Influence of Campus Infrastructure on Students' Performance at Universiti Kebangsaan Malaysia

Yue Yue* & Doris Padmini Selvaratnam

Faculty of Economics and Management, Universiti Kebangsaan Malaysia

***Correspondent Author**

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ABSTRACT

In the context of higher education, campus infrastructure plays a crucial role in influencing students' learning experience and performance. However, there is still a lack of in-depth research on the specific impact of various types of campus infrastructure on the students of Universiti Kebangsaan Malaysia. Therefore, this study aims to comprehensively examine the impact of campus infrastructure on student performance at this university. A random sampling technique was used to select 323 students from a total of 25,525 students. Data were collected through a well-designed questionnaire, which was divided into five sections covering different aspects of infrastructure. The reliability and validity of the questionnaire were ensured through pre-testing. Data was analyzed using SPSS, involving descriptive statistics and content analysis techniques. The results showed that environmental factors such as noise, air quality, lighting, and temperature had a significant perceived impact on students. The adequacy of extracurricular infrastructure varied from facility to facility and was related to student participation and performance. Facilities for people with disabilities have a certain level of awareness and accessibility. Digital infrastructure has both strengths and areas for improvement. This study contributes to a better understanding of the relationship between campus infrastructure and student performance, providing valuable insights for universities to optimize infrastructure and improve the quality of education.

Keywords: Campus Infrastructures, Student Learning, Student Performance

INTRODUCTION

Background of the Study

In today's society, higher education undoubtedly occupies a pivotal position. It is a lighthouse that leads the development of society, continuously delivering high-quality talents to society, promoting progress in various fields, and providing fertile soil for academic innovation and advancement. As a key university with significant influence in Southeast Asia, Universiti Kebangsaan Malaysia shoulders a great mission and carries the earnest expectation of knowledge transmission, scientific research breakthroughs, and talent cultivation in the region and even in the wider field.

With the rapid development of the times, education has long since broken the boundaries of the traditional classroom mode of instruction. Subsequently, the core concept of campus infrastructure has become the focus of attention. Campus infrastructure refers to the comprehensive combination of hardware foundation and software support that ensures the smooth implementation of educational activities. Specifically, in terms of physical facilities, modern research has shown that sound, light, temperature, air quality, and other factors in the learning environment are directly related to students' physiological comfort and psychological state, which in turn have a profound impact on cognitive functions such as learning, attention, and memory. For example, Shield and Dockrell (2003) found that noise from external sources such as traffic and aircraft significantly disrupts communication in classrooms and adversely affects students' ability to concentrate and process information, highlighting the crucial need for sound insulation in educational environments. Students exposed to a noisy

environment for a prolonged period of time absorb knowledge much slower than their peers in a quiet environment.

In terms of extracurricular infrastructure, it is important to emphasize that extracurricular time is a critical period for the overall growth of students. Extracurricular facilities on campus, such as club rooms, sports grounds, and art creation spaces, provide a platform for students to develop their interests, hone their social skills, and foster team spirit. These holistic qualities, in turn, will contribute to their academic performance.

Concerning infrastructure for students with disabilities, it is essential to emphasize that equity in education is now a widespread concern. As a country known for its diversity and inclusiveness, Malaysian universities have a responsibility to ensure that students with disabilities are able to integrate into campus life without barriers. Infrastructures such as suitable wheelchair ramps, guiding facilities for the blind, and special learning equipment are the keys to unlocking the doors of knowledge for students with disabilities. Without these, their path to learning will be fraught with difficulties.

Focusing on digital infrastructure, the world is undergoing rapid digital transformation, and the demand for digitally skilled manpower across industries has surged. Universities being the cradle of talent, the quality of digital infrastructure on their campuses directly determines whether students can keep up with the times. For example, during the widespread implementation of online teaching and learning during the pandemic, those universities with complete digital facilities could adapt quickly and ensure uninterrupted teaching and learning. Students also took the opportunity to hone their online learning and collaboration skills, building an advantage for their future careers.

In Malaysia, the management of higher education infrastructure is governed by a robust legal and regulatory framework designed to ensure quality, accessibility, and sustainability. The Private Higher Educational Institutions Act 1996 (Act 555) and the Education Act 1996 (Act 550) provide comprehensive guidelines on the establishment, operation, and maintenance of universities, ensuring compliance with national standards. Additionally, the Malaysian Qualifications Framework (MQF), established under the Malaysian Qualifications Agency Act 2007 (Act 679), sets requirements for educational institutions to uphold quality assurance in infrastructure and learning environments. Furthermore, accessibility laws, such as the Persons with Disabilities Act 2008, mandate inclusive infrastructure to support students with disabilities, reinforcing Malaysia's commitment to equitable education. These regulations collectively shape the development of campus infrastructure, ensuring that universities are well-equipped to meet the needs of a diverse student population.

Problem Statement

While infrastructure significantly influences educational outcomes, most existing studies focus on primary and secondary schools, leaving a gap in understanding its impact at the university level. Unlike younger students, college students require specialized facilities, reliable digital access, and well-maintained learning environments to support their academic pursuits and overall well-being. Since universities provide a broader range of facilities and services, their infrastructure may exert a more distinct and multifaceted impact on student performance.

Recognizing the importance of university infrastructure, the Malaysian government has introduced initiatives like the National Higher Education Strategic Plan (NHESP) and the Malaysia Education Blueprint (Higher Education) 2015-2025, which emphasize the development of smart campuses, improved accessibility for students with disabilities, and the expansion of digital infrastructure to support hybrid learning. Additionally, public funding programs like the MyRen Network have improved high-speed internet access across campuses, while the Higher Education Loan Fund (PTPTN) indirectly supports students by facilitating well-equipped learning spaces. However, despite these initiatives, challenges persist, including outdated physical facilities, insufficient accommodations for students with disabilities, and disparities in digital access, particularly in rural campuses. Furthermore, although government policies set ambitious infrastructure goals, their implementation and maintenance often vary across institutions, leading to inconsistent outcomes.

To address these concerns, this study examines the actual impact of campus infrastructure on student performance at Universiti Kebangsaan Malaysia (UKM). Specifically, this research aims to explore how

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different aspects of infrastructure influence student outcomes through the following objectives and research questions.

Research Objectives and Research Questions

The main objective of this study was to discover how campus infrastructure impacts students' performance at Universiti Kebangsaan Malaysia.

To properly approach our subject, we asked ourselves these four questions that would guide this study:

1) How do environmental factors in campus infrastructure affect student performance?

2) How does the adequacy of a campus's extracurricular infrastructure affect students' extracurricular participation and academic performance?

3) How do school disability facilities impact the performance of students?

4) How do digital facilities on campus impact students?

Importance / Significance of This Study

1) By examining how physical factors such as sound, light, temperature, and air quality affect the learning environment, this study can help educational policymakers understand and implement necessary infrastructure improvements. These improvements can help create more effective learning environments, directly improving students' academic performance and satisfaction.

2) Extracurricular activities are vital to students' physical and mental well-being. By examining how extracurricular recreational facilities such as fields, gaming rooms, music rooms, and drama rooms affect students' physical and psychological development, this study can provide empirical data to support schools' investment in promoting holistic student development. This enhances students' learning experience and contributes to their social, emotional, and psychological well-being.

3) For students with disabilities, campus accessibility is key to their ability to complete their studies successfully. By investigating the facilities provided for students with disabilities at the Universiti Kebangsaan Malaysia, this study can reveal current facilities' effectiveness and possible shortcomings and promote a more inclusive and equitable educational environment. This not only contributes to the academic success of students with disabilities but also encourages their inclusion in the campus community.

4) Digital facilities play a crucial role in modern education, providing students with online resources, virtual learning platforms and collaboration tools. Investigating students' use of digital facilities can inform the optimization of digital infrastructure, which not only helps to improve students' learning experience but also helps them to better adapt to the digital economy and enhances the competitiveness of universities in the global education landscape.

Limitations

Due to the inability of the sample respondents to respond frankly, the results may not be accurate in their views on all relevant questions.

Delimitations

The instruments used only suggestions according to the Likert scale model to manage the data collected.

LITERATURE REVIEW

The impact of school facilities on learning outcomes

1) Air quality

The relationship between indoor air quality and student performance had been the focus of extensive research, indicating significant educational implications. Poor air quality in schools had been identified as a contributor to increased absenteeism, particularly among students suffering from asthma. The resultant rise in absences and impaired concentration levels suggested that student achievement metrics reflected health conditions rather than actual learning capabilities.

A pivotal study by McGowen (2007) introduced the concept of "sick building syndrome,'' a condition manifesting through symptoms such as lethargy, dry skin, and headaches. This syndrome not only diminished the well-being of students and teachers but also negatively impacted their performance. The underlying causes of poor indoor air quality included many contaminants such as bacteria, viruses, allergens, and pollutants emitted from office equipment, cleaning products, pesticides, and building materials like flooring, paints, and adhesives. Moreover, significant moisture within buildings exacerbated these conditions by fostering mold growth, further compromising the health of school occupants.

Hutton (2014) further expanded on these findings by highlighting carpets as a commonly overlooked source of indoor air pollutants. Carpets could trap flu viruses, COVID-19, and allergens from outside, redistributing them throughout the day as people move about. This continual cycle of contamination presented a persistent challenge to maintaining healthy indoor environments in educational settings.

Together, these studies underscored the critical need for improved ventilation and regular maintenance of school facilities to enhance indoor air quality. Addressing these environmental factors was essential for safeguarding student health and ensuring that academic assessments accurately reflected students' true learning outcomes rather than the adverse effects of environmental quality.

