Learning Environments and Educational Outcomes: The Role of Campus Infrastructure in Student Performance in Higher Education

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Abstract

The infrastructure of a university extends beyond a mere teaching environment; it significantly influences students' daily experiences, well-being, and motivation to participate in productive study activities. This study analyzes how infrastructure components such as computer laboratories, libraries, cafeterias, sports facilities, social events, transportation, and the hygiene of clinics affect academic achievement, a growing concern as schools struggle to meet learning objectives with limited resources and different student needs. The research

utilized Structural Equation Modeling (SEM) to analyze the direct and indirect relationships between students' perceptions of infrastructure quality and their academic performance in higher education. One hundred twenty students from two distinct campuses on different colleges have completed a web-based questionnaire. According to the SEM, libraries, sports, food, transportation, and medical facilities contribute to academic success and student performance. Blending social and technical resources for academic usage is crucial. Furthermore, for the future work multigroup tests, and longitudinal replication should concentrate on the model, while it is essential to address abnormalities in computer-lab reporting.

Key Words

Learning environment, Academic Performance, Higher Education, Egypt

الملخص :

تتجاوز البنية التحتية للجامعة مجرد بيئة تعليمية؛ فهي تؤثر بشكل كبير على تجارب الطلاب اليومية ورفاهيتهم وتحفيزهم للمشاركة في أنشطة دراسية مثمرة. تُحلل هذه الدراسة كيفية تأثير مكونات البنية التحتية، مثل مختبرات الحاسوب والمكتبات والكافيتريات والمرافق الرياضية والفعاليات الاجتماعية والمواصلات ونظافة العيادات، على التحصيل الدراسي، وهو مصدر قلق متزايد في ظل سعي المدارس جاهدةً لتحقيق أهداف التعلم في ظل محدودية الموارد واختلاف احتياجات الطلاب. استخدم البحث نمذجة المعادلات الهيكلية (SEM) لتحليل العلاقات المباشرة وغير المباشرة بين تصورات الطلاب لجودة

البنية التحتية وأدائهم الأكاديمي في التعليم العالي. أكمل مائة وعشرون طالبًا من حرمين جامعيين مختلفين في كليات مختلفة استبيانًا إلكترونيًا. ووفقًا لنمذجة المعادلات الهيكلية، تُسهم المكتبات والمرافق الرياضية والطعام والمواصلات والمرافق الطبية في النجاح الأكاديمي وأداء الطلاب. يُعد دمج الموارد الاجتماعية والتقنية للاستخدام الأكاديمي أمرًا بالغ الأهمية. علاوة على ذلك، ينبغي أن تركز الاختبارات متعددة المجموعات والتكرار الطولي في العمل المستقبلي على النموذج، مع ضرورة معالجة التشوهات في تقارير مختبرات الحاسوب

الكلمات المفتاحية :

بيئة التعلم، الأداء الأكاديمي، التعليم العالي، مصر

1- Introduction

While the shape and spatial configuration of the school environment is important, it is quite difficult to identify how it impacts the learning process, and often leads to neglect during institutional planning. Daily, students make use of libraries, lecture halls, and even laboratories and other suitable areas on the college grounds. Students undergo a myriad of educational processes and utilize a variety of instructional approaches. The physical campus offers more than just academic convenience; it also provides psychological and motivational tools that stimulate the students' feelings and performance. Schools are blending more modern educational techniques, increasing student recruitment, and expanding criteria for inclusivity and

representation. Educational buildings have transformed from simple construction designs to sophisticated teaching aids.

This research focuses on the relationship between the infrastructure and facilities offered in universities with the scholarly performance of students. This includes the impact of computers and other relevant laboratories, libraries, clinic cleaning standards, social events, and even transportation on the academic performance of students at the university. It looks at the junction of fields by asking a key question: In what ways does a university's infrastructural design influence the academic achievement and engagement levels of students? This approach brings together concepts from educational psychology, architecture, and institutional policy to offer sufficient clarity regarding the utilization of space for pedagogical purposes.

2- Literature Review

The focus on pedagogical and policy approaches in higher education over the years has significantly influenced curriculum design, educator quality, and student motivation. University infrastructure represented in the library, computer lab, sports facilities, social events, cafeteria, transportation, and a medical clinic hygiene, which had been neglected for years in literature, however, it may improve students' performance, motivation, and cognitive engagement while enhancing academic activities. As more complex learning environments has been exist

understanding the impact of infrastructure on student experience and achievement is both necessary and critical as modern educational institutions. Although these elements undoubtedly affect academic achievement, The university's physical and technological infrastructure is a significant yet underexplored factor influencing academic achievement, alongside other elements. Each variable selected in the model will be discussed in the following sections

2.1 Library

Libraries are essential in helping students do better in school in several ways, by providing resources, getting students involved and holding classes. A number of studies have found a positive correlation between library use and student performance. The researchers analyzed the relationship between academic performance, measured by GPA, and undergraduate students' library use to gain insights into this connection; for example, Scoulas, et al. (2024) found that library visits and website usage were the most popular campus involvement activities reported by students. Students with lower GPAs (2.5–2.99) visited libraries least often; those with higher GPAs were more likely to use the library website. The study by Contreras, Delgadillo & Riveros (2019) analyzes how household crowding negatively affects children's academic performance in Latin America and reveals that access to school libraries helps students improve their overall performance,

particularly increasing language scores from 0.072 to 0.091. Kim (2017) looks at student performance in relation to academic library use. Allison (2015) found a higher use of an academic library and an increase in GPA. The study also showed a correlation between library use and student retention. Jager (2014) found that students who performed better academically typically used more library resources. Soria et al. (2014) found freshman students who used the library performed better on exams and kept more than those who did not. Based on Wong (2011), students' cumulative grade point average (GPA) and book debt displayed a positive correlation. according to these findings using academic libraries increases students' access to resources and improve their academic competency, which in turn raises their achievement.

2.2 Computer labs

Since providing access to necessary technological tools, can fostering motivation and engagement, and supporting better academic outcomes through improved learning environments and testing conditions, computer labs are essential in universities. Tien & Fu, 2008, did not directly discuss the impact of computer labs on student performance in Taiwan, However, they examine the digital divide among college students, focusing on two key aspects: computer use and computer knowledge They found a moderate positive effect on students learning outcomes between the proportion of time students spent on academic-related

computer work and computer knowledge, especially software knowledge. Hanaysha et al., 2023, discovered a notable positive influence of ICT on student engagement, which subsequently affect the academic performance. In the meantime, they discussed how the university facilities had a positive impact on student engagement and academic performance. Lopez's 2025 did not address the impact of computer labs on student performance but examined the impact of technological factors, including reliable, internet access and usage of online resources as the study found that access to reliable internet and effective utilization of online resources enhance student success. Also, the study revealed that institutional support, mainly materials and tutoring services access, significantly impacted academic outcomes. Patterson & Patterson (2017) demonstrate how using computers in classrooms affected students' performance, indicated a significant drop in student grades, particularly among males and those with lower performance level. At the same context, Mostafa, & youssef, (2024) discussed the importance of the classroom factors and how it affects student performance.

2.3 Social Events

According to Sahin et al. (2024), in their research which shows that "social events" is one of the five most important subfactors that determine the overall quality of services at colleges. As these activities make the campus more lively and encourage students to get

involved, which improves the student experience and helps them do well in school. Because of this, holding events that make the social environment dynamic develops relationships between people and makes learning easier. But not much is understood about how the "friend effect" works (Kaklauskas et al., 2013). Also, research shows that the socioeconomic position of children from middle-class and upper-class households affects how well they do in school and how successful they will be in the future. These findings agreed with Martin et al. (2020) who demonstrated that several academic benefits might encourage students to make friends and socialize even if they don't directly help with schoolwork. This help can be especially helpful at tough times when students often turn to each other for support and guidance. According to these studies we can conclude that university social events can have a good effect on students' academic success.

2.4 Sports facilities

Current peer-reviewed studies demonstrate a positive correlation between the availability of sports facilities and student academic achievement. A study conducted in Nigeria indicates that educational institutions with better physical facilities generally see higher student achievement (Calustus Ojirika & Oteyi, 2023). Safodien et al. (2025) qualitatively found that campus recreation areas enhanced student athletes' time management and mental health, linking these improvements to

academic success at the tertiary level. According to Nguri in his study (2024), found that teenagers engaging in over 90 minutes of moderate-to-intense physical activity, provided they have access to suitable facilities, demonstrate improved test scores and enhanced cognitive function. Nguri, 2024; Calustus Ojirika & Oteyi, 2023; Safodien et al., 2025) all concur that well-equipped, easily accessible sports environments foster students' academic, psychological, and physical growth, while balancing athletic and academic responsibilities is essential for optimal outcomes.

