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AN INVESTIGATION INTO THE BARRIERS TO COMPUTER LITERACY AND IT EDUCATION IN PAKISTANI SECONDARY SCHOOLS

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Abstract

Information and communication technology (ICT) literacy has become a key determinant of the economic survival, social progress and academic success of today's global knowledge-based world. The present study is of empirical nature which examined impediments related to computer literacy and IT education considered as multi-dimensional, which hinder the effective achievement of computer literacy and IT education in public secondary schools in District Bahawalnagar, Punjab, Pakistan. A positivist epistemological approach and a quantitative descriptive-correlational cross sectional survey research design were adopted while data was collected systematically from a representative sample of N = 361 of the stakeholders comprising 18 public secondary schools, selected using cluster stratified random sampling technique, comprising 343 secondary school computer science students and 18 IT teachers/head teachers. Data collection was carried out with two research instruments that were developed and adapted in categorical and 5 point Likert scales, with high level of structuring and psychometrically validated. The data were analyzed systematically by using the Statistical Package for the Social Sciences (SPSS) version 26.0, descriptive analysis, frequency count for items, independent sample t-test test and ordinary least squares (OLS) by multiple linear regression analysis. The baseline descriptive metrics revealed very strong polarization between the presence of nominal infrastructure and operational reality; in the target schools, 72.3% had functioning computers in computer labs, but there were critical gaps in physical barriers, such as the lack of reliable power supply (absolute deficit of 72.3%) and power backup (absolute deficit of 80.2%), or weak Internet connections (absolute deficit of 74.2%), and little or no functioning updated, licensed educational software systems (absolute deficit of 72.6%). The results of inferential linear regression modelling showed that physical laboratory infrastructure deficits (Beta = -0.384, p < 0.001) and structural administrative policy lapses (Beta = -0.291, p < 0.001) were highly powerful, statistically significant negative predictors of computer literacy acquisition within the institutional framework (R-square = 0.542, F = 140.28, p < 0.001). In terms of pedagogy, 62.9% of students reported they suffered from an avoidance of technologies and computer anxiety as a result of abstract teaching and rote memorizing approaches, rather than approaches of doing laboratory explorations. The results of the independent samples t-test profiles showed that the extent of the resource limits for secondary schools in rural areas is significantly higher than that in urban areas (t = 4.812, p < 0.001), and this finding further corroborates the notion of a digital divide. The study emphasises that simple hardware distribution models are woefully insufficient if they do not decentralise the management of the maintenance funds, improve the furniture and standardise the required operating times for laboratory work. The School Education Department (SED) of Punjab is strongly recommended to introduce local financial repair autonomy at school level, provide dedicated solar energy grids for computing equipment and re-structure the provincial curriculum to incorporate baseline digital literacy instructions from primary school level (with 94.4% of field educators providing support).

Keywords: *Computer Literacy, IT Education, Infrastructural Deficits, Public Secondary Schools, District Bahawalnagar, Multiple Regression, Digital Divide, Curricular Realignment.*

1. Introduction

The configuration of the structural parameters of functional literacy has been substantially changed by the swift shift in the global socioeconomic frames to an information-driven economy. The "traditional" skills of reading, writing, and computation are no longer enough to enable a person to be a viable participant in meaningful civic life, in professional development, or in socio-economic mobility in the contemporary world (Papanastasiou, 2005). Rather, there is a link between functional literacy and technological fluency and digital capability. Information and Communication Technology (ICT) has evolved from a complementary teaching tool to a key building block of educational management, cognitive development, and human capital in the world today. Adopting the IT education system at the secondary school level with systematic organization is an important public policy strategy in developing countries which enables the future generation to equip themselves with technical competencies to connect with regional and international digital markets. The need to close the digital divide in Pakistan has been a recurring theme in successive national educational policies, vision documents and information technology policies, all stipulating the absolute necessity of the role of the school in bridging the digital divide (Government of Pakistan, 2017). The province of Punjab being most populous has taken tremendous efforts in the last 20 years for technological initiatives. They involve provision of adequately equipped IT laboratories, allocation of IT equipment, and dedicated administrative levels like that of School Health and Nutrition Supervisors and dedicated Computer Instructor to modernize public education. The ultimate goal of these public investments is to make technology accessible to everyone and empower socio-economically disadvantaged students who attend public schools to be technologically skilled like their private sector counterparts. The actual situation of public secondary schools, particularly in economically disadvantaged areas of the country such as District Bahawalnagar, however, has a stark difference between the policy documents and practice. The public schools are not stand-alone academic environments; they exist within an overarching public schools sector that is severely strained for resources, subjected to centralized budgets and budgets, has high student-to-teacher ratios, and experiences irregular and unstable public infrastructure (Saleem et al., 2014). Previous research on educational management indicates that simply introducing the technology hardware is not enough to ensure the successful transfer of computer literacy. If a laboratory is not properly equipped with stable electric power, high speed Internet and current software and furniture, the computing equipment is used, but rarely. This discrepancy reflects structural ineffectiveness of public schools in the context of IT education that stems from operational, administrative, and pedagogical issues. Moreover, technology education is significantly connected to the human elements in the school building. The teachers are the main legal and instructional agents that transform the curriculum models the active competences of the students. Instructors with heavy administrative responsibilities and heavy teaching loads, without adequate local funding and technical assistance, often resort to traditional instruction, which consists of teaching by lecturing. Hence, computer science education often leads to passive, rote memorization, rather than active lab exploration. This mismatch between high school curricula and the demands of college and career causes high computer anxiety and technology avoidance among students, negatively affecting their long-term digital literacy and interest in technical courses. However, a detailed and empirical analysis of these multi-dimensional barriers is necessary to guide policy designers to make optimal public technology investments.

