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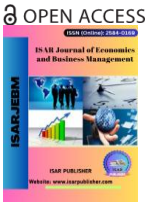

ISAR Journal of Economics and Business Management

Volume 3, Issue 2, 2025, Page: 39-46

Abbriviate Title- ISAR J Econ Bus Manag

ISSN *(Online)*- 2584-0169

https://isarpublisher.com/journal/isarjebm

Unveiling the Impact of Student Characteristics Influencing Computer Science Performance in Open Distance Learning

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Article History

Received: 01.01.2025
Accepted: 14.02.2025
Published: 28.02.2025

Abstract: This study examined how student characteristics and secondary education backgrounds influence the academic performance of first-year Bachelor of Science students in Computer Science at the Kandy Regional Centre of the Open University of Sri Lanka (OUSL). Using a deductive approach, a random sample of 110 students was selected from a population of 183, and data was collected through a self-administered questionnaire. The findings indicated no significant difference in performance in Level 3 Computer Science courses between male and female students. Similarly, there was no significant difference in grades between students who had passed the General Certificate of Education (Advanced Level) in the Bio-Science and Physical-Science streams. Additionally, unemployed and unmarried students performed better than employed and married students. Crucially, the study found that proficiency in English is essential for success in Computer Science courses at the university level. This study had some limitations. First, it was conducted at a single regional center within OUSL, limiting the generalizability of the findings and future research should include all regional and study centers to obtain a larger, more representative sample. Second, since this study relied solely on a quantitative survey, a mixed-methods approach in future research could provide deeper insights into students' perceived challenges with English proficiency. Finally, more advanced statistical analyses could be used to establish causal relationships between relevant factors. It is recommended that, prior to beginning their undergraduate programs, students receive targeted language training, as language barriers may limit the academic performance of students with limited English proficiency.

Keywords: Student characteristics, academic performance, secondary education, computer science, open distance learning.

Introduction

Countries continuously progress with economic challenges and social transformations conveyed by globalization and technological innovations. Education is crucial in meeting these challenges, as it improves knowledge and high-level skills, gateway to better opportunities, and drives faster economic growth (Simoes, Oliveira, & Nunes, 2022). Enhancing the accessibility and equity of higher education has long been a priority for any country. Besides this, establishing demanded skills and expertise levels according to the needs and demands of 21st-century society has been another challenge (Wani, Asgar, & Srivastava, 2023). Consequently, computers and information technology have become integral to higher educational institutions globally. Education begins at birth and continues throughout the lifespan of an individual.

In Sri Lanka, schooling typically begins at the age of five, and the educational journey becomes increasingly challenging as the students' progress. Today, individuals of all ages, from children to adults, often participate in informal learning throughout their careers and even after retirement. With the advancement of technology, many universities worldwide now offer distance education courses and programs to meet the diverse educational needs of students. The open distance learning (ODL) system has significantly advanced this goal by providing learner-centric education and skill development. It is especially beneficial for marginalized sections of society, utilizing various instructional media such as print, audio-visual content, and multiple online platforms. This evolving educational system plays a pivotal role in the global discourse on knowledge construction and dissemination. By designing and implementing innovative, cost-effective delivery strategies, it effectively reaches a worldwide audience (Wani, Asgar, & Srivastava, 2023).

The Open University of Sri Lanka (OUSL) is the premier Open and Distance learning institution in Sri Lanka where students can pursue their studies through Open and Distance Learning (ODL) methodologies which are characteristically different from

Cite this article:

Megasooriya, G. M. C. S., Daulagala, P. W. H. K. P., Perera, M. J. R., (2025). Unveiling the Impact of Student Characteristics Influencing Computer Science Performance in Open Distance Learning. *ISAR Journal of Economics and Business Management, 3*(2), 39-46.

conventional universities (Jayatilleke & Kulasekera, 2020). Distance education adopts a student-centered approach, where the instructor acts as a facilitator, encouraging students to engage actively in peer learning. This emphasizes the collaborative and supportive nature of distance learning (Kerimbayev, Umirzakova, Shadiev, & Jotsov, 2023). However, the degrees awarded by The Open University of Sri Lanka as a distance education institute are treated as equivalent to degrees awarded by any other conventional university under the purview of the University Grants Commission, Sri Lanka. There are currently six faculties at OUSL: Natural Sciences, Engineering Technology, Humanities and Social Sciences, Management Studies, Education and Health Sciences. The Faculty of Natural Sciences currently offers a variety of programs, including certificates and diplomas, with a primary focus on advancing its degree programs.