2.5 Cafeterias

Several studies indicate that enhancing the quality of food, the environment, and the accessibility of school cafeterias significantly impacts kids' academic and cognitive performance. (Marcano-Olivier et al., 2019) demonstrate that a behavioral nudge intervention that rearranged fruits and vegetables in school cafeterias significantly increased healthy eating, hence enhancing memory and focus which lead in order to improve their performance. (Snelling et al., 2024) studies the cafeterias providing structured options, such as fruit and vegetable appetizers, saw an enhancement in both consumption and cognitive preparedness, hence sustaining students' engagement in academic activities. Universal free meal policies (UFSM) increased participation and were consistently associated with improved academic performance, reduced food insecurity, and fewer disciplinary issues (MacFarlane

et al., 2024). The findings indicate a synergistic model: accessible, nutritious meals provided in clean, supportive, and well-structured cafeteria environments enhance dietary quality, alleviate hunger, and maintain students' focus, thereby establishing the cognitive foundation for improved academic performance across diverse student populations.

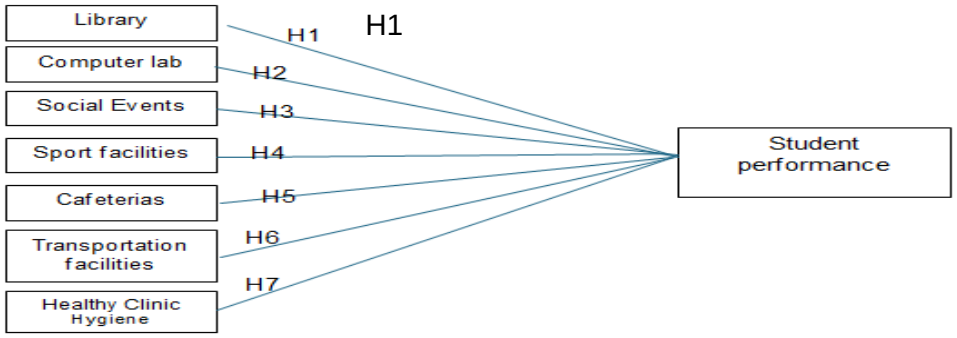
2.6 Transportation Facilities

There is a strong correlation between student academic performance and the availability of transportation, according to recent peer-reviewed studies. According to a systematic study by Lidbe et al. (2022), longer, unpredictable commutes are consistently associated with lower grades and a higher likelihood of dropping out, however transportation can help reach better institutions. Furthermore, Burzacchi et al. (2024) used GPS data to demonstrate that long urban commutes causally lower first-year university GPA through stress mediation and time loss. According to Igwe and Endurance (2025), the University of Abuja's irregular campus transportation caused low academic performance, increased stress, and poor attendance. When taken as a whole, these studies show a distinct theme: while inadequate transit infrastructure impairs performance, dependable, easily accessible, and effective transportation promotes regular attendance, mental health, and academic success.

2.7 Healthy Clinic Hygiene

There have been a number of studies done on this subject in developing countries. Pradhan et al. (2020) found that environmental and personal hygiene initiatives in primary schools made students far more likely to practice good hygiene, which led to fewer illnesses and more interest in school in Pakistan. In Nigeria, meantime, Olowolafe et al. (2020) say that well-run school clinics cut down on absences by 30% and dropouts by 31%, which improves performance by 38% by giving students timely medical care and support. Worldwide research of Pereira (2023) also found that better education about sanitation and hygiene lowers the number of diseases, increases attendance, and improves academic performance, especially for girls. Peer-reviewed studies show a strong link between good clinic hygiene in schools and students doing well in school. The results show that better access to healthcare and stricter hygiene rules in schools lead to better grades, fewer absences, and better health.

3. Research Model



H1 There is a significant relationship between Library and Student performance.

H2 There is a significant relationship between Computer lab and Student performance.

H3 There is a significant relationship between Social Events and Student performance.

H4 There is a significant relationship between Sport facilities and Student performance.

H5 There is a significant relationship between Cafeterias and Student performance.

H6 There is a significant relationship between Transportation facilities and Student performance.

H7 There is a significant relationship between Healthy Clinic Hygiene and Student performance.

This research uses a quantitative research method to measure the factors affecting the student performance. To test these

hypotheses an online questionnaire has been developed and adapted from different questionnaires.

The target population is undergraduate and postgraduate students in one of the international universities working in Egypt. The questionnaire was distributed via the student's portal. A response of 120 students has been received.