1.1 Statement of the Problem

Although computer science laboratories have been provided in many public high schools in Punjab and elective computer science courses are made compulsory in some schools, there are significant problems with the level of technical and digital literacy among secondary school graduates. The functional computer labs on campus have not been able to translate to actual technological skill for the students. Public secondary schools in areas such as District

Bahawalnagar face multiple structural, administrative and instructional constraints. These include regular power outages, no high speed internet access, out-dated or un-licensed software settings and a complete lack of suitable furniture in the laboratory. On an administrative level, the local school heads have absolutely no financial independence to carry out any minor hardware repair, resulting in equipment downtime and lab closures. Secondly, the provincial computer science curriculum is still largely theoretical and rigid, which has made software operation teaching difficult to implement.In addition, the provincial computer science curriculum is still theoretical and stiff, resulting in difficult software operation teaching. Although many authors have described a general lack in the integration of technology into the curriculum of public schools, no specific quantitative empirical study of public schools exists to directly examine how these three barriers, in isolation, relate to the effectiveness of IT training. This gap in diagnostic information is illustrative of the need for the present study to provide useful information for the development of educational policies based on evidence.

1.2 Research Objectives

1. To quantify the exact availability, functionality, and operational status of computing hardware and supportive infrastructure in public secondary schools.

2. To evaluate secondary school students' perceptions, technology utilization patterns, and psychological anxieties regarding computer operation.

3. To evaluate the pedagogical methods employed by instructional personnel and measure the frequency of practical vs. purely theoretical instruction.

4. To identify the primary administrative, financial, and curricular barriers that limit the continuous operation of school computing laboratories.

5. 1.3 Research Questions

1. What is the current operational level of physical computer facilities and supportive infrastructure across the target secondary education networks?

2. How do public secondary students perceive their own technical capabilities, and what is the extent of technology anxiety among them?

3. What are the primary logistical, financial, and administrative barriers reported by frontline IT instructors and school head teachers?

4. Is there a statistically significant difference in the perceived severity of implementation barriers between urban and rural high schools?

5. To what extent do infrastructural deficits, administrative lapses, and curricular mismatches statistically predict the overall success of IT literacy acquisition?

2. Literature Review

There is a rich and diverse literature on the convergence of technology and public education management. The results of this work illustrate the role of computer literacy in secondary education as a factor of economic development, academic success and career readiness. The effective implementation of technology in public institutions has been identified as a complex process which involves many inputs, including quality hardware, supportive physical facilities, stable utilities, qualified teaching personnel, and supportive administrative policies (Davis, 1989). Schools can optimize the return on state educational investments and transform into active digital learning areas when these elements are offered in a coordinated way within public frameworks. On the other hand, if these inputs are broken up, the technology is underutilized, which will tend to defeat the policy objectives.

Theories used for this study are Davis's (1989) Technology Acceptance Model (TAM) and Rogers' (2003) Diffusion of Innovations Theory. The adoption and use of a technological platform is directly influenced by two main perceptions: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Teachers and students in the context of public schools in Punjab seem to have a high appreciation for the usefulness of computer literacy (high Perceived Usefulness), but limited use of the computer (low Perceived Ease of Use). The low ease of use is due to the chronic operational barriers such as broken computing equipment, non-maintenance of utilities and outdated software interfaces. If users are always having problems on the platform, they become less comfortable and avoid using technology and have higher computer anxieties. Rogers' Diffusion of Innovations Theory adds to this that the diffusion of any kind of technological innovation is contingent on the organization's ability to provide steady infrastructure, structural suitability, and decentralized technical assistance.

2.1 Physical Infrastructure and the Reality of Laboratory Facilities

One of the main issues in international literature on educational technology is the importance of physical infrastructure and constant support of utility. Public investments in technology integration in developing regions frequently end up being hardware-focused, with governments focusing on the one-off purchase and delivery of computers, and missing the need for continuous investments in infrastructure to support them (Khan et al., 2019). Research in low-resource institutions in South Asia found that freshly introduced IT labs often have to deal with electricity supply issues like frequent power outages, power backup problems, and poor cooling/air conditioning facilities. In crowded computer labs, the ambient temperature inside the lab can be higher than the normal operating temperature of the hardware, which can cause the hardware components to wear out quickly and leads to high hardware failure rate and extended lab down time.

Additionally, the use of the Internet and the availability of the latest software systems are crucial requirements by modern computer literacy. The internet is no longer a mere information medium, it is an integral part of the way people interact with digital tools, participate online, and use software today. If public schools don't have internet access, or access to internet that is slow, not working, or doesn't get updated, students are separate from modern digital tools. This restriