

STUDENTS' USE OF ONLINE ENGLISH RESOURCES FOR SCIENCE LEARNING: A SURVEY AND INTERVIEW STUDY

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ABSTRAK

Penggunaan materi berbahasa Inggris dalam pembelajaran sains semakin meningkat seiring dengan berkembangnya pembelajaran daring, khususnya pada bidang kimia. Mahasiswa memiliki akses yang luas terhadap berbagai sumber digital berbahasa Inggris, namun belum banyak penelitian yang mengkaji bagaimana mereka memanfaatkan sumber tersebut serta kendala yang dihadapi dalam penggunaannya. Penelitian ini bertujuan untuk menganalisis pemanfaatan sumber belajar daring berbahasa Inggris oleh mahasiswa kimia dan mengidentifikasi hambatan yang mereka alami dalam proses pembelajaran. Penelitian ini menggunakan metode campuran yang mengintegrasikan analisis kuantitatif deskriptif dan analisis kualitatif tematik. Data dikumpulkan melalui survei yang memuat pertanyaan mengenai kebiasaan belajar, jenis sumber yang digunakan, serta tantangan yang dihadapi mahasiswa. Data kemudian dianalisis untuk mengidentifikasi pola penggunaan dan permasalahan yang dominan. Hasil penelitian menunjukkan bahwa mahasiswa secara rutin memanfaatkan situs akademik, jurnal digital, video pembelajaran, dan kamus daring untuk meningkatkan pemahaman konsep kimia dan memperkaya kosakata ilmiah. Sumber-sumber tersebut dinilai membantu dalam memperdalam materi dan mendukung proses belajar mandiri. Namun demikian, mahasiswa masih menghadapi sejumlah kendala, seperti kesulitan memahami istilah ilmiah, keterbatasan kemampuan bahasa Inggris, kesulitan menilai kredibilitas sumber daring, serta tantangan dalam mengintegrasikan informasi dari berbagai platform. Penelitian ini menyimpulkan bahwa sumber belajar daring berbahasa Inggris berkontribusi signifikan terhadap pembelajaran kimia, tetapi diperlukan pendampingan dan bimbingan yang memadai untuk meningkatkan literasi bahasa dan digital mahasiswa.

Kata Kunci : Bahasa Inggris untuk Tujuan Khusus, Sumber daya Bahasa Inggris, Pembelajaran daring, Pendidikan sains.

ABSTRACT

The usage of English-language materials in science education has increased due to the growing popularity of online learning, especially in situations including chemistry. Students have access to a vast array of scientific knowledge through English-language digital resources, but little is known about how they use these tools and what obstacles they face. The purpose of this study is to examine how chemistry students use online English resources and to determine the difficulties they encounter while using these resources for educational objectives. This study adopted a mixed-methods research design integrating descriptive quantitative analysis and thematic qualitative analysis. Through a survey, data was collected on chemistry students' study habits, challenges, and most-used virtual English resources. To find reoccurring issues and prevalent behaviors, the collected data was examined using straightforward techniques. The study indicates that students regularly utilize academic websites, digital journals, educational films, and online dictionaries to improve their comprehension of chemistry. These items are considered advantageous for improving understanding of topics and augmenting vocabulary in scientific terms. Students face several challenges, including difficulties in understanding scientific terminology, low proficiency in English, evaluating the credibility of online sources, and integrating information from multiple digital platforms. In conclusion, online English resources substantially increase chemistry teaching in the field of science. Nevertheless, suitable instructional supervision and assistance are essential for assisting students in

surmounting language and digital literacy obstacles, hence augmenting the efficacy of English for Specific Purposes in online learning contexts.

Keywords : *English for Specific Purposes , English resources ,Online learning, Science education*

INTRODUCTION

In the digital age, many educational resources are accessed online, predominantly in English. English-language online reading resources in science education are increasingly gaining in quality and global coverage, proven to help students access global scientific knowledge and enhance their understanding of complex science topics. The inclusion of these online materials has greatly changed how students engage with school-related content, now granting them entry to worldwide collections of data, scholarly publications, and learning websites that were once out of reach (Huang, Tlili, Yang, & Chang, 2020). These digital reading materials have allowed students to engage with genuine scientific discourse and become acquainted with the vocabulary utilized in the global scientific research community (Setiawan & Anindita, 2024). Furthermore, many multimedia parts of digital resources, such as simulations and films, increase comprehension by physically depicting abstract chemical concepts, hence enhancing cognitive processing (Johnson & Downing, 2021).

The incorporation of online English resources in Indonesian science classrooms reflects a growing trend of integrating digital materials into both instructional and autonomous learning. Contemporary research indicates that tertiary institutions throughout Indonesia have incorporated a range of digital applications and web-based materials to augment established instructional approaches, acknowledging the crucial role of technology-supported education within scientific disciplines. This method of combining different things shows an even bigger change in how people teach, where teachers mix real-life teaching with online stuff to create mixed learning places. Also, lots of students use online materials outside of the normal school environment, which shows they can learn on their own and make the standard lessons even better (Costa J. , 2024).

With this changing trend in learning resources, students must recognize the importance of English in supporting their understanding of science material. Students need to read, interpret, and communicate scientific concepts in English effectively to acquire high-quality scientific concepts. For students to understand specific works while conveying complex concepts in a second language, proficiency in science subjects necessitates both topic knowledge and linguistic skills (Airey, 2020) Because they have to interpret technical terms, appreciate procedural details, and interact with research material that mostly depends on English as the communication medium, Sains students have unique problems (Galloway, 2021).

Several previous studies have also examined students' opinions on online English-language learning resources. Engineering students stated that online learning resources through educational websites significantly helped them improve their grammar skills. They were quite satisfied with the language development they received (Ahmed ElQersh, 2024). Furthermore, English language students were also found to use online resources to improve their vocabulary acquisition and reading speed (Nguyen L. V., 2024). Other research conducted at the high school level showed that reading strategies from online resources increased student engagement in reading and improved in-depth comprehension of texts (Zhang, 2013). In science study programs, interactive online tutorials were also found to be significantly effective in improving their language proficiency (Kramer, Olson, & Walker, 2017). On the other hand, some students also encountered technical difficulties and a lack of additional support for mentoring in the use of digital learning resources (Romadhon, 2024).

Furthermore, prior studies have shown how crucial technology and effective teaching methods are to enhancing scientific education. Tisoglu's (2021) study examined the use of online multimedia tools in conventional scientific laboratories and found that, when properly integrated into lab activities, these digital resources may increase student engagement and improve their understanding of subjects. Similarly, Ali's (2023) assessment of the literature showed that the use of digital technology in scientific education improves teacher effectiveness, particularly in terms of establishing learning environments where students can engage more and are the primary emphasis. In (Dayal P. D., 2022), Dayal and Chand also highlighted several effective teaching and learning strategies for science classrooms, emphasizing the value of lesson planning, student participation, and the utilization of information related to real-world scenarios to help students learn in a way that makes sense to them. When taken as a whole, these findings show how important it is to include digital resources and innovative teaching methods to improve scientific education for kids (Dayal P. D., 2022).

The examination mentioned above indicates that a number of holes need to be filled. First, there is a dearth of research on English-language materials for science education, particularly in chemistry and physics. Because of this, little is known about how these services impact students' educational experiences. There is a conspicuous lack of study that specifically looks at how English resources are used in education, especially in places where English is not the predominant language, despite the growing excitement for digital instructional materials in a variety of academic sectors. The existing corpus of scholarly study tends to individually examine science education or broad language acquisition, neglecting to adequately examine the connection between proficiency in English and a deep comprehension of scientific subjects (Galloway, 2021). Furthermore, rather than examining how students actually engage with these materials and the learning results they produce, the majority of existing research focus on the type and availability of resources (Huang, Li, Huang, & Jiang, 2023).

Second, limited surveys of student perceptions in Indonesia indicate that there is still insufficient data on how Indonesian students perceive and utilize English-language online science resources. There currently exists few research analyzing students' views and actions toward English-language scientific information in Indonesia (Setiawan & Anindita, 2024). Due to the lack of sufficient data, it can be challenging to identify precise hurdles that Indonesian scientists learners have while utilizing and accessing English-language materials, such as linguistic challenges, technological difficulties, or factors that motivate. Additionally, teachers and policymakers cannot create focused interventions to facilitate the successful integration of these tools into the curriculum without sufficient awareness of student attitudes. Thus, there is a crucial understanding gap about the contextual variables influencing the effective adoption of English-speaking online science materials due to the paucity of research on the viewpoints of Indonesian students (Huang, Tlili, Yang, & Chang, 2020).

Third, additional empirical study on the function and impact of English-language online platforms in science learning is required, as evidenced by the paucity of attention paid to their efficacy in scientific contexts. The usefulness of online platforms for scientific teaching and learning has not been particularly examined in recent research, which have mostly assessed them from the standpoint of general educational technology (Johnson & Downing, 2021). Specialized research is needed to fully address the unique features of science education, which have not been sufficiently covered in the literature to date. These features include the necessity of comprehending complex molecular structures, chemical and physical reactions, and laboratory procedures through English-language materials (Costa J. , 2024). Moreover, educators find it challenging to make

well-informed decisions about the selection and application of resources due to the lack of evidence regarding which characteristics of English-language online platforms most significantly contribute to improved learning outcomes in science (Airey, 2020).

Students rely on English-language webpages and videos for science because they frequently offer more thorough and current scientific explanations. In-depth explanations of difficult scientific ideas that could not be easily found in Indonesian language materials are provided via international platforms like Khan Academy, YouTube instructional channels, and open-access publications (Huang, Tlili, Yang, & Chang, 2020). For students looking for up-to-date knowledge, these English-medium resources are useful since they often contain cutting-edge research discoveries and modern scientific advancements that haven't yet been translated or adapted into local languages (Setiawan & Anindita, 2024). Additionally, by offering several representations of chemical structures, reaction processes, and laboratory methods, the interactive and visual components included in many English scientific materials improve conceptual understanding (Johnson & Downing, 2021).

When trying to understand scientific information, students struggle to accurately understand technical English terms. Scientific vocabulary has special language challenges that require students to switch between two linguistic frameworks while processing complicated scientific knowledge since many technical phrases lack specific counterparts in Indonesian (Airey, 2020). Nomenclature systems, procedural descriptions, and conceptual phrases are a few examples of specialized language used in research that need to be precisely interpreted to prevent crucial information from being misunderstood (Galloway, 2021). Rahmawati et al. (2022) claim that students' frequent incapacity to discern between phrases that sound same or comprehend meanings that are peculiar to a certain context might cause them to get confused about basic chemical concepts and experimental procedures. The complexity of scientific publications' technical jargon, which requires greater English proficiency levels than usual academic reading, further complicates things for students with intermediate language abilities. Consequently, students' capacity to understand and successfully apply scientific information is hampered by the linguistic complexity of science materials in English (Ali, 2023).

In the field of science, students commonly mix terminology from both Indonesian and English, which usually results in language ambiguity and misconceptions. Students may develop conceptual ambiguities and might develop inadequate or faulty cognitive models of chemical processes as a result of alternating between English and Indonesian words when learning scientific subjects. Students may struggle to comprehend that the two versions relate to a same underlying notion when they are exposed to the same subject presented differently in English and Indonesian sources. This might result in fractured knowledge frameworks (Costa J. , 2024). Students' ability to express scientific ideas clearly is also impacted by this language combination since they may employ imprecise mixed terminology or fail to convey the intended meaning to instructors or peers. Additionally, when students are asked to demonstrate their understanding by using consistent scientific language, the inconsistent use of terminology may detract from assessment results (Galloway, 2021).

Materials for teaching English that are pertinent to certain scientific fields are created using the English for Specific Purposes (ESP) framework. In certain academic or professional contexts, such scientific education, the ESP method emphasizes the necessity of adjusting language training to the unique communication demands of pupils (Starfield, 2020). According to Hyland (Hyland, 2021), recent applications of English for Specific Purposes in science education show that concentrating on the vocabulary, common communication styles, and format requirements specific

to a given subject area significantly enhances students' comprehension and production of scientific documents. In order to effectively engage science students with English-medium scientific information, modern ESP teaching blends subject and language learning, acknowledging that science students must concurrently gain both verbal competence and conceptual comprehension (Airey & Linder, 2008). Furthermore, teachers may identify the specific language challenges faced by scientific students and offer targeted interventions to overcome these problems according to the needs analysis of the ESP framework (Basturkmen & Hong, 2023).

Technology Acceptance Model (TAM) explains the factors that influence students' willingness to adopt and use online English resources effectively. Students' acceptance of digital learning platforms, especially for language and content learning materials, is still heavily influenced by perceived utility and perceived ease of use, according to recent study using TAM in educational contexts (Al-Emran, Mezhuyev, & Kamaludin, 2020). According to studies on scientific students' use of online resources, when students feel that English-medium digital resources are easily available and enhance their academic performance, they are more engaged and use them consistently (R. Scherer, 2021). The impact of external factors like system quality, information quality, and institutional support on influencing students' views and subsequent technology adoption behaviors is also acknowledged by the expanded TAM framework (Marangunić, 2021). Furthermore, post-pandemic studies have shown that views and actual use of online learning resources are highly moderated by perceived behavioral control and past experience with digital learning tools (Mailizar, 2021).

Learning motivation theory (Self-determination) underlines the role of autonomy and intrinsic motivation in encouraging students to use digital learning tools. Students' intrinsic motivation and engagement with online learning resources are greatly increased when their basic psychological needs for autonomy, competence, and relatedness are met, according to recent applications of Self-Determination Theory (SDT) in digital learning contexts (Deci, 2020). Studies on self-directed learning using digital tools reveal that students have greater levels of perseverance and deeper cognitive processing when they are in charge of their education and are able to self-regulate how they use online English scientific materials. According to research explicitly looking at motivation in scientific education settings, students who feel competent using English-medium science materials become more intrinsically motivated and utilize them more frequently and strategically (Hyewon Jang, 2022). By providing flexible access, competence-building feedback systems, and chances for students to interact with the content, online learning design that incorporates SDT ideas also emphasizes creating environments that support learners' autonomy. As a result, self-determination theory emphasizes how crucial it is to develop students' independence and internal drive in order to encourage their consistent and significant use of online English science resources (Johnson & Downing, 2021).

This study is to investigate how chemistry students use online English resources to aid in their learning process, taking into account the background and gaps in earlier research. In particular, the study aims to determine the kinds of online English resources that students utilize most often and to examine the difficulties they have while using these resources to learn chemistry. Finding difficulties reveals obstacles that could prevent successful learning, while knowing students' resource choices offers insight into their learning habits and information-seeking techniques in scientific contexts that are taught in English. While identifying problems helps uncover obstacles that may impede successful learning, knowing students' resource choices offers insight into their learning habits and information-seeking techniques in scientific contexts that are taught in English. Thus, two research issues are addressed in this study: (1) Which online English

resources do chemistry students most regularly use? and (2) What challenges do students face in using online English resources for chemistry learning?

METHOD

This study employed a mixed-methods approach, incorporating a quantitative survey design complemented by qualitative interviews. This approach was chosen to gain an overview of the use of English-language online resources and to gain a deeper understanding of students' experiences and perceptions.

The research team consisted of science students who frequently use English-language online educational resources. The participant group comprised 49 students, mostly from the Chemistry Education Study Program at UIN Syarif Hidayatullah Jakarta, as well as a number of science students from various universities in Indonesia. The sampling approach used was purposive sampling, focusing on students who had used English-language online educational platforms for their science courses. The study was conducted online over two weeks.

Quantitative data collection was conducted using a questionnaire designed on Google Forms consisting of 25 statements rated on a Likert scale from 1 to 5, including: (1) issues related to access and technology, (2) difficulties in understanding content, (3) motivation and learning approaches, (4) significance and practicality of references, and (5) mental effort required. Qualitative data were obtained through semi-structured interviews with nine students, three students from each class, to deepen and clarify the survey findings.

Quantitative data were analyzed descriptively using averages and percentages using Microsoft Excel and SPSS to illustrate patterns and trends in student responses. Meanwhile, qualitative data were analyzed using thematic analysis techniques to identify key themes emerging from the interviews.

RESULT

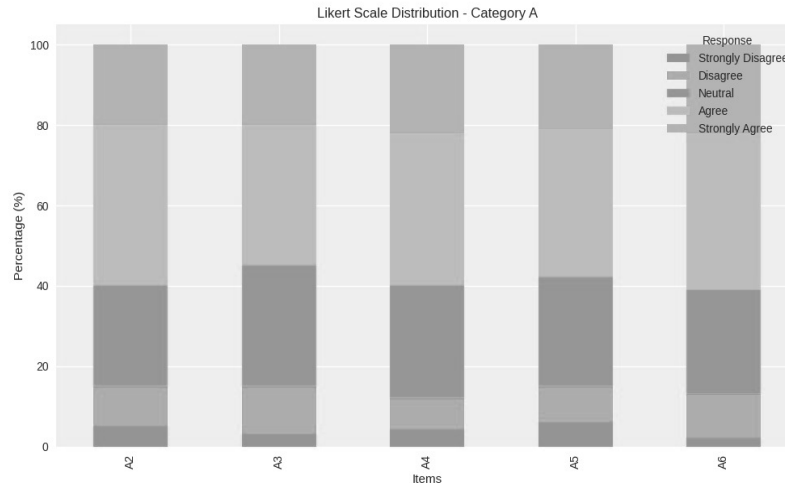
This study involved 49 respondents from three different classes in the science Education study program as well as several science students from other institutions. The research instrument consisted of 25 statements grouped into five main categories: Accessibility & Technical Challenges, Content Difficulties & Comprehension Challenges, Motivation & Learning Behavior Challenges, Relevance & Usefulness Challenges, and Cognitive Load & Overload Challenges. All items used a 1–5 Likert scale. In addition to quantitative data, this study was also supplemented with qualitative data through in-depth interviews with three students from classes A, B, and C to provide a more comprehensive picture of the challenges faced when using online English-language science learning resources.