2) Noise

Classroom noise significantly impacted student engagement and performance, creating barriers to effective learning. Shield and Dockrell (2008) highlighted that noise from external sources such as traffic and aircraft disrupted communication and adversely affected students' ability to concentrate and process information, which was particularly detrimental in learning environments. Similarly, Klatte, Bergström, and Lachmann (2013) provided evidence that noise impaired cognitive performance in children, affecting critical functions such as attention and memory, which were essential for academic success. The need for well-designed acoustic environments in schools was further emphasized by the American National Standards Institute, which had set guidelines to minimize these disruptions (ANSI/ASA, 2010). These guidelines stressed the importance of controlling sound sources and enhancing classroom acoustics to foster better learning conditions. Additionally, Crandell and Smaldino (2000) discussed how children with hearing impairments were particularly vulnerable to poor acoustic environments, suggesting that enhanced classroom acoustics could substantially improve educational outcomes for these students. Together, these studies underscored the critical need for schools to invest in infrastructure that effectively mitigated noise pollution to enhance student well-being and educational performance.

3) Lighting

Lighting in educational environments played a crucial role in enhancing student performance. Research indicated that adequate lighting improved mood and energy and was essential for optimal cognitive functioning and academic success. Heschong (2003) noted that natural light in classrooms significantly boosted students' test scores, particularly in math and reading, by providing an environment that supported concentration and reduced eyestrain. Furthermore, Barrett and Zhang (2015) demonstrated that well-lit classrooms contributed to a 26% faster learning rate in reading and a 20% faster rate in math. These studies highlighted the profound impact that adequate lighting conditions could have on student learning outcomes, emphasizing the need for schools to incorporate natural and artificial lighting solutions that facilitated educational achievement.

4) Temperature

The temperature in classroom settings critically influenced student learning and performance. Lan (2014) found that optimal classroom temperatures could enhance student concentration and cognitive performance, with deviations from this optimum associated with decreased attention span and reduced academic achievement. Moreover, Wargocki and Wyon (2007) provided empirical support, demonstrating that students exposed to appropriate thermal conditions performed better on mathematical tasks and showed improved memory retention compared to those in environments that were too hot or cold. These findings underscored the importance of maintaining a comfortable thermal environment in schools to optimize student learning and performance, highlighting the need for educational institutions to consider temperature control as a key component of effective classroom management.

The impact of extracurricular facilities on student performance

The impact of extracurricular facilities on student performance was well documented, indicating that adequate recreational spaces significantly enhanced educational outcomes. According to Trudeau and Shephard (2010), school access to sports facilities and other recreational areas promoted physical activity, which was directly linked to improved academic achievement and better classroom behavior. Furthermore, Feldman and Matjasko (2007) found that engagement in school-based extracurricular activities was associated with higher grades and an increased likelihood of college attendance. These studies demonstrated the critical role that well-equipped extracurricular facilities played in supporting students' physical health and academic success, emphasizing the importance of including robust recreational infrastructure in educational settings to foster the holistic development of students.

The impact of disability infrastructure on student performance

Providing facilities for students with disabilities significantly influenced their academic performance and overall school experience. According to a study by Riddell and Tinklin (2006), accessible educational facilities and supportive services enabled students with disabilities to participate fully in academic and social activities, leading to improved educational outcomes. Moreover, Burgstahler (2015) highlighted that when schools actively worked to remove physical and instructional barriers, students with disabilities demonstrated higher levels of engagement and academic achievement. These findings underscored the importance of inclusive design in educational environments, ensuring that all students had equal opportunities to succeed regardless of their physical capabilities.

The impact of digital infrastructure on student performance

Digital infrastructure played a pivotal role in enhancing educational outcomes by providing students with the tools and resources necessary for effective learning. According to Tan and Bhalla (2015), access to reliable internet and digital platforms facilitated the acquisition of knowledge, enabling students to access online resources, collaborate on projects, and engage in virtual classrooms. This was particularly significant in the context of blended and remote learning models, where digital infrastructure directly impacted the quality of education.

Furthermore, studies by Henrie, Halverson, and Graham (2015) highlighted that digital platforms like learning management systems (LMS) fostered improved communication between students and educators, leading to better academic performance. The availability of tools such as online discussion boards, assignment submission portals, and virtual feedback mechanisms enhanced student engagement and academic productivity.

Additionally, digital literacy, supported by robust infrastructure, correlated with improved problem-solving skills and critical thinking, essential competencies for academic success in the digital era. However, inadequate or unreliable digital infrastructure, such as slow internet speeds or outdated systems, could hinder learning, as noted by Hockly (2011). This highlighted the importance of continuous investment in digital infrastructure to ensure equitable access and support for all students.

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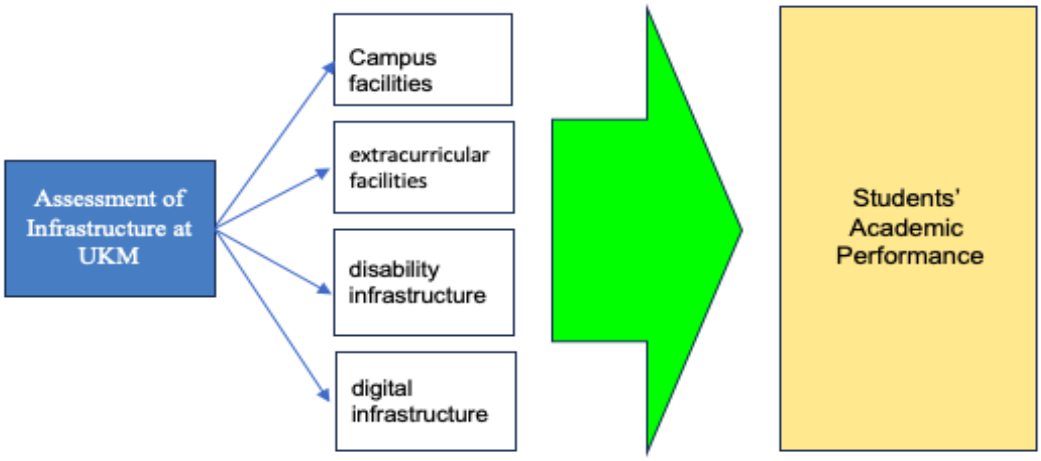
Conceptual Framework

Based on the literature review, the conceptual framework of the study is illustrated as shown in Diagram 2.1.

Diagram 2.1 Influence of Campus Infrastructure on Students' Performance at Universiti Kebangsaan Malaysia



Source: Author

The Diagram 2.1 elucidates that the focus of the study will be on parameters of campus facilities, extracurricular facilities, disability infrastructure and digital infrastructure towards students' academic performance.

METHODOLOGY

This study aims to determine the impact of the campus infrastructure at Universiti Kebangsaan Malaysia on students. Four concerns were addressed:

1) How do environmental factors in the educational environment affect student performance?

2) How does the adequacy of a campus's extracurricular infrastructure affect students' extracurricular participation and academic performance?

3) How do campus disability facilities impact the performance of students?

4) How do digital facilities on campus impact students?

Research Design

This study employs a descriptive survey design to systematically examine the impact of campus infrastructure on students' academic performance at Universiti Kebangsaan Malaysia (UKM). Drawing on the methodologies of Mugenda & Mugenda (2010), Gay (1981), and Kerlinger (2002), the researcher adopts this design to objectively describe current conditions by collecting empirical data on physical, extracurricular, accessibility, and technological infrastructure. The target population consists of all 25,525 registered students at UKM.

A random sampling method ensures representativeness and minimizes selection bias. Based on a 95% confidence level and a margin of error between 5% and 5.5%, the calculated sample size ranges from 314 to 379 participants. To account for an expected response rate of 20%, 1,895 students are invited, resulting in 323 valid responses for analysis. The research instrument is a structured questionnaire divided into five sections: student demographics, physical environment factors (sound, lighting, air quality, temperature), extracurricular facilities, accessibility infrastructure for students with disabilities, and electronic resources. The questionnaire utilizes validated 5-point Likert scales adapted from existing educational infrastructure assessment tools to ensure reliability and validity.

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Reliability of the Instruments

In order to ensure the scientific reliability of the questionnaires, the first 100 are selected for reliability tests before conducting the large-scale survey.

Item	Corrected item-total correlation (CITC)	Alpha if Item Deleted	Cronbach Alpha
2.1 Noise interferes with students' learning.	0.356	0.943	0.943
2.2 Classroom noise affects all Phd of particular concern for students with hearing loss or attention deficits.	0.424	0.943	
2.3 Poor air quality contributes to absenteeism, especially among students with asthma.	0.409	0.943	
2.4 Poor air quality contributes to lethargy, dry skin, and headaches.	0.374	0.943	
2.5 Natural lighting boosts the morale of teachers and students.	0.345	0.943	
2.6 Lack of sufficient light can increase absences and decrease student achievement.	0.297	0.944	
2.7 Temperatures that are too hot or too cold compromise the performance of students.	0.376	0.943	
3.2 Adequacy of the following extracurricular facilities. [Field]	0.630	0.941	
3.2 Adequacy of the following extracurricular facilities. [E-sports room]	0.508	0.942	
3.2 Adequacy of the following extracurricular facilities. [Music rooms]	0.661	0.941	
3.2 Adequacy of the following extracurricular facilities. [Theatre rooms]	0.640	0.941	
3.2 Adequacy of the following extracurricular facilities. [Physical sports space]	0.490	0.942	
3.2 Adequacy of the following extracurricular facilities. [Others]	0.674	0.941	
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Field]	0.499	0.942	
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [E-sports]	0.330	0.943	
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Music rooms]	0.561	0.942	
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Theatre rooms]	0.503	0.942	

3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Physical sports space]	0.499	0.942	
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Others]	0.647	0.941	
4.1 Are you aware that the campus provides relevant facilities for students with disabilities?	0.439	0.943	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Elevators]	0.521	0.942	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible restrooms]	0.710	0.940	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible pathways]	0.695	0.941	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Barrier-free bus]	0.654	0.941	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible parking space]	0.683	0.941	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Specially equipped learning equipment]	0.663	0.941	
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Others]	0.702	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Elevators]	0.656	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible restrooms]	0.690	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible pathways]	0.671	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Barrier-free bus]	0.633	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible parking space]	0.607	0.941	
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Specially equipped learning equipment]	0.673	0.941	

4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Others]	0.724	0.941	
4.4 To what extent do you agree that improvements to facilities on campus have a positive impact on campus life for students with disabilities?	0.456	0.942	
4.5 How often do students with disabilities participate in extracurricular activities?	0.334	0.943	
4.6 To what extent do you agree that students with disabilities can be integrated into campus life?	0.340	0.943	
4.7 To what extent do you agree with the campus's acceptance of students with disabilities?	0.249	0.944	
5.1 To what extent do you think the campus network is fast and secure ?	0.342	0.943	
5.4 To what extent do you approve of the availability and quality of your digital library?	0.440	0.942	
5.6 To what extent do you agree that teams, Google Meetings, and Canvas facilitate your learning?	0.323	0.943	
5.7 To what extent do you agree that digital infrastructure facilitates your learning?	0.302	0.943	

Note: Standardized Cronbach's α = 0.943

Table 3.1 shows the results of the reliability test, and the Cronbach's Alpha coefficient was used to measure the internal consistency between the indicators. Cronbach's Alpha is a commonly used method of reliability analysis and is suitable for evaluating the level of internal consistency of a scale. In this analysis, the total Cronbach's Alpha coefficient was 0.943, indicating that the questionnaire has a high level of internal consistency.

Validity of the Instruments

In order to ensure the scientific validity of the questionnaires, the first 100 were selected for validity tests before conducting the large-scale survey.

Table 3.2: Validity test

Validity Sort										
Item	Loading									Communality (Common Variance)
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	
2.1 Noise interferes with students' learning.	0.119	0.027	-0.025	0.736	0.105	0.145	0.170	-0.214	0.128	0.680
2.2 Classroom noise affects all Phd of particular concern for students with hearing loss or attention deficits.	0.197	0.069	-0.118	0.705	0.172	0.114	0.116	0.012	0.273	0.685

2.3 Poor air quality contributes to absenteeism, especially among students with asthma.	0.154	0.148	0.064	0.796	-0.080	0.099	-0.021	0.041	-0.154	0.725
2.4 Poor air quality contributes to lethargy, dry skin, and headaches.	0.021	0.237	0.100	0.792	0.035	-0.084	-0.066	0.200	-0.090	0.754
2.5 Natural lighting boosts the morale of teachers and students.	-0.073	0.117	0.218	0.477	0.096	0.068	0.090	0.582	0.200	0.695
2.6 Lack of sufficient light can increase absences and decrease student achievement.	-0.141	0.084	0.335	0.657	-0.036	0.099	0.052	0.146	0.024	0.606
2.7 Temperatures that are too hot or too cold compromise the performance of students.	-0.033	0.198	0.120	0.481	0.320	0.124	0.106	0.463	-0.146	0.650
3.2 Adequacy of the following extracurricular facilities. [Field]	0.263	0.705	0.238	0.113	-0.046	-0.002	0.000	0.268	0.227	0.760
3.2 Adequacy of the following extracurricular facilities. [E-sports room]	0.115	0.805	0.136	0.117	0.056	0.024	0.078	-0.092	-0.045	0.714
3.2 Adequacy of the following extracurricular facilities. [Music rooms]	0.278	0.670	0.256	0.164	-0.022	0.253	0.203	-0.205	0.029	0.767
3.2 Adequacy of the following extracurricular facilities. [Theatre rooms]	0.212	0.766	0.224	0.236	-0.082	0.144	0.220	-0.075	-0.051	0.822
3.2 Adequacy of the following extracurricular facilities. [Physical sports space]	0.136	0.824	0.042	0.046	0.125	-0.086	-0.050	0.123	0.161	0.767
3.2 Adequacy of the following extracurricular facilities. [Others]	0.338	0.647	0.152	0.152	0.022	0.234	0.105	0.272	-0.060	0.723
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Field]	0.060	0.252	0.650	0.199	0.005	0.075	-0.021	0.229	0.233	0.642
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [E-sports]	0.159	0.135	0.721	-0.027	-0.077	0.081	-0.036	-0.302	-0.269	0.741
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Music rooms]	0.228	0.076	0.847	0.152	0.007	0.059	0.072	0.033	0.123	0.824
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Theatre rooms]	0.200	0.078	0.836	0.088	0.162	-0.035	0.082	-0.120	0.013	0.802

3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Physical sports space]	0.124	0.194	0.784	-0.036	0.011	0.073	0.100	0.230	0.225	0.789
3.4 To what extent do you agree that the following extracurricular facilities have contributed to your academic performance? [Others]	0.446	0.213	0.704	0.046	-0.009	0.037	0.036	0.202	-0.153	0.809
4.1 Are you aware that the campus provides relevant facilities for students with disabilities?	0.421	0.146	-0.112	0.120	-0.080	0.609	0.080	0.254	-0.132	0.691
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Elevators]	0.457	0.118	0.216	0.050	-0.042	0.062	0.095	0.037	0.689	0.763
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible restrooms]	0.593	0.306	0.083	0.117	0.311	0.257	-0.155	-0.032	0.362	0.785
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible pathways]	0.576	0.350	0.262	0.112	0.128	0.182	-0.342	0.041	0.206	0.746
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Barrier-free bus]	0.654	0.367	0.232	0.113	0.108	0.013	-0.370	-0.139	-0.000	0.797
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Accessible parking space]	0.657	0.344	-0.013	0.150	0.253	0.097	-0.131	0.061	0.200	0.707
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Specially equipped learning equipment]	0.662	0.338	0.117	0.019	0.198	0.259	-0.303	-0.163	0.099	0.801
4.2 Based on your observations, how accessible are the following campus facilities for students with disabilities? [Others]	0.619	0.303	0.350	0.026	0.083	0.176	-0.281	-0.023	0.225	0.766
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Elevators]	0.745	0.068	0.211	0.016	-0.041	0.050	0.229	0.199	0.325	0.806
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible restrooms]	0.834	0.061	0.101	0.052	0.256	0.074	0.188	0.028	0.046	0.821

4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible pathways]	0.880	0.174	0.104	-0.044	0.069	0.001	0.042	0.052	0.046	0.829
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Barrier-free bus]	0.878	0.073	0.170	0.034	0.017	-0.015	0.047	-0.083	-0.076	0.821
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Accessible parking space]	0.832	0.108	0.047	0.046	0.071	-0.061	0.097	0.003	0.077	0.732
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Specially equipped learning equipment]	0.873	0.044	0.147	0.117	-0.018	0.182	0.078	-0.096	-0.094	0.857
4.3 In your view, how adequate are the following facilities in supporting students with disabilities? [Others]	0.855	0.132	0.164	0.008	0.017	0.248	0.129	0.047	-0.001	0.856
4.4 To what extent do you agree that improvements to facilities on campus have a positive impact on campus life for students with disabilities?	0.182	0.456	0.014	0.124	0.426	0.063	0.068	0.312	-0.213	0.589
4.5 How often do students with disabilities participate in extracurricular activities?	0.070	0.116	0.139	0.189	0.065	0.710	-0.005	-0.294	0.039	0.670
4.6 To what extent do you agree that students with disabilities can be integrated into campus life?	0.221	-0.045	0.137	-0.013	0.694	0.212	0.106	-0.015	0.020	0.609
4.7 To what extent do you agree with the campus's acceptance of students with disabilities?	0.150	0.031	-0.081	0.092	0.775	-0.087	0.186	0.040	0.037	0.684
5.1 To what extent do you think the campus network is fast and secure ?	0.142	0.035	0.086	0.079	0.077	0.748	-0.030	0.174	0.093	0.640
5.4 To what extent do you approve of the availability and quality of your digital library?	0.228	0.113	0.239	0.081	0.111	0.229	0.570	-0.090	0.236	0.582
5.6 To what extent do you agree that teams, Google Meetings and Canvas facilitate your learning?	0.140	0.213	0.031	0.111	0.402	-0.168	0.623	0.104	-0.028	0.668
5.7 To what extent do you agree that digital infrastructure facilitates your learning?	-0.083	0.235	0.124	0.228	0.398	0.006	0.597	0.123	-0.047	0.661
Eigenvalue (Unrotated)	13.640	4.404	3.073	2.304	2.165	1.526	1.376	1.229	1.121	-

Explained Variance (Unrotated)	32.475%	10.485%	7.316%	5.486%	5.156%	3.633%	3.277%	2.925%	2.668%	-
Cumulative Explained Variance (Unrotated)	32.475%	42.960%	50.276%	55.762%	60.918%	64.551%	67.828%	70.753%	73.421%	-
Eigenvalue (Rotated)	8.714	4.721	4.485	3.636	2.151	2.140	1.928	1.561	1.499	-
Explained Variance (Rotated)	20.747%	11.241%	10.679%	8.657%	5.122%	5.096%	4.591%	3.717%	3.570%	-
Cumulative Explained Variance (Rotated)	20.747%	31.988%	42.667%	51.324%	56.446%	61.543%	66.134%	69.851%	73.421%	-
KMO	0.823									-
Bartlett's Test of Sphericity	3303.881									-
df	861									-
p Value	0.000									-

Note: Blue numbers represent absolute loadings greater than 0.4, while red numbers indicate communalities less than 0.4.

Table 3.2 shows the validity test result using KMO and Bartlett's test for validity verification. From the above table, we can see that the KMO value is 0.823, the KMO value is more than 0.8, the research data is very suitable for extracting the information, and the validity is good from the side.

Data Analysis Techniques

Data from the field was tabulated, coded, and entered into the Statistical Package for Social Science (SPSS). This software facilitated the data analysis process. According to Orodho (2004), descriptive statistics involved tabulating, graphing, and describing data from a population sample. The research used descriptive statistics like frequency tables, bar graphs, and percentages. Qualitative data was analyzed using content analysis techniques. Findings were presented through frequency tables, percentages, pie charts, bar graphs, and other means.

