by describing the structure of plasma membrane instead of the significance of selectively permeable characteristic'*. This question requires the candidates to demonstrate their understanding of the plasma membrane structure and to discuss the significance or importance of the selectively permeable characteristic to the living cells. In doing so, the candidates must possess good writing skills and language ability to express their ideas successfully.

According to the feedback, the candidates also tend to use '*vague terms'*, which means imprecise and unclear words in communicating ideas. The candidates write *'move into plasma membrane' instead of 'pass through plasma membrane' in explaining the movement in and out of substances through the plasma membrane.* The term *'move into'* is not the right term to use since move into and pass through do not have the same meaning. Another example of language challenges is '*Some candidates mentioned only that 'the plasma membrane consists of phospholipid and protein', but they must mention 'transmembrane/transport protein' in answering the question'. The answer statement 'the plasma membrane consists of phospholipid and protein'* is not accepted as it is not a complete sentence. Candidates should include the type of protein, either *'transmembrane'* or *'transport'* protein, in the sentence to make it complete. Table 1 provides an overview of the issues faced by STPM Biology candidates. The data is arranged according to themes.

Table 1. Issues Faced by Candidates in Answering STPM Biology Essay Questions

Issues faced	Quantity	%
Content	568	52.83
Content and Language	273	25.40
Content and Technical Term	24	2.23
Content, Language, and Technical Term	61	5.67
Technical Term	79	7.35
Technical Term and Language	35	3.26
Language	35	3.26
TOTAL	1075	100

As can be seen from Table 1 from 1075 total issues faced by candidates in answering STPM Biology essay questions, the most frequent is in relation to the *content* (52.83%) with 568 occurrences. This is followed by *content and language* (25.40%) with 273 occurrences, *technical term* (7.35%) with 79 occurrences, *content, language and technical term* (5.67%) with 61 occurrences, *language and technical term and language* (3.26%) with 35 occurrences, while the least problematic issue is *content and technical term* (2.23%) with only 24 occurrences.

The frequency of the types of challenges faced by candidates in answering STPM Biology Essay Questions, as signaled in the Candidates' Reports, shows that STPM Biology candidates mainly lack content knowledge as they face mostly challenges related to the 'content'. However, the candidates also face challenges in the content and language area as they cannot articulate their thoughts clearly when writing their answers in English, which is not their mother tongue. The candidates may also lose marks due to other language-related challenges involving problems in using correct technical terms.

CONCLUSION

The analysis done on STPM Biology Candidates' Reports reveals seven categories of challenges: 'content,' 'content and language,' 'content and the technical term,' 'content, language, and technical term,' 'content, language, and the technical term,' 'technical term,' 'technical term and language,' and 'language.' Notably, 'content' accounted for 52.83% and 'content and language' for 25.40%. Thus, it can be concluded that the STPM Biology candidates mainly lack content knowledge and English language writing skills. In addition, a new CR format is proposed, which suggests using tables to categorize feedback according to types of mistakes and provide samples of correct and incorrect answers. This study emphasizes two key factors for improving biology education: effective subject delivery and candidates' English language writing skills. This study can be applied to a wider scope by looking at examiners' feedback in section B, involving comments on structured questions. Feedback for Section B may contain other misconceptions, misunderstandings, and mistakes in Biology than the ones occurring in Section C.

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