Table1: Respondents' Demographic Data

Attribute	Category	Frequency	Percent
Campus	Alexandria	111	92.5%
	Cairo	9	7.5%
College	CMT	55	45.8%
	CLC	2	1.6%
	Computer Science	10	8.3%
	Logistics	49	40.8%
Program	Undergraduate	64	53.3%
	Postgraduate	56	46.6%
Gender	Male	24	20%
	Female	96	80%
Total	Total	120	

The questionnaire consists of university infrastructure questions in addition to the demographic data section. all questions used the five level Likert scales. The options for each question use points from 1 to 5 to represent; strongly disagree,

disagree, neutral, agree, and strongly agree, respectively, demographic data includes campus, college name, program, and gender. SPSS25.0 and AMOS23.0 are the statistical packages used to examine the relationship between the model's variables.

A reliability analysis and factor Analysis have been run on the questionnaire with acceptable values.

4. Data Analysis

In this section the researchers will define the results of the survey, the responses demographic was analyzed which are Campus, college name, program, and gender.

Model fitness in SEM analysis supports the empirical variables validity used for anticipating the fitness model. SEM is also used to measure error level in the model and describes the link among the variables (Baron & Kenny, 1986). Table 2 shows confirmatory factor analysis fit.

Table 1: Confirmatory Factor Analysis Model Fit

Model Fitting Index	Value	Accepted Value
C*hi*-square/df	4.023	<5.0
Comparative fit index (CFI)	0.917	>0.90
Root mean residual (RMR)	0.038	<0.08
Goodness of fit index (GFI)	0.894	>0.90
Adjusted goodness of fit index (AGFI)	0.928	>0.85
Root mean square error of approximation	0.053	<0.08
Standardized means square residual	0.059	<0.08

All variables except social events show significant positive impacts on student performance. The most significant factor is

library facilities (path coefficient = 0.712), followed by health facilities (path coefficient = 0.682). Social events did not show a significant direct effect on student performance, which aligns with previous findings that extracurricular engagement may contribute more to soft skills than GPA.

This outcome partially aligns with earlier studies (Rahmatulloh, 2022; Umar & Ko, 2022; Yusuf et al., 2022; Staccione et al., 2022), where infrastructure-related factors were highlighted as crucial for enhancing academic achievement.

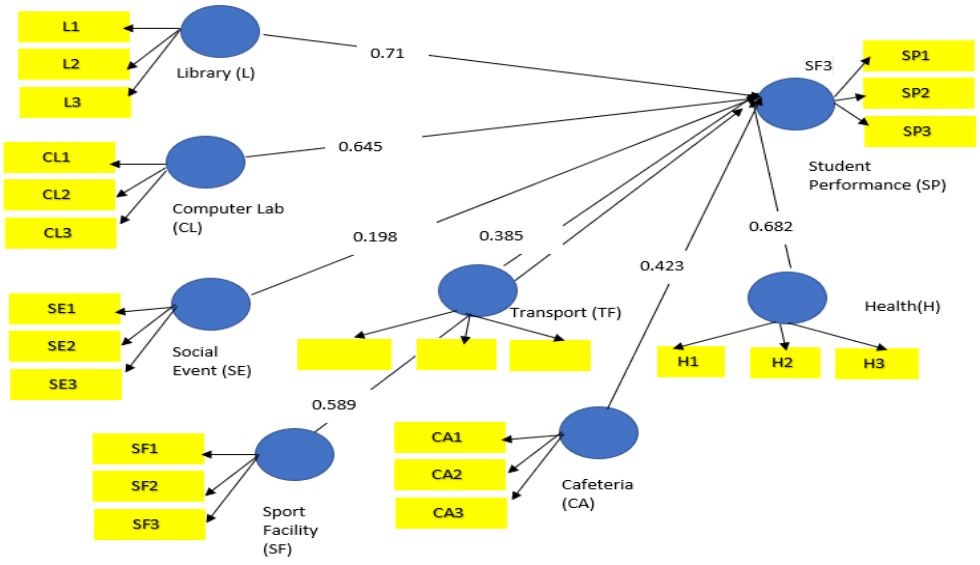


Figure 2: SmartPLS output of the bootstrapping approach

This study investigated how discrete elements of university infrastructure relate to student academic performance (SP). Placing the SEM findings within recent evidence, the model as specified yields a coherent picture in which learning resources, health and wellbeing supports, and basic services explain meaningful variance in SP, while some social or technological amenities show more equivocal effects.