DATA ANALYSIS AND DISCUSSION

Data analysis and reporting of findings were done in the form of tables, frequency distribution, percentages, bar charts, and pie charts. The purpose of this study was to investigate the impact of infrastructure on the performance of UKM students.

The results of the study are discussed in the following areas: the following themes derived from the research questions and demographic information of the students. The study had four objectives to determine the effect of physical factors of sound, light, temperature, and air on student performance. To analyze the impact of the adequacy of extracurricular facilities on students. To determine the impact of campus disability facilities on students. To determine the extent of the impact of electronic infrastructure on student performance.

Demographic Characteristics for the Students

The study explored the demographic background of the students. These backgrounds include gender, age, ethnicity, education level, first year on campus, and personal CGPA. Because students from different backgrounds may have different views and opinions about campus infrastructure, it is more beneficial to the accuracy of the study to cover all ranges of students in this way.

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The data was analyzed for respondents from different backgrounds, and the results are shown in Table 4.1 below.

Table 4.1: Basic information of students

Item	Option	Frequency	Percent(%)	Cumulative Percent (%)
1.1 Gender	Female	169	52.32	52.32
	Male	154	47.68	100.00
1.2 Age	18-22	185	57.28	57.28
	23-27	73	22.60	79.88
	28-32	45	13.93	93.81
	33 and above	20	6.19	100.00
1.3 Race	Chinese	111	34.37	34.37
	Indian	42	13.00	47.37
	Malay	146	45.20	92.57
	Others	24	7.43	100.00
1.4 Your education level	PhD	46	14.24	14.24
	Postgraduate	43	13.31	27.55
	Undergraduate	234	72.45	100.00
1.5 Year of Study	Year 1	61	18.89	18.89
	Year 2	102	31.58	50.46
	Year 3	111	34.37	84.83
	Year 4	49	15.17	100.00
1.6 What is your cumulative grade point average (CGPA) value?	3.00-3.66	170	52.63	52.63
	3.67-4.00	113	34.98	87.62
	Below 2.99	40	12.38	100.00
Total		323	100.0	100.0

As can be seen from Table 4.1, there were 323 students in the study, of which 169 (52.32%) were female and 154 (47.68%) were male. The results of the study show that the number of male and female students is approximately the same, thus enabling a representative picture of the campus infrastructure.

In terms of age distribution, the highest number of respondents was 185 (57.28%) aged 18–22 years. This was followed by 73 respondents aged 23-27 (22.60%), 45 respondents aged 28-32 (13.93%) and 20 respondents aged 33 and above (6.19%). This shows that most of the respondents are concentrated in the age group of 18-22 years old.

In terms of ethnicity, Malays were the most prevalent with 146 (45.20%). This was followed by Chinese with 111 (34.37%). Indians totaled 42 (13%). From these figures, it can be seen that ethnic diversity is more conducive to the authenticity of the survey.

In terms of education, there were 46 PhDs, accounting for 14.24% of the respondents. There were 43 (13.31%) postgraduate students. There were 234 (72.45%) undergraduate students. From these data, it can be seen that the overall educational level of the respondents is high.

In terms of the year of study, 61 (18.89%) were in the first year of study. 102 (31.8%) were in the second year of study. In the second year, there were 102 (31.58%). In the third year there were 111 (31.58%).

Campus Environmental Infrastructure

The impact of environmental factors on students is shown in Table 4.2 below.

Table 4.2: The influence of environmental factors on students

Item	Mean	Standard deviation
2.1 Noise interferes with students' learning.	3.861	1.118
2.2 Classroom noise affects all Phd of particular concern for students with hearing loss or attention deficits.	3.619	0.997
2.3 Poor air quality contributes to absenteeism, especially among students with asthma.	3.712	1.016
2.4 Poor air quality contributes to lethargy, dry skin, and headaches.	3.808	1.003
2.5 Natural lighting boosts the morale of teachers and students.	3.988	0.972
2.6 Lack of sufficient light can increase absences and decrease student achievement.	3.650	0.971
2.7 Temperatures that are too hot or too cold compromise the performance of students.	3.954	1.043

From Table 4.2, we can see that in the item "2.1 Noise interferes with students' learning, " the mean is 3.861 and the standard deviation is 1.118. This shows that most respondents believe that noise interferes with students' learning to a certain extent; although the opinions of the respondents are relatively concentrated, there are also some differences.

Secondly, "2.2 Classroom noise affects all students, with special attention to students with hearing loss or inattention." The mean is 3.619 and the standard deviation is 0.997. This shows that most of them agree that classroom noise affects students with hearing loss or inattention, and the opinions of the respondents are relatively consistent.

For "2.3 Poor air quality leads to absenteeism, especially for asthmatic students," the mean is 3.712 and the standard deviation is 1.016. This means that most respondents believe that poor air quality leads to absenteeism,

especially for asthmatic students, although the opinions are relatively concentrated and there are some differences.

"2.4 Poor air quality leads to drowsiness, dry skin, and headaches." The mean is 3.808 and the standard deviation is 1.003. This shows that the respondents generally believe that poor air quality can lead to drowsiness, dry skin and headaches, and the respondents' opinions are highly consistent.

"2.5 Natural lighting can improve the morale of teachers and students." has a mean of 3.988 and a standard deviation of 0.972, which shows that most respondents agree that natural lighting can improve the morale of teachers and students, and the consistency is high.

For "2.6 Insufficient light will lead to increased absenteeism and decreased student grades," the mean is 3.650 and the standard deviation is 0.971, which shows that most respondents agree that insufficient light will lead to low morale. Respondents believe that insufficient light will lead to increased absenteeism and decreased student grades, and the respondents' views are relatively consistent.

For "2.7 Too high or too low temperature will affect students' grades." The mean is 3.954 and the standard deviation is 1.043, indicating that the vast majority of respondents believe that too cold or too hot temperature will affect students' grades. Although most opinions are consistent, there are still some differences.

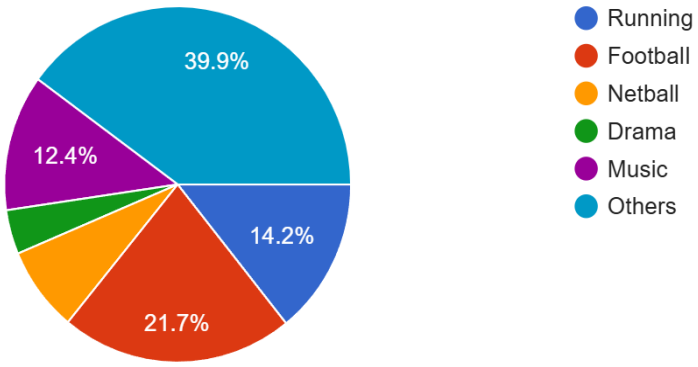
In general, from the perspective of mean, the mean of all indicators is above 3.6, reflecting that the respondents generally believe that these environmental factors have an impact on students and teachers. From the perspective of standard deviation, except for a few indicators, the standard deviation of most indicators is around 1, indicating that the opinions of the respondents are relatively consistent, which also verifies the consensus on the impact of these environmental factors on the educational environment to a certain extent.

Extracurricular Campus Infrastructure

The study aims to collect information on the adequacy of extracurricular infrastructure and conduct relevant analysis.

First, the proportion of students participating in different extracurricular infrastructure projects was investigated.

Figure4.3: The proportion of students participating in extracurricular activities

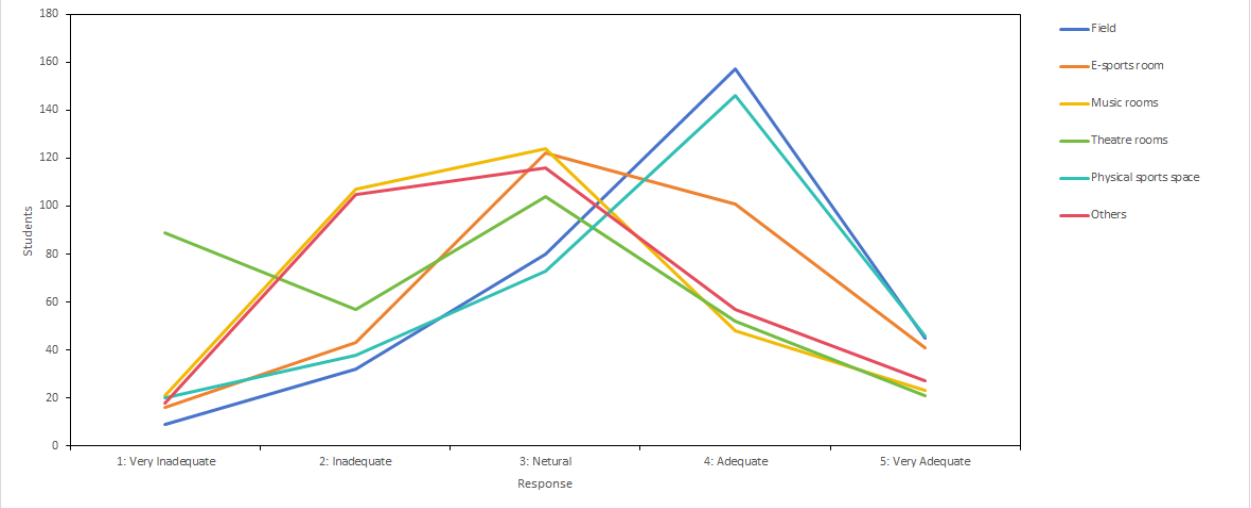


Source: Author

As shown in Figure 4.3, it is found that other categories account for the largest proportion (39.9%), football accounts for 21.7%, indicating that football is relatively popular among students, running accounts for 14.2%, music accounts for 12.4%, netball accounts for 7.7%, and drama accounts for the least (4%), indicating that drama classrooms may have fewer facilities.