Accessibility and Technical Challenges

The survey results show that science students still experience a number of accessibility and technical challenges when utilizing online English-language science learning resources. The highest percentages appear in indicators related to internet connection instability, long page loading times, and technical challenges with videos or learning simulations. For example, more than 40% of respondents agreed that unstable internet connections disrupted the learning process, and more than 38% agreed that long loading times reduced learning comfort. In addition, more

than a third of respondents also acknowledged that some platforms were difficult to access via their devices and that technical obstacles in videos or online modules occurred quite frequently.

These quantitative findings were reinforced by the interview results. Due to access and technological limitations, HF said he frequently could not completely comprehend the topic when learning was not done in person. TA also mentioned that he had to utilize a laptop for more stability because high-resolution video content frequently lags. MA attested that a persistent challenge was signal interference. Overall, both the survey and interview data show that technical aspects remain a major factor limiting the effectiveness of using English-language online science learning resources.



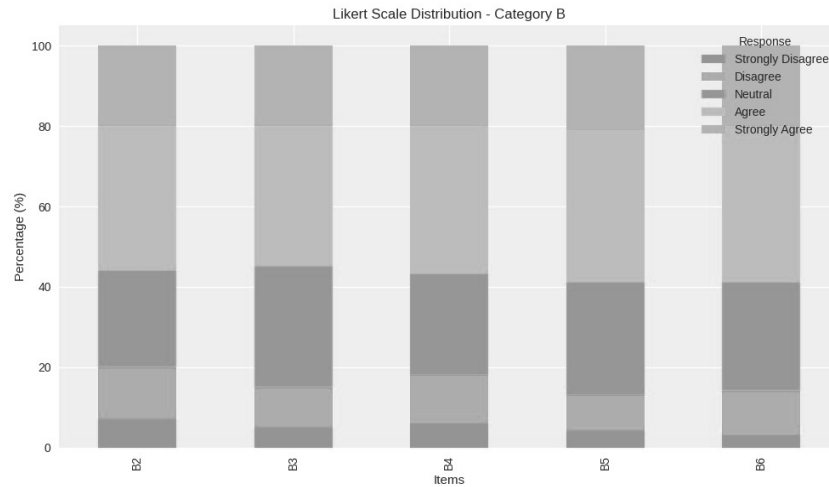
Picture 1. Accessibility and Technical Challenges

Difficulties in Understanding the Material and Comprehension Challenges

Difficulties in understanding the material are one of the biggest challenges for students. Most respondents reported difficulties in understanding technical science terms in English, reading scientific articles, and following dense presentations of material. In many indicators, the Neutral to Agree group dominated, indicating that linguistic and academic barriers were quite significant. For example, the percentage of students who had difficulty understanding science terms and the structure of scientific articles reached more than 60% in the Neutral to Agree category. In addition, most respondents considered the speed of the instructional videos to be too fast, and more than half of the respondents had difficulty understanding the graphs and diagrams presented.

A more detailed picture of these obstacles may be seen in the interview data. TA claimed that because the presentation was overly complex, he frequently had to reread some scientific terminology many times. Even though he previously grasped the fundamental ideas, MA stressed that lengthy phrases in English literature slowed down his comprehension. HF also stated that his limited English skills made it much more difficult for him to absorb the science material. These findings indicate that linguistic, conceptual, and visual challenges play a major role in reducing

students' level of understanding of English-language science material.

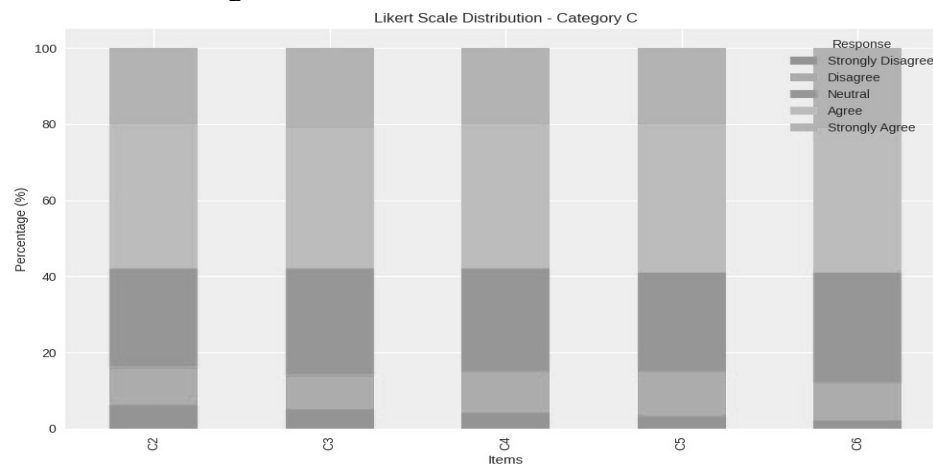


Picture 2. Difficulties in Understanding the Material and Comprehension Challenges

Motivation and Learning Behavior Challenges

The use of English learning resources also affects students' motivation, focus, and learning behavior. Most respondents showed a neutral tendency when asked about decreased motivation, distractibility, procrastination, difficulty focusing, and low self-confidence. This tendency reflects the existence of significant affective barriers in the learning process. Nearly half of the respondents stated that they were often distracted and procrastinated because the material was boring or too difficult. In addition, more than a third of respondents admitted that they lacked confidence in using English learning resources.