Various factors influence students to choose disciplines for their undergraduate studies. These can be categorized into three broad groups, those are academic environment and resources, perceptions of the discipline and career, and finally their experience in the selected discipline (Hein G., et al., 2012). For the Bachelor of Science (B.Sc.) degree, prospective students should initially enroll in three disciplines out of the seven currently accessible disciplines, namely Botany, Zoology, Pure Mathematics, Applied Mathematics, Chemistry, Physics, and Computer Science during their first year at the University. Out of these three disciplines, two of them are considered as major disciplines at Level 4 and Level 5 (second and third year).

For the B.Sc. Degree at The Open University, students who studied for their Advanced Level Examination in the Bio-science stream must choose three subjects from Botany, Zoology, Chemistry, Physics, or Computer Science (CS). On the other hand, a Physical Science student can select 3 disciplines from Pure Mathematics, Applied Mathematics, Chemistry, Physics or Computer Science. For both categories, Computer Science is an open subject. Additionally, they can select Computer Science as one of their major disciplines or as a minor discipline for the award of the B. Sc. degree.

Computer science is explored and challenged by humans daily. It is the study of the theory, design, use and analysis of computer devices. Computer literacy is essential for daily living as society rapidly transitions to an electronic or digital era. Degrees in Computer Science and Information and Communication Technology (ICT) have seen an enrolment increase in the past decade (ICT TRENDS_ ICT for Education, 2019; Zweben S., & Bizot B. , 2014). Students are required to be proficient in computer application skills to compete in today's global job market. Students who obtain degrees in computer science have a strong possibility of finding professional employment in a variety of sectors, including the food, manufacturing, and healthcare industries.

It is interesting to note that the majority of students at the Open University choose Computer Science as their major discipline even if they have no prior knowledge gained from the schools on the subject. This may be due to the important aspects of computer science. Computer science education provides students with increased knowledge, skills, and proficiencies that are required by the industry. Such skills include project management, problem solving and understanding human behavior in addition to classic computer science skills such as programming and computational thinking (Pappas, et al., 2016).

Gender is the range of physical, biological, mental, and behavioral characteristics pertaining to and differentiating between the feminine and masculine population. It is believed that gender also has considerable effects on the academic performance of students especially in science and computer subjects. In fact, it has been the general belief in many parts of the globe that male students tend to perform better compared to the female students in mathematical related and technology-based disciplines. Several studies showed that women are not successful in a computing environment (P.F. & P., 1984; Taylor & Mounfield, 1989; Varma, 2009). In contrast there were some other studies which demonstrated that women had performed as well as men in computing (Werth, 1986; Clarke & Chambers, 1989).

However, the acquisition of computer knowledge and the skills at university education is much depends on the existing skills that the students have accumulated during their pre-university studies and secondary education at schools. It is nearly impossible for the students to be self-competent in their tertiary education at the university and subsequently at the workplace without having a prior knowledge and skills in the field of computing. In order to improve and increase the academic performance of university undergraduates in computer science education, different approaches are needed to be discussed. This present study is focused on surveying the effects of the knowledge that the individuals in the target group have acquired during their secondary education and the gender difference towards their academic performance in computer science during their first year at the university.

Methodology

The research methodology included a survey conducted through the delivery and collection of a self-administered questionnaire among the members of the target group. A questionnaire consisted of dichotomous questions with 'yes' and 'no' options, open ended questions and questions where the respondents have to mark their choice (by a tick) by considering the options given. The questionnaires were distributed among randomly selected 110 students registered for 2019/2020 academic year at the Kandy Regional Centre, The Open University of Sri Lanka. They had been registered for at least one course out of the three courses of the discipline of Computer Science. The course codes and the weightages of the three courses of level 3 (first year) are given below in Table 1.

Table 1: *Course codes and weightages of three courses of Computer science discipline*

Course code	Course title	Credit weightage (C)
CSU3200	Introduction to Computer Programming	2
CSU3301	Database Management Systems	3
CSU3301	Data Structures and Algorithms	3

Students were informed that the survey was entirely on a voluntary basis and would not affect their academic performance or evaluation of the course/s.