We envisioned that differences in the percentage of students participating in extracurricular activities might be due to differences in the adequacy of facilities, so we investigated this.

Figure 4.4: Adequacy of extracurricular facilities

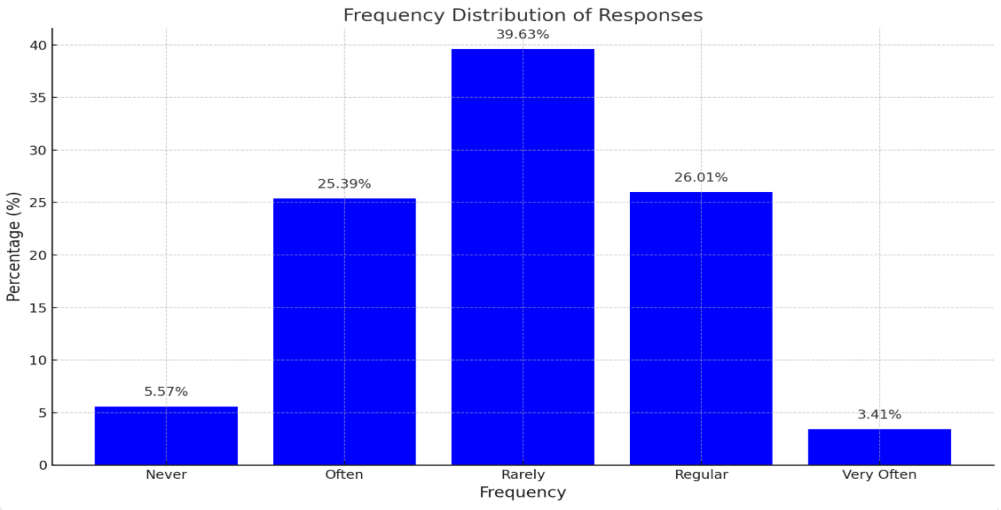


Source: Author

As shown in Figure 4.4 above, it can be observed that about 150 students considered the field and physical sports space as adequate, 122 students considered the E-sports room as moderately adequate, 107 students considered the music room as inadequate, 89 students thought the theater classroom as very insufficient, and for the other facilities that were not enumerated, 116 students considered them as moderately adequate.

The frequency of participation in extracurricular activities collected in this research question is shown in the figure below.

Figure 4.5: Frequency of participation in extracurricular activities



Source: Author

From figure 4.5, It was found that 128 (39.6%) students rarely participated in extracurricular activities, 84 (26%) students participated regularly, and 82 (25.4%) students participated frequently. 18 (5.6%) students never participated in activities, and 11 (3.4%) students participated frequently. This reflects that the students are not very active in extracurricular activities, probably due to the limitation of time and resources.

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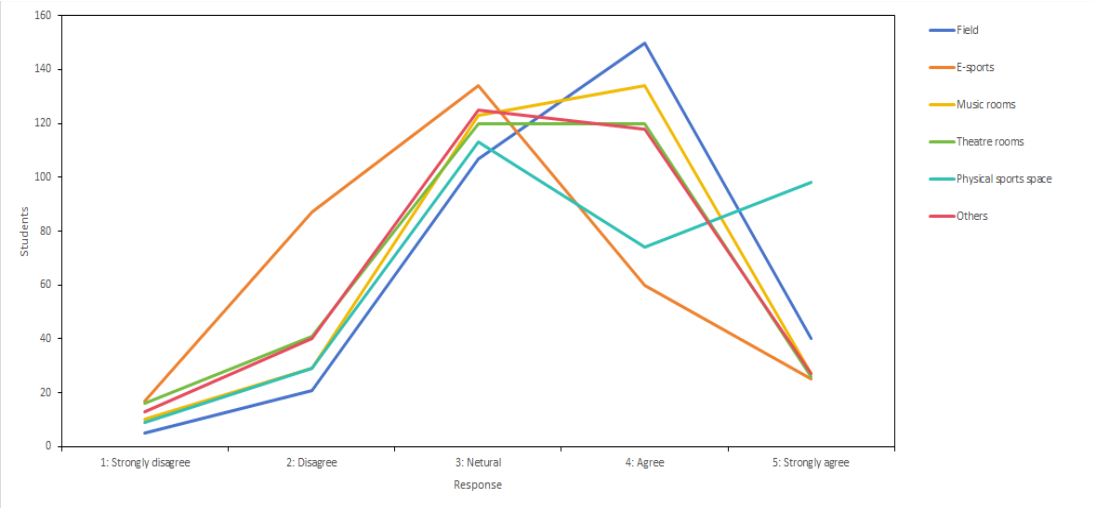
Research suggests that moderate engagement in extracurricular activities can help improve academic performance, so different activities may have different levels of impact. We surveyed students.

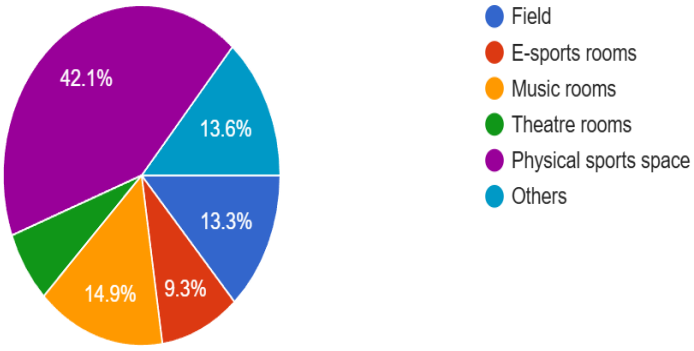
Figure 4.6: Impact of extracurricular facilities on academic performance



Source: Author

According to Figure 4.6, it was found that close to half of the students agreed that fields help their academics, 134 students thought that the music room helped improve their personal performance, 134 students were neutral about the e-sports room, for the theatre room, 120 students each were neutral and supportive, 98 students strongly agreed that a physical sports space for sports helped improve their personal performance, and for the other facilities, more students remained neutral. Based on these findings, the adequacy of facilities was also correlated with student performance.

Figure 4.7: Infrastructure enhances student performance



Source: Author

As can be seen in Figure 4.7, 136 students (42.1%) felt that the physical sports space had a significant impact on their performance enhancement, 43 students (13.3%) felt that the fields helped them in their studies, 48 students (14.9%) were interested in music and felt that the music room helped in relaxation and stimulated creativity, and a smaller percentage of the students felt that the e-sports room enhanced their performance with only 30 students (9.3%), and 22 students (6.8%) thought that the theatre room helped enhance learning.

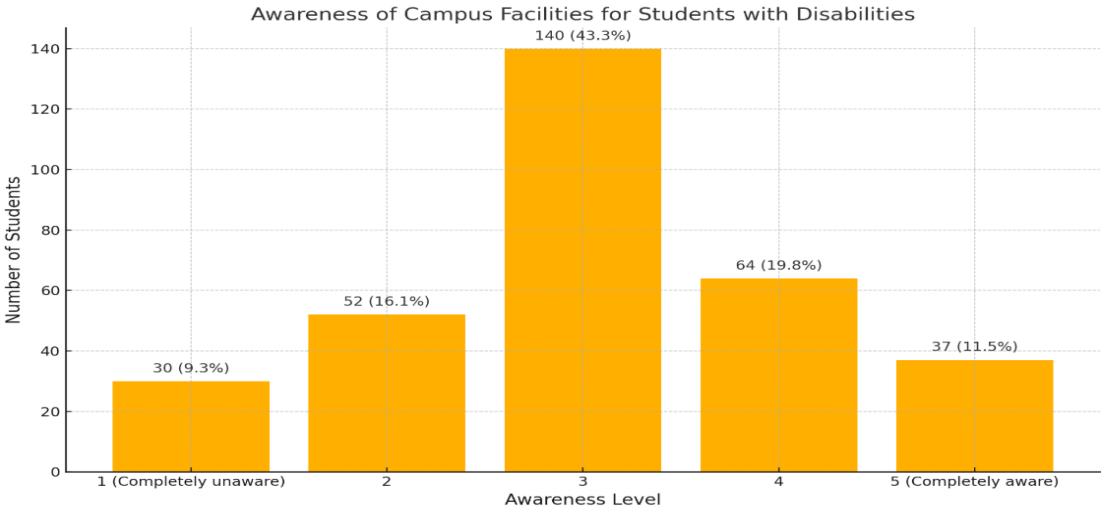
Campus disability infrastructure

The purpose of this study is to ensure that students with disabilities are able to participate in school activities on an equal basis and enjoy the same educational resources and opportunities as other students, as well as to

understand that the school environment is safe and accessible for students with disabilities to promote their physical and mental health and to make improvements for further facility upgrades.

So let's start by tallying up the level of subconscious concern about disability facilities.