The interviews further confirmed these findings. HF stated that he had difficulty focusing due to his limited understanding of terminology, so learning in English did not have a particularly positive effect on his motivation. TA explained that the fear of misunderstanding science terms initially made him less confident, before he finally found a more suitable learning strategy. MA described his learning process as a mixture of feeling challenged and overwhelmed, which required him to spend more time understanding the material. Overall, these findings show that affective factors such as motivation, confidence, and learning discipline are greatly influenced by the use of English in online science learning.

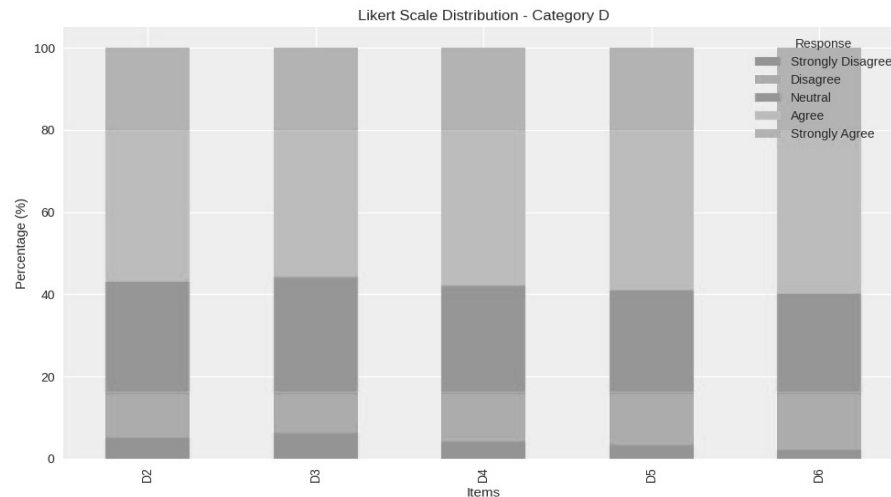


Picture 3. Motivation and Learning Behavior Challenges

Relevance and Usability Challenges

Most students felt that English-language science learning resources were not always relevant to their academic needs. This was reflected in the high percentage in the Neutral category more than half of respondents were unsure whether the online materials they encountered were truly relevant to their assignments, practical work, or science learning in lectures. Many students also stated that they had difficulty finding sources specific to English for Specific Purposes (ESP) in science, and felt that the available material was too general or lacked focus. In addition, the lack of ability to select the right sources was also evident from the high level of uncertainty among respondents in assessing the quality and relevance of the material.

The interviews showed a similar picture. TA assessed that although English-language sources are very useful for assignments and international journals, much of the material cannot be directly applied in lectures, so he has to sort through it selectively. MA stated that the material is helpful, but only in certain contexts, such as understanding more detailed practical procedures. HF admitted that it was helpful when searching for foreign journals, but still had difficulty determining which sources were most relevant. These findings confirm that relevance and ease of use remain major issues in the utilization of English-language online science learning resources.