Data Analysis

Parametric Data Analysis (PDA) was applied using a Statistical Analysis System (SAS) to analyze the data provided by each student and the data collected from the Open University Management Information System (OMIS). In an analysis of data, the Great Point Average (GPA) was considered as the dependent variable, and it was calculated by giving a value for each grade in Table 2.

Table 2: *All possible grades that a student can obtain and the corresponding GPA values*

Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	FA
GPA (G)	4.0	4.0	3.7	3.3	3.0	2.7	2.3	2.0	1.7	1.5	0.0

For the following four situations the students have not faced the final examination and there was no grade or GPA value in Table 3. Thus, these four conditions were omitted from the calculations.

Table 3: *Conditions not considered for data analysis*

Situation	GPA Value
RX (eligible, but not sat for the final examination)	-
Pending (registered for the course, but not eligible for the final examination	-
Not registered	-
Dropped the course/courses	-

The following were considered as independent variables or grouping variables of this study.

Gender (Male, Female)

Employment status (Yes, No)

Marital status (Yes, No)

A/L subject stream (Physical Science, Biological Science)

English language skill (Poor, Moderate, Excellent)

The independent variables 1-4 were tested using the Two-independent sample T test and the variable 5 was tested using the One-way ANOVA test.

Findings and Discussion

Among the 183 students enrolled in the first-year computer science courses for the academic year 2019/2020 at Kandy Regional Centre, 110 were randomly selected (60%) for the survey. Some students had offered all 3 courses while the others had offered either one or two courses depending on their likelihood. From the chosen group, 104 students had submitted the individually filled questionnaire (95%) and only 100 were considered for the data analysis rejecting 04 incomplete questionnaires.

Demographic Data of the Respondents

The age of the respondents varied from 18 (the minimum age for registering for a degree at the Open University) to 35 years. Even though there is no upper limit age barrier for the students to register for a course at the Open University, there were no students elder than 35 years in this sample. This data revealed that the majority (80%) of the students enrolled were in between the ages of 18 and 25 and 20% of the students were between the ages of 26 to 35 (Table 4). The lack of students above 36 years may stem from a perception that they lack the technical skills, especially compared to younger peers, to successfully grasp the concepts in fields like computer science.

Table 4: *Demographic profile of the respondents*

Category	Number of students (%)
Gender	
Male	35
Female	65
Age Group	
18 – 25 years	80
26 – 35 years	20
36 – 50 years	00
Over 50 years	00
Marital status	
Married	12
Single	88

Impact of Gender Difference on Academic Performance

Several studies have been conducted across the world and found that there is a noticeable gender disparity in students' academic performance (Apata, 2011; Agbaje, Rashidat O & Alake, Ese M, 2014; Dania, 2014). Some studies reported that female students have outperformed their male counterparts (Dayioglu & Turut-Asik, 2007; Kawaileh & Zara, 2011; Orabi, 2007) and they were likely to be more adaptive in learning in different environments. Some of these researchers pointed out that there was no significant gender difference in students' academic achievement (Goni, Yaganawali, Ali, & Bularafa, 2015) while others found a significant difference with either the males or the females performing better.

A low number of female students involved in computer science was documented in many surveys. Between 2000 and 2012, in United States, there was a 64% decrease in the total number of first-year female undergraduate students who were interested in choosing computer science as their major discipline (DuBow, 2013). Further, in schools and in degree levels in universities, there is a low female adoption of computer science qualifications seen in the UK and other developed countries (Ruel, Wagner, & Gillespie, 2016).

More generally, there are concerns that females lack educational and professional goals in computer science, which is often considered to be gendered as a male domain (Wonga & Kemp, 2018). These gendered discourses are often reinforced by parents, teachers and the media (Cohoon & Aspray, 2013). The unfortunate truth is that the representation of women in computer science occupations has declined in the last decades (Landivar, 2013). Even in world-famous companies; only 17% of Google's engineering workforce, 21% of Pinterest's technical team, 15% of Facebook's workforce, and 20% of Apple's global engineering workforce are women (Lien, 2015). In contrast, the group of undergraduates randomly selected for this study consisted of 65 females and 35 males, majoring female students approximately twice the number of male students in Table 4. Given this obvious gender gap, it was worth of analyzing the data to determine whether there was any performance gap at the final examination between these male and female groups of students. The outcomes of the Two independent sample T-test in this regard in Table 5 as follows.