Table 2: Hypothesis Acceptance and Rejection

Hypothesis	Path Coefficient	Significance	Status
H1.1: Library-> SP	0.71	0.000	Accepted
H1.2: Computer Lab-> SP	0.645	0.000	Not accepted
H1.3: Social Event-> SP	0.198	0.261	Not accepted
H1.4: Sport facility->SP	0.589	0.000	Accepted
H1.5: Cafeteria-> SP	0.423	0.000	Accepted
H1.6: Transport facility -> SP	0.387	0.000	Accepted
H1.6: Health -> SP	0.682	0.000	Accepted

The SEM demonstrates generally acceptable fit. The relative chi-square ($\chi^2/df = 4.023$) falls below common cutoffs (≤ 5), indicating acceptable parsimonious fit. CFI = .917 exceeds the conventional .90 threshold, supporting acceptable comparative fit; RMSEA = .053 ($\approx$ .05–.08 range) and SRMR = .059 both indicate modest approximate fit and low residuals; RMR = .038 likewise suggests small absolute residuals. Two indices warrant caution: GFI = .894 sits just below the conventional .90 benchmark (a marginal

miss), whereas AGFI = .928 is comfortably above its more lenient threshold—together these results imply that the model is adequate but that some localized misfit or omitted minor pathways may exist and should be explored in sensitivity checks (e.g., modification indices, cross-validation).

By interpreting hypotheses, it has been found that there are strong, significant positive effects emerged for Library ($\beta = .71$, $p < .001$), Sport Facility ($\beta = .589$, $p < .001$), Cafeteria ($\beta = .423$, $p < .001$), Transport ($\beta = .387$, $p < .001$), and Health ($\beta = .682$, $p < .001$). The library effect is significant and aligns with recent longitudinal evidence that associates library use and access to online licensed resources with elevated semester and cumulative GPAs, especially among students utilizing off-campus access. This suggests both direct educational assistance and implications for equity (Kabo et al., 2024). There are a several ways that sports facilities can help people become more healthier, fitter, and smarter. Recent systematic reviews conducted by Brown et al. (2024) support the findings, indicating a correlation between these variables and enhanced academic performance at the university level. The positive transit coefficient aligns with research demonstrating that shorter, more reliable commutes can elevate student performance by enhancing attendance, sleep quality, and mental well-being (Kaushik et al., 2023). The cafeteria effects demonstrate a correlation among food security, nutrition, and time on task. The results are consistent with what has been found by

Loofbourrow and Scherr (2023) that food systems on campus that help students who don't have enough to eat and encourage them to eat regular meals are linked to better persistence and academic success. The clinic → SP pathway corresponds with longitudinal studies indicating that compromised mental health forecasts subsequent deterioration in academic performance, and that campus health and counseling services can serve as essential protective factors (Chu et al., 2022).

Two noteworthy issues require emphasis. First, the result from the Computer Lab ($\beta = .645$, $p < .001$) seems to be internally inconsistent with the designation "Not accepted." Second issue is Social Event → SP was nonsignificant ($\beta = .198$, $p = .261$). Meta-analytic work on student engagement shows that merely attending social events does not guarantee cognitive engagement or higher grades; the quality, purposiveness, and academic alignment of out-of-class activities determine whether social involvement translates into measurable SP gains (Li & Xue, 2023). Alternatively, multicollinearity or suppression, such as the co-variation of computer lab usage with library or online access, may have led to interpretive ambiguity. Considering the mixed evidence regarding ICT and performance, the effects of digital infrastructure are significantly dependent on pedagogical integration and quality rather than mere availability (Valverde-Berrocoso et al., 2022). Administrators should prioritize robust, well-resourced learning and health services (libraries, health

centers, dining, sports, and reliable transport) as part of student success portfolios. Policy investments should prioritize equitable access through measures such as off-campus e-resource authentication, transit subsidies, and subsidized meal plans, as equity improves the effectiveness of infrastructure (Kabo et al., 2024; Loofbourrow & Scherr, 2023). Integrate sports and wellbeing into student success programs and align ICT investments with pedagogical supports.

5. Limitations and future research.

The model's marginal GFI and the inconsistencies in computer-lab reporting highlight the need for additional model diagnostics, including multigroup tests, VIF assessments, and longitudinal replication.

Future studies should distinguish between usage and presence, such as the frequency and reasons for individuals utilizing the library or computer lab. Additionally, researchers should assess mediation through engagement and well-being, and utilize experimental or quasi-experimental designs to clarify the interconnections.

The SEM provides a conclusive determination: libraries, sports facilities, food accessibility, transportation and medical facilities represent infrastructure that directly supports studying and is strongly correlated with student performance. For

academic purposes, social and technological resources must be carefully combined to work.

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