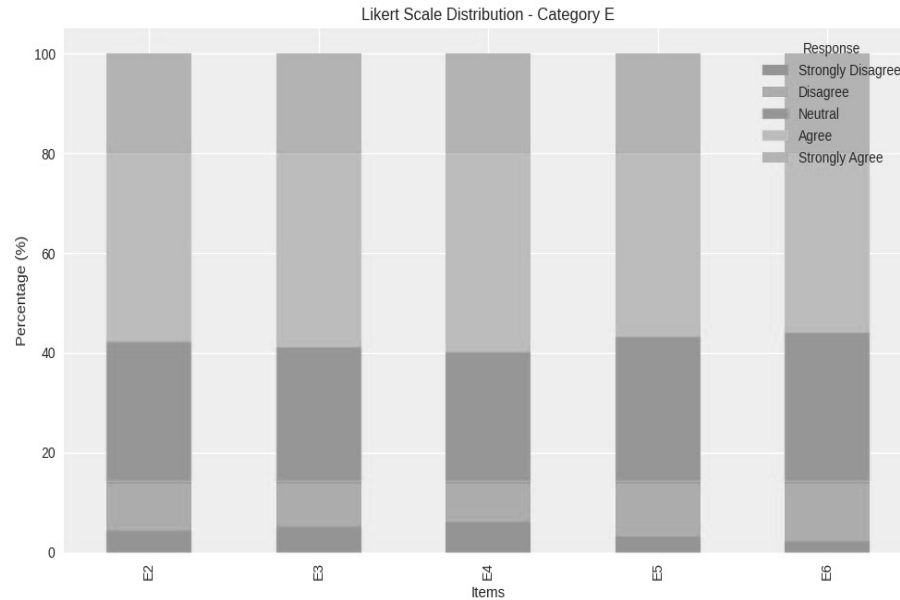


Picture 4. Relevance and Usability Challenges

Cognitive Load and Overwhelm Challenges

The survey's findings indicate that when students use scientific learning materials in English, they frequently encounter an overwhelming amount of cognitive burden. Overall, more than 60% of respondents gave a Neutral to Agree response to questions on information density, text length, platform layout, and difficulty memorizing new terminology. This indicates high cognitive demands when students have to process science information in a foreign language. In addition, the need for additional guidance to understand the material is also very prominent, as seen from the high percentage of Agree and Strongly Agree on these indicators.

Interview data reinforces these results. HF explained that he needed to manage his time well so as not to become overwhelmed. TA mentioned that he usually divided the material into small sections and summarized it in his own words to reduce the information load. MA did something similar by highlighting important points and looking for simpler explanations. In general, these strategies illustrate students' efforts to cope with the high cognitive load and complexity of information in English-based science learning.



Picture 5. Cognitive Load and Overwhelm Challenges

Findings

The first finding is about accessibility, and technological problems remain a big worry. Typically, students encounter sluggish loading times, erratic internet connections, and malfunctioning services. Accessibility has a major impact on learning comfort, as seen by the large proportion in the "Neutral" to "Agree" range. These findings confirm that the effectiveness of online learning is highly dependent on the quality of digital infrastructure.

Second, students have difficulty understanding science content in English. Technical terms, scientific articles, diagrams, and videos are the main sources of difficulty. The high percentage of responses in the "Neutral" to "Agree" categories for these items indicates that academic and visual literacy in English is still underdeveloped among students.

The usage of English also has an impact on learning behavior and motivation. When accessing English-language materials, students express poor self-confidence, boredom, frequent interruptions, and decreased motivation. Significant emotional obstacles in the learning process are shown in the high "Neutral" answers across all categories. A common misconception is that online materials have little to do with scientific needs. Students consider a lot of resources to be hard to assess, too general, and devoid of scientific focus. Given the high proportion of "Neutral" responses, more discipline-specific and carefully selected resources are needed. Cognitive load is one of the main barriers to understanding. A disorganized structure, too many details, and foreign language are the main causes of information overload. The high percentage of "Neutral" and "Agree" responses indicates that most students are able to comprehend the intricacy of the material.

DISCUSSION

Interpretation of students' experiences using online platforms for science learning shows that digital exposure enhances comprehension when supported by proper guidance. Student experiences show that online English platforms make science learning more flexible and accessible. Ermawati (Ermawati, Analysis of the effectiveness of online chemistry learning during the Covid-19 pandemic, 2024) asserts that online learning increases student autonomy and

involvement by enabling them to access multimedia resources at any time and learn at their own speed. Similarly, through visual and aural interactions, Tisoglu (Tisoglu T. , 2021) shows that using online multimedia enhances comprehension of science subjects. These studies show how digital environments foster self-directed learning and improve English proficiency. Consequently, online English platforms are used to foster independent and interactive science learning experiences.

Implication for integrating English-based digital media into science education suggests that curriculum designers should blend language and content learning more effectively. The integration of English-based digital media in science teaching has significant value in improving students' global academic competence. Using scientific literature in English improves one's scientific vocabulary and general understanding of the subject, per Oktapianti's (Oktapianti S. , 2022) research. On the other side, Dayal and Chand's (Dayal P. D., 2022) study highlights how by relating abstract concepts to practical uses, digital learning environments promote creativity and a thorough understanding of fundamental ideas. Both findings provide credence to the idea that English-language digital media have a substantial impact on linguistic and scientific literacy. Therefore, the employment of English-based digital tools in science education can simultaneously improve scientific cognition and language proficiency.