Table 5: *T-Test*

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	95	-0.37	0.7105
Satterthwaite	Unequal	65.733	-0.37	0.7137

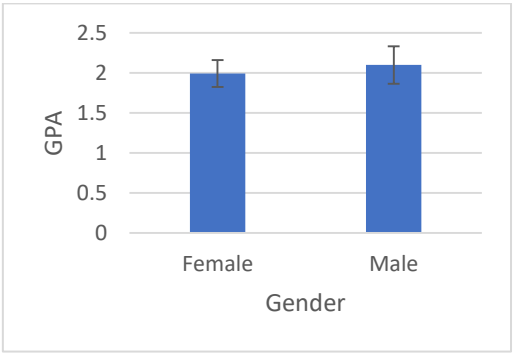

Figure 1: *Influence of gender on GPA of undergraduates*

The influence of gender on GPA of undergraduates is shown in Figure 1. According to the above T test results, there is no significant difference in academic performance between male and female undergraduates since the calculated p-value in Two independent sample T-test was more than 0.05 (0.7105). Therefore, the GPA values of Computer Science subjects are not affected by the gender of the target group.

Impact of Employment Status on Academic Performance

Within the 100-student sample, only 39 students were employed in different sectors (Figure 2) while the remaining 61 students were unemployed. According to the information collected, those employed 39 students have secured jobs in different fields, out of which some are very much related to computing. These employed students may have enrolled for a degree offering computer science as a discipline to obtain better career opportunities, job satisfaction, and personal development or as an investment in the future. Since computer science field includes a wide array of interesting and diverse occupations such as software developers, database administrators, web developers, and many more, the unemployed majority in the age group between 18 – 25 years may be looking forward to find a fresh occupation in the field of computing after completing the degree.

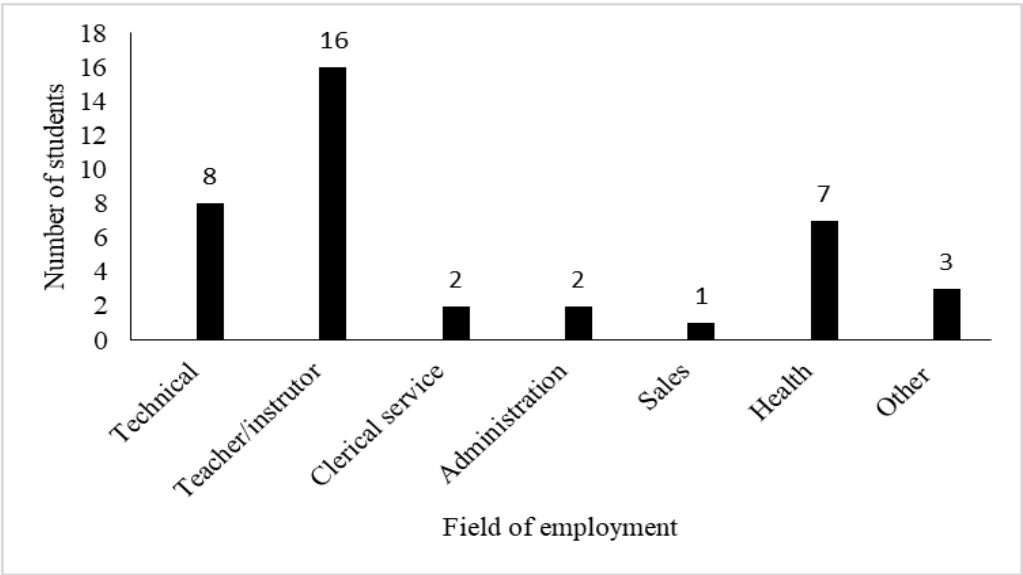

Figure 2: *Different fields in which students are engaged in occupations*

The outcomes of the impact of employment status on academic performance, tested using Two independent sample T-test are as follows.