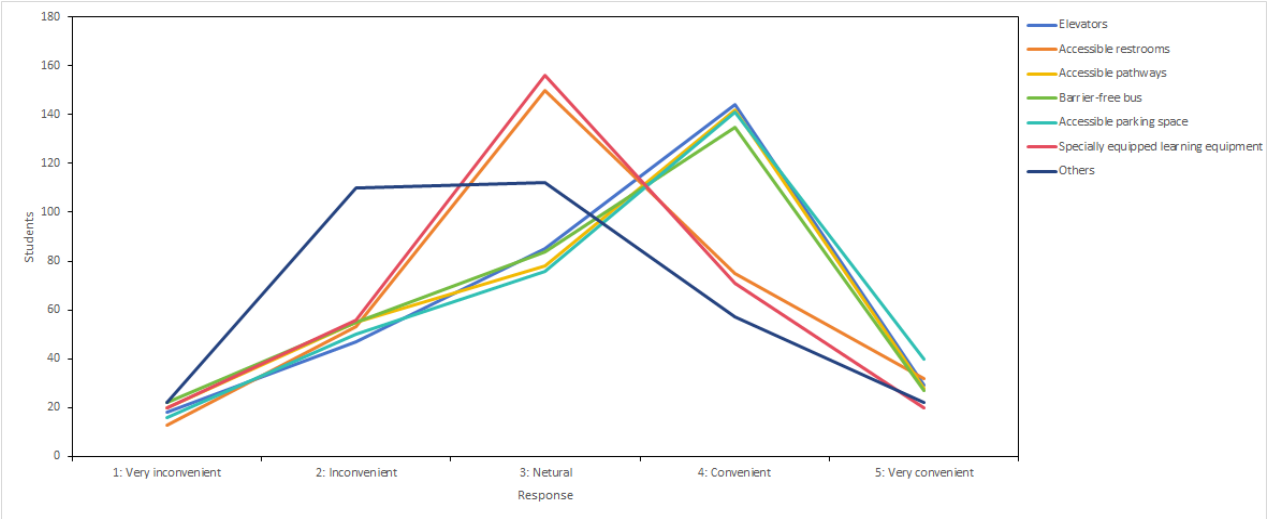
Figure 4.8: Awareness of campus facilities for students with disabilities



Source: Author

Figure 4.8 illustrates students' awareness of campus facilities designed for people with disabilities. The data shows that while a large percentage of students (74.6%) demonstrated moderate to high awareness (levels 3, 4, and 5), the largest single group (43.3%) reported only moderate understanding (level 3). This suggests that while awareness exists, it lacks depth for many. Conversely, a significant 25.4% of respondents (Levels 1 and 2) had low levels of awareness, highlighting a gap in effective communication or outreach by these facilities.

Figure 4.9: The accessibility of the campus's disability facilities to students

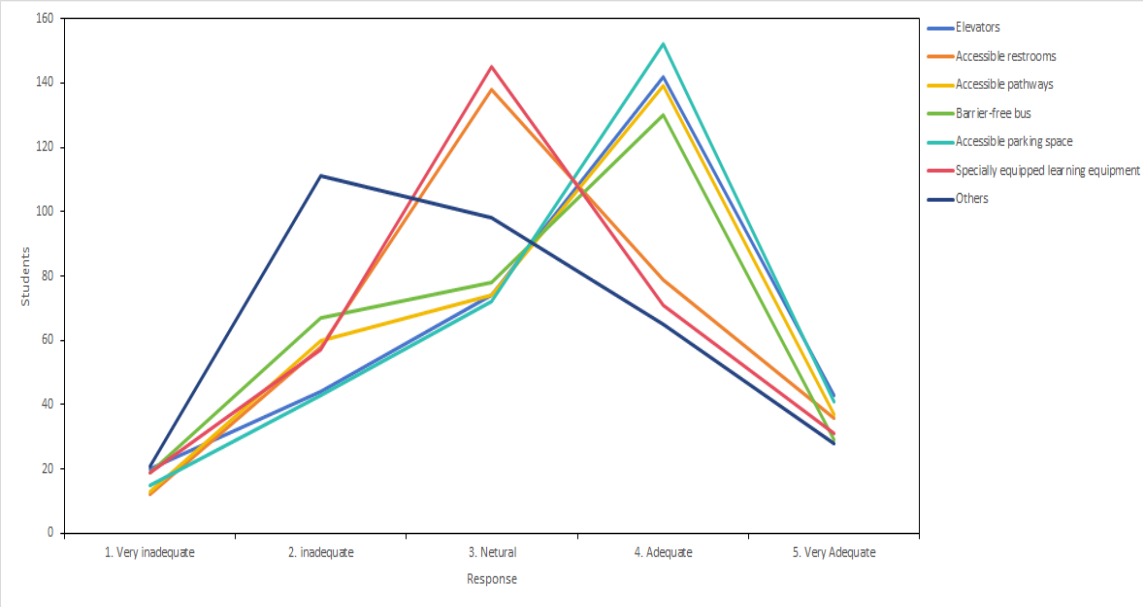


Source: Author

Figure 4.9 investigates the level of accessibility of the school's disability facilities, and based on this line graph, we find that three facilities are accessible: elevators, accessible pathways, accessible parking spaces, and barrier-free buses. There were 150 students who were neutral about the accessibility of the accessible restrooms, 156 students were neutral about the accessibility of the special equipmented learning equipment, and for the other equipment surveyed, there was a small difference between the number of people who were neutral and those who thought they disagreed.

Then, in order to understand the adequacy of these facilities, we conducted a survey on this.

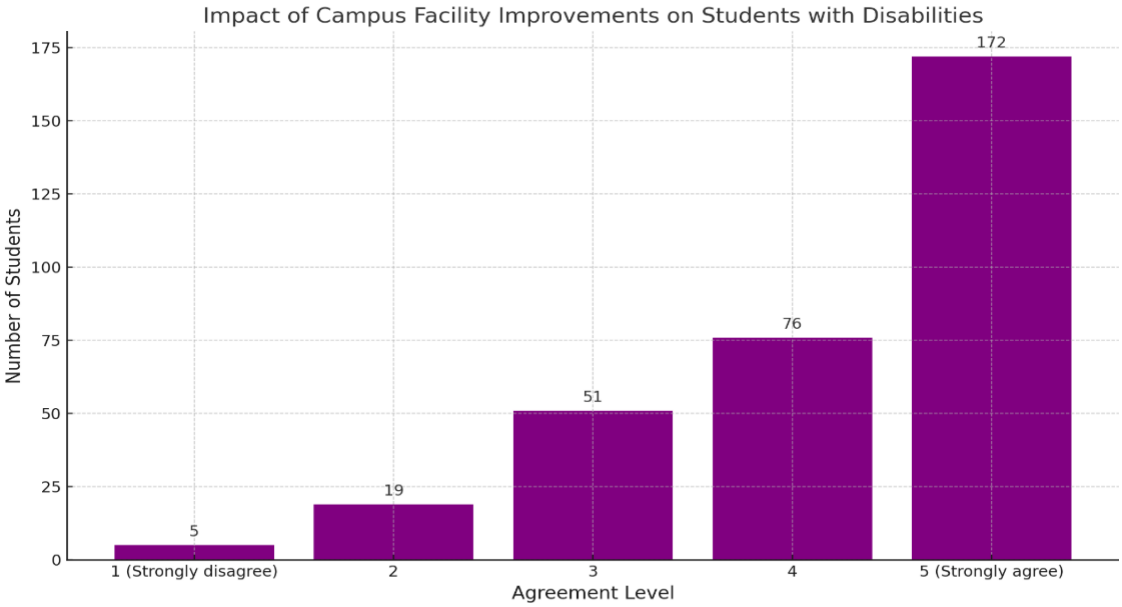
Figure 4.10: Adequacy of disability facilities



Source: Author

As shown in Figure 4.10 above, on the Disability Facilities Adequacy Survey, the majority of students indicated adequacy in the four areas of elevators, accessible pathways, barrier-free buses, and accessible parking space; however, the majority of students were neutral on the two areas of accessible restrooms and special learning equipment, and more students indicated inadequacy for other equipment not listed.

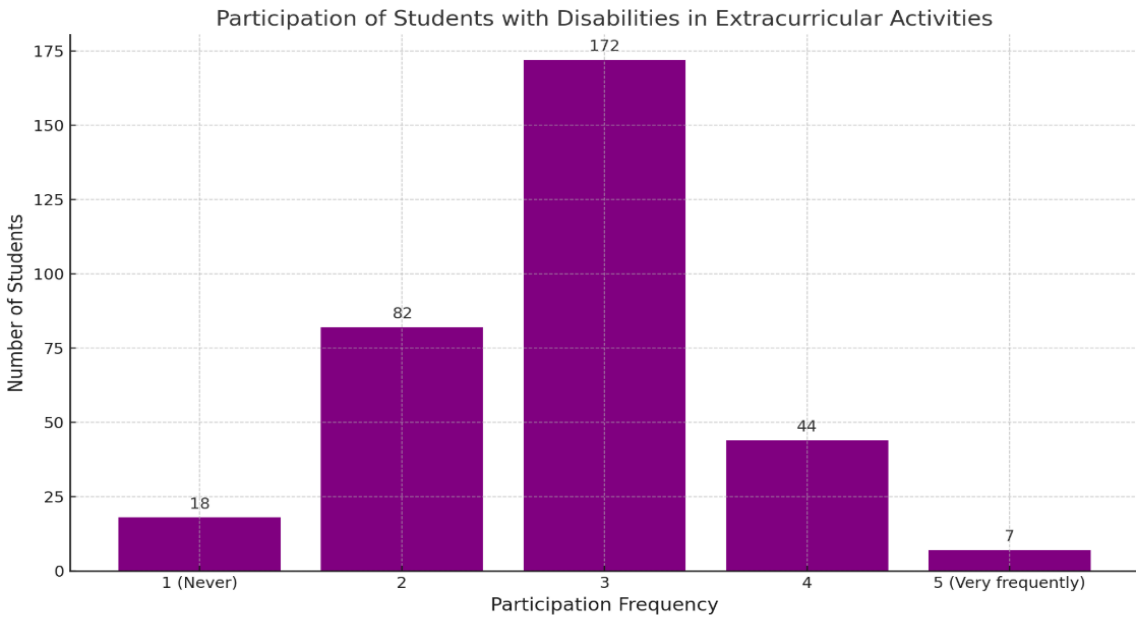
Figure 4.11: Impact of campus facility improvements on students with disabilities



Source: Author

From Figure 4.11, it can be observed that the vast majority of respondents (53.3% selected a score of 5) believe that improvements to campus facilities have a positive impact on the campus life of students with disabilities. This suggests that infrastructure improvements on campus play a key role in enhancing the campus experience for students with disabilities.