Alignment of results with previous research on online English learning confirms the consistency of current findings with global studies in similar fields. The results of this study are consistent with previous studies that support the effectiveness of science teaching with English as the medium of instruction. English as a medium of instruction (EMI) raises pupils' academic performance and global preparedness, according to Prayuda et al. (Prayuda, Purba, & Gultom, 2024). Teachers view EMI as a useful strategy for enhancing students' comprehension of scientific ideas and communication abilities, according to a paper published in the Wiley/TESOL Journal in (Journal, 2024). This connection shows how important it is to incorporate English into scientific instruction in order to foster worldwide academic abilities. Thus, the present results validate earlier studies highlighting the function of EMI in fostering language and cognitive development in scientific education.

In addition, the results of this research align with earlier studies indicating that the use of online learning materials in English expands students' availability to worldwide scientific literature and promotes self-directed learning (Nguyen T. T., 2024; Alizadeh, Exploring engagement and perceived learning outcomes in an immersive flipped learning context, 2024). There is more evidence to support the notion that using technology in language instruction might improve students' flexibility and involvement in learning (Handayani, 2024; Sertel, Demir, & Korkmaz, 2021). This suggests that the application of technological resources has a beneficial effect on the educational experience, particularly in the field of science education that depends on worldwide resources.

Nevertheless, the issues encountered with spoken language in this study are consistent with findings about English for Specific Purposes (ESP), which indicate that scientific research participants face difficulties because of specialized terminology and scientific communication principles (Costa J. , 2024). Because students must absorb scientific ideas and comprehend a foreign language at the same time, this challenge may raise cognitive strain. According to other studies, even when access to foreign learning materials is easily accessible, inadequate English language competency might prevent people from making the most of them (Nafiah, 2025).

The outcomes of this study about students' challenges when assessing the reliability of online assets are further supported by research on digital literacy (Patigu, Suryani, & Rahmawati,

2024). Students do not instantly acquire the abilities necessary to critically assess or synthesize the wealth of understanding available on digital platforms. Students often have trouble identifying amongst authoritative academic sources and fraudulent online material due to their lack of technological expertise. Thereby, Alruwaili (2023) highlights the value of analytical abilities in understanding digital and numerical data, especially because these abilities have to exist to facilitate well-informed academic decision-making.

Additionally, prior studies have demonstrated that students' enthusiasm and preparedness to learn have an impact on online learning (Singh A. K., 2022). Some students showed adaptive behavior by using online dictionaries and additional resources to enhance their learning, despite the fact that they encountered a variety of difficulties. This indicates that intrinsic motivation and independent learning strategies play a role in the successful use of English-language online learning resources.

Therefore, compared with previous research, this study's findings reinforce the finding that the use of English-language online resources has significant potential to improve science students' academic literacy. However, its effectiveness is strongly influenced by language competency, digital literacy, and adequate pedagogical support.

CONCLUSION

English-language websites are useful resources for scientific education as they offer clear explanations and exposure to new vocabulary. Online resources in English have been shown to be successful in raising students' comprehension and interest in scientific classes. English for Specific Purposes (ESP) promotes the integration of language with subject knowledge, which enhances students' comprehension of technical science words, according to Dudley-Evans and St. John (Dudley-Evans & St. John, 2021). According to Manapova (Manapova, 2025), online learning resources can boost productivity and motivation in science education if they are created methodically. This viewpoint demonstrates how students may connect language and scientific abilities with the use of English-based materials. As a result, English-language internet materials are useful tools for raising pupils' academic and scientific comprehension.

Effectiveness influenced by English proficiency, learning motivation, and accessibility indicates that personal and contextual factors significantly determine learning success. The effectiveness of online English resources depends heavily on students' language skills, motivation, and ease of access to learning platforms. Peng and Xie (Peng & Xie, 2021) point out that in classrooms where English is the primary language of teaching, students who are more motivated and have superior English proficiency typically do better. Furthermore, Ermawati (Ermawati, Analysis of the effectiveness of online chemistry learning during the Covid-19 pandemic, 2024) highlights that consistency in learning engagement and comprehension results is determined by accessibility to digital tools. Both findings highlight that cognitive and external factors influence the success of online English science learning. Therefore, students' success in using online English resources is influenced by internal motivation and external learning support systems.

Understanding of scientific terminology and reading comprehension enhance as they expose students to authentic academic texts and multimedia materials. A strong understanding of scientific terms in English and good reading skills contribute significantly to improved science learning outcomes. According to Firmayanto et al. (Firmayanto, Heliawati, & Rubini, 2021), students' science achievement is negatively impacted by inadequate English language proficiency because they have trouble comprehending important words. On the other hand, specialist ESP materials assist students in mastering the technical language necessary for reading and

comprehending scientific writings, according to Uspayanti and Indriyani (Uspayanti & Indriyani, 2024). Therefore, developing English literacy in a scientific context is crucial for achieving better learning outcomes in science.

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