Table 6: *Two independent sample T-test*

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	95	-6.39	<.0001
Satterthwaite	Unequal	93.696	-6.75	<.0001

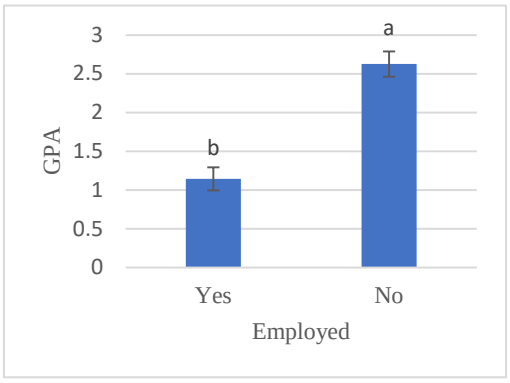

Figure 3: *Effect of employed or unemployed status on GPA*

The effect of employed or unemployed status on GPA is shown in Figure 3. According to the above T test (Table 6) results there is a significant difference between employed/unemployed status and GPA values of the final examination, since the calculated p-value in sample T-test was less than 0.05 (.0001). The analysis of grades revealed that the unemployed students have scored well at the final examination compared to the employed students.

Students' professional work causes their time to be divided between study and work. This division can significantly influence their academic achievements, decreasing their academic performance and causing loss of interest in studies (Milosz and Milosz, 2017). Unemployed students may achieve better academic results because they have fewer obligations and more time to focus on their studies. In contrast, working students often face financial demands that require them to divide their time between work and education

Impact of G.C.E (A/L) Subject Stream on Academic Performance

Out of 100 students of the sample, 12 undergraduates have done their university entrance examination in the Physical science stream while the remaining 88 undergraduates were Biological Science students. But none of the students of these two streams have followed computer science as a subject for their university entrance examination.

The outcomes of the analysis results of the impact of the G.C.E (A/L) subject stream on academic performance are as follows.

Table 7: *Two independent sample T-test*

Method	Variances	DF	t Value	Pr > |t|
Pooled	**Equal**	**95**	**-1.25**	**0.2149**
Satterthwaite	**Unequal**	**14.611**	**-1.29**	**0.2166**

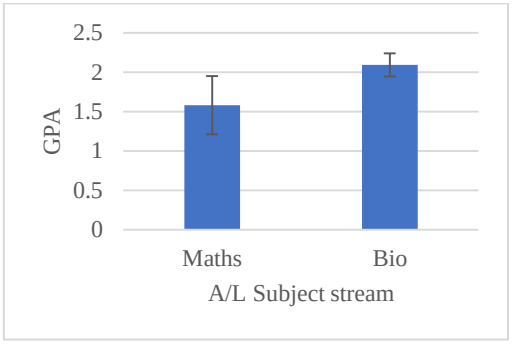

Figure 4: *Effect of A/L subject stream on GPA*

Figure 4 above shows the effect of A/L subject stream on GPA. According to the above test results there is no significant difference between Physical science and Biological science students in scoring grades for the computer science subjects at their first year examinations. The calculated p-value in sample T-test exceeded 0.05 (0.2149) and hence the GPA values were not affected by the A/L subject stream.

Computer science and Biology are two disciplines that focus on the investigation of systems. Biology frequently refers to living things and Computer Science typically refers to the structure and operation of a computer system. Additionally, both fields use mathematical models to aid in the explanation and prediction of behavior. But in society as well as among biology students, there is a fair and considerable fear on studying computer subjects, because they find that computer science is more challenging. But the hardness or easiness of a subject really depends on the individual student's strengths and weaknesses. This study revealed that there is no effect of the stream of one's A/L education to pursue a degree with computer subjects. In the modern world, regardless, any student who wishes to pursue a better career in future should consider computer science as an essential subject to follow.

Effect of Marital Status on Academic Performance

There were 12 married students and 88 unmarried students in the sample.