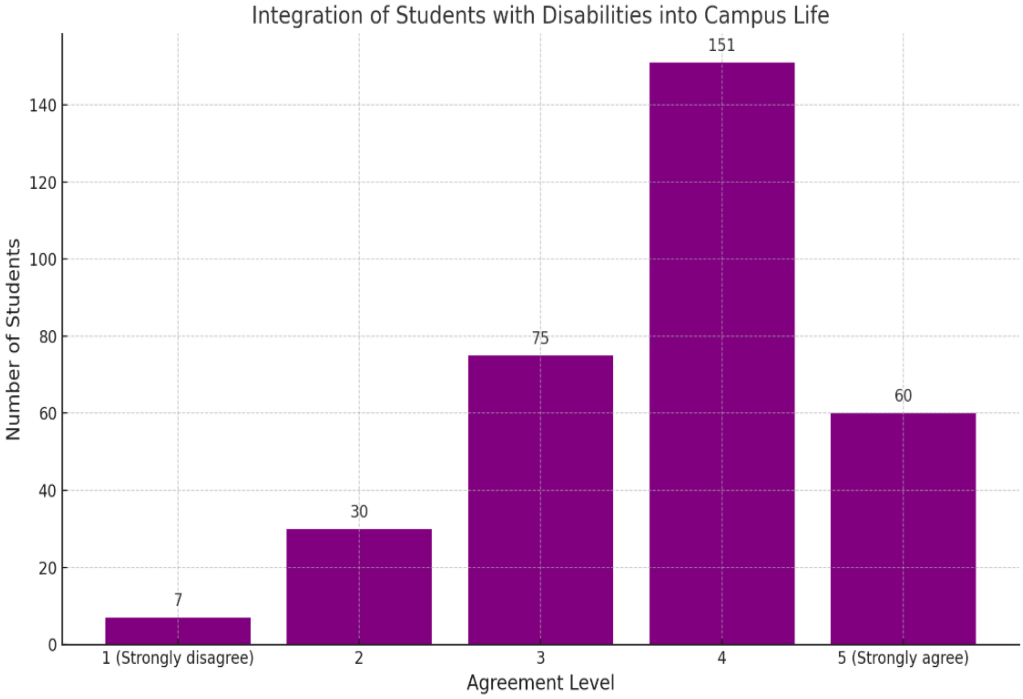
Figure 4.12: Participation of students with disabilities extracurricular activities



Source: Author

From Figure 4.12, a larger percentage of respondents (53.3% selected a score of 3) indicated that students with disabilities occasionally participate in extracurricular activities. This reflects limitations in the accessibility of extracurricular activities or the willingness of students with disabilities to participate.

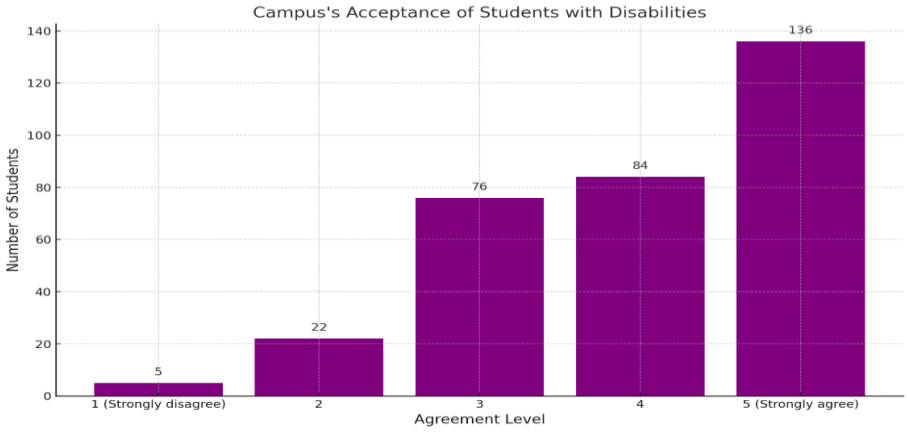
Figure 4.13: Integration of students with disabilities into campus life



Source: Author

From Figure 4.13, the majority of respondents (46.7%) selected a score of 4 and believed that students with disabilities are well integrated into campus life, but a certain percentage (18.6%) selected a score of 5 and had reservations, indicating that there is still room for improvement in terms of full integration.

Figure 4.14: Campus's acceptance of students with disabilities



Source: Author

From Figure 4.14, a relative majority of respondents (42.1% selected a score of 5) felt that the campus was very accepting of students with disabilities. This indicates that the majority believe the campus environment is supportive and inclusive of students with disabilities.

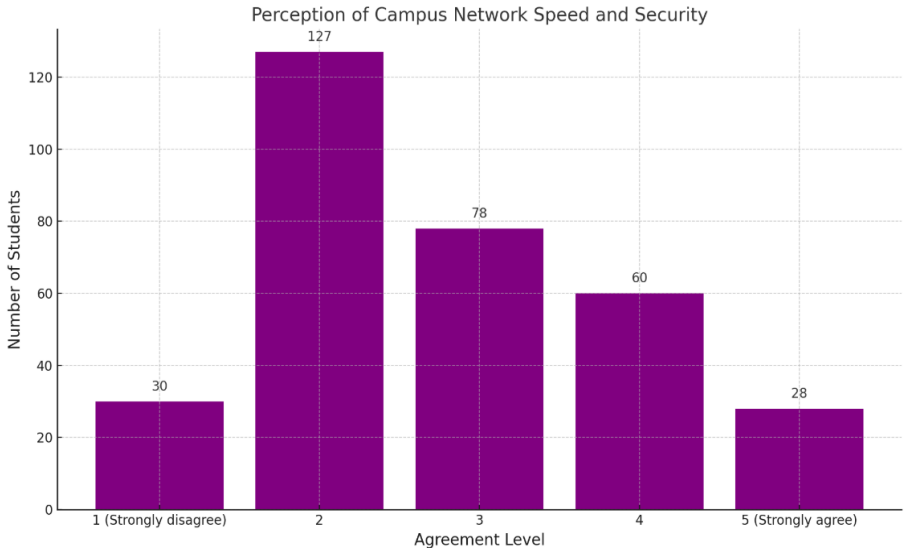
Overall, these data show that the majority of respondents believe that campuses are relatively friendly to students with disabilities, although there may still be some challenges to full inclusion and participation. These insights may provide a basis for further improving campus facilities and enhancing the participation of students with disabilities.

Digital infrastructures

The focus of this survey section was to assess the impact of digital facilities on student performance on campus. Survey data includes student perceptions of internet speed and security, frequency of connectivity issues, use of digital library resources, recognition of the quality of the digital library, frequency of use of digital conferencing platforms (e.g., Teams, Google Meetings, or Canvas), and extent of use of digital library resources. These tools aid in learning. In addition, it assesses the overall impact of digital infrastructure on learning.

First, we investigate the speed and safety of the campus network.

Figure 4.15: Perception of campus network speed and security



Source: Author

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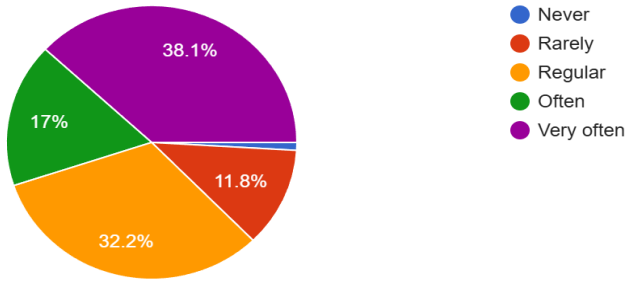
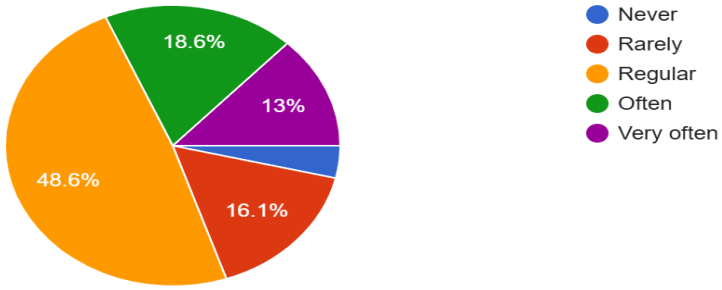
According to Figure 4.15, 127 of these students (39.3%) indicated that the internet speed was bad and the internet security was poor, while 30 students (9.3%) agreed to an even greater extent, indicating that the quality of the school's internet could be improved.

Figure 4.16: The frequency of network problems



Source: Author

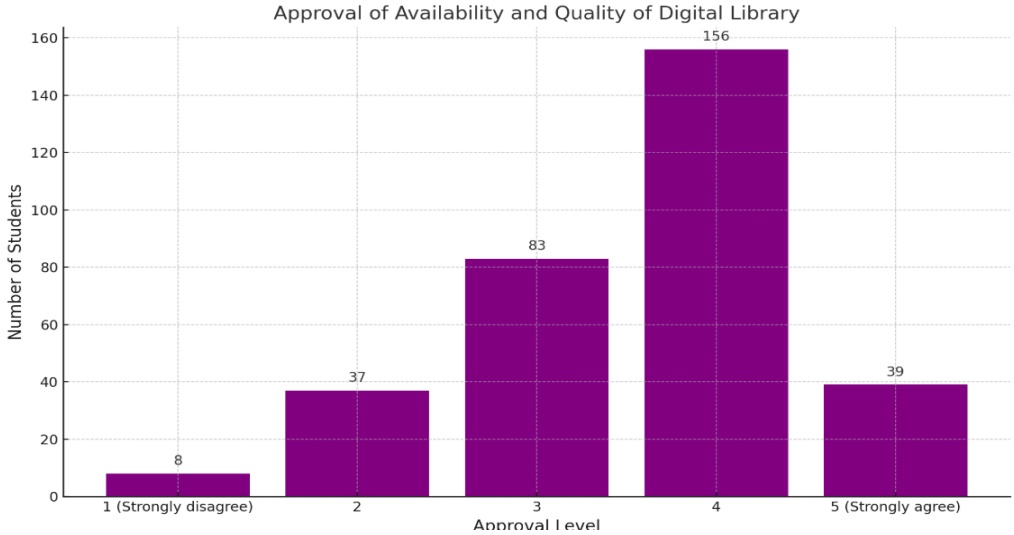
Figure 4.17: Digital library resources frequency



Source: Author

From Figures 4.16 and 4.17, it can be concluded that more than the average number of students perceived frequent problems with Internet connectivity, but in their daily studies, students usually use digital libraries on a regular basis, which makes this issue of Internet connectivity particularly important.

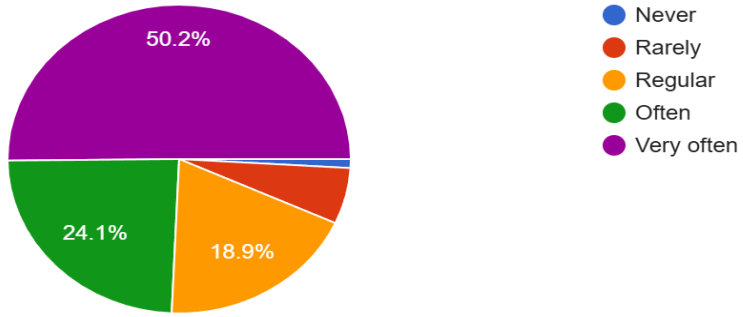
Figure 4.18: Approval of availability and quality of digital library



Source: Author

The majority (48.3% rated 4 and 25.7% rated 3) approve of the availability and quality of the digital library, indicating satisfaction with these resources. This suggests that the digital library meets the needs of most students effectively. A smaller group expressed dissatisfaction (11.5% rated 2 and 2.5% rated 1). This could indicate specific issues or unmet needs among a segment of the student population.

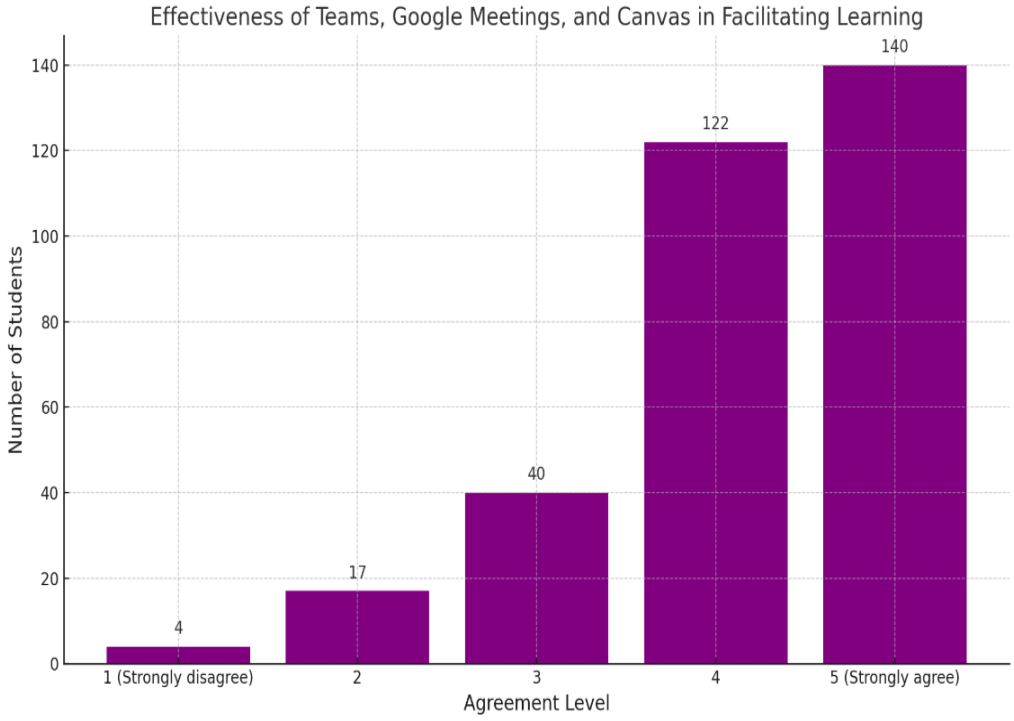
Figure 4.19: Frequency of digital app use



Source: Author

Over two-thirds of the students use these platforms regularly (50.2%) or very often (18.9%), highlighting their critical role in daily academic activities. A smaller fraction use these tools rarely (24.1%) or never (6.8%), which might suggest either a preference for other methods of communication and learning or less engagement with remote or blended learning modalities.

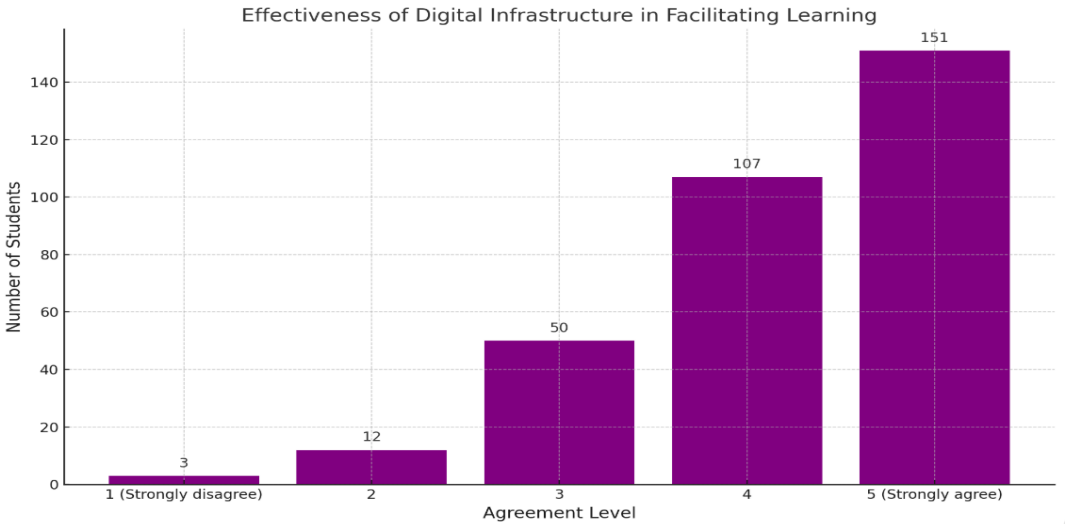
Figure 4.20: Effectiveness of teams, google meetings, and canvas in facilitating learning



Source: Author

A substantial majority find that Teams, Google Meetings, and Canvas facilitate their learning (37.8% rated 4 and 43.3% rated 5), emphasizing the effectiveness of these tools in enhancing educational outcomes. Fewer students are neutral (12.4% rated 3) or disagree (5.3% rated 2 and 1.2% rated 1) with the statement, indicating that while the majority benefit, there is a minority for whom these tools may not be as effective.

Figure 4.21: Effectiveness of digital infrastructure in facilitating learning



Source: Author

The majority of students agree that digital infrastructure facilitates their learning, with 46.7% strongly agreeing (rated 5) and 33.1% agreeing (rated 4). This strong endorsement underscores the importance of robust digital infrastructure in supporting educational activities. A smaller number of students feel neutral or dissatisfied with the support provided by the digital infrastructure (15.5% rated 3, 3.7% rated 2, and 0.9% rated 1), suggesting areas where improvements could be made.

CONCLUSION

This study systematically examined the influence of campus infrastructure on students' performance at Universiti Kebangsaan Malaysia (UKM), focusing on environmental factors, extracurricular facilities, disability infrastructure, and digital facilities. By analyzing survey responses from 323 students across diverse demographic backgrounds, the findings provide comprehensive insights into how various aspects of campus infrastructure affect academic outcomes, participation, and overall student satisfaction.

In terms of campus environmental infrastructure, the mean values of all related indicators were above 3.6, indicating that students generally perceived environmental factors such as noise, air quality, lighting, and temperature to have an impact on their learning and teaching experiences. The relatively small standard deviations suggested a certain degree of consensus among respondents. Noise was considered a significant interference, especially for students with hearing impairments or attention deficits. Poor air quality was associated with absenteeism and physical discomfort, while natural lighting was believed to boost morale. Inadequate light and extreme temperatures were also thought to negatively affect student achievement.

Regarding extracurricular campus infrastructure, football was relatively popular among students, while drama participation was low, possibly due to facility limitations. The adequacy of different facilities varied, with fields and sports spaces being rated more highly than music rooms and drama classrooms. Students' participation in extracurricular activities was not highly active, but those who moderately engaged tended to have better academic performance. The adequacy of facilities was positively correlated with their perceived impact on performance, with physical activity spaces having the most significant influence.

For campus disability infrastructure, although 74.6% of students had moderate to high awareness of disability facilities, a significant portion lacked in-depth understanding. Elevators, accessible pathways, accessible parking spaces, and barrier-free buses were relatively accessible, while accessible restrooms and special learning equipment received more neutral ratings. The majority of students believed that improvements to campus facilities would benefit students with disabilities, and most thought the campus was accepting of them. However, there were still challenges in fully integrating disabled students into campus life and extracurricular activities.

In the digital infrastructure aspect, a considerable number of students were dissatisfied with the campus network speed and security, despite regularly using digital libraries. The digital library received relatively high approval for its availability and quality. Digital conferencing platforms were widely used and considered effective in facilitating learning. Overall, students generally agreed that digital infrastructure played a positive role in their learning, although there was room for improvement.

In conclusion, campus infrastructure at Universiti Kebangsaan Malaysia has a multi-faceted impact on students' performance. To enhance the educational experience and outcomes, efforts should be made to optimize environmental conditions, improve and balance the distribution of extracurricular facilities, enhance disability infrastructure, and upgrade digital infrastructure. Future research could explore the long-term effects and potential interactions among different types of infrastructure.

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