Table 8: *ANOVA table : Effect of marital status on GPA*

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	95	-2.48	0.0148
Satterthwaite	Unequal	18.999	-3.37	0.0032

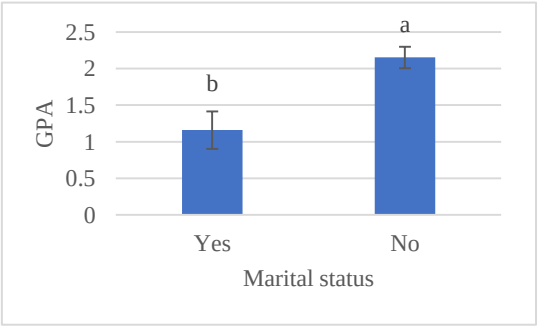

Figure 5: *Effect of Marital Status on GPA*

Figure 5 shows the effect of marital status on GPA of undergraduates. According to the above test results, there is a significant difference between married/unmarried status and GPA since the calculated p-value was less than 0.05 (0.0148). Therefore, marital status has an effect on GPA.

Students who decide to get married while enrolled in studies may encounter more challenges, including increased stress, new responsibilities, and mental health problems, all of which will lower their academic performance. In this sample of students analyzed 18 married students showed less performance than the remaining unmarried students. This could be due to one or a few of the above-mentioned reasons.

Impact of English Language Skills on Academic Performance

The one-way analysis of variance (ANOVA) was used to analyze this set of data.

This analysis is used to determine whether there are any statistically significant differences between the means of three or more independent variables. Out of the 110 students in the sample, 6 and 12 number of students reported having poor and excellent English language skills respectively. Rest of the students reported having average English language skills.

Table 9: *ANOVA table : Impact of English Language Skills*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	12.6235899	6.3117950	3.76	0.0269
Error	94	157.8046266	1.6787726		
Corrected Total	96	170.4282165			

According to the above ANOVA table, at least there is a significant difference 0.0269 (P<0.05) among means of skill levels.

Excellent level of English knowledge has higher GPA than Poor and moderate levels of English language skill in Figure 6.

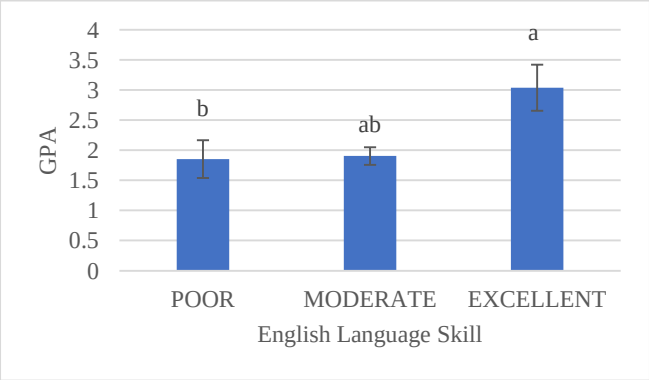

Figure 6: *Effect of English Language Skill on GPA*

It can be concluded that proficiency in English is crucial for effectively studying Computer Science subjects. Students with high self-perceived English proficiency demonstrated the highest mean GPA (Ghenghesh, 2015 ; Martirosyan, Hwang, & Wanjohi, 2015; Nasirudeen & Xiao, 2020). Proficiency is defined as the ability of students to effectively use the English language to create and convey meaning in both spoken and written forms while pursuing their university studies (Department of Education, 2009). For students whose mother tongue is not English and who aspire to enter university, a lack of English language proficiency can hinder their ability to fully engage in the learning process and succeed in academic courses. Struggling academically may lead to low self-esteem, frustration, lack of motivation, and a decreased interest in attending lectures and tutorials (Department of Education, 2009; Ghenghesh, 2015 ; Gunasekara RMRM, 2022).

Recommendations

Since students with higher English proficiency at university entry tend to perform better in both their degree courses and English skills, they are more likely to engage fully in the learning process, leading to improve academic outcomes. Therefore, it is recommended that the institution raise the English entry requirement. As shown by this research, such a change could significantly impact academic quality and academic success. Steps should be taken to enhance prospective students' language proficiency prior to starting their undergraduate programs, rather than concurrently, and to provide targeted support to further develop their language skills.

Limitations and Future Research

This study faced certain limitations. First, it was conducted at only one regional center within the OUSL. Future research should include all regional and study centers to achieve a larger, more representative sample. Second, this study relied on a quantitative survey; adopting a mixed-methods approach in future research could offer deeper insights into students' perceived challenges with English language proficiency. Third, more robust statistical analyses could be employed to establish causal relationships between relevant factors in this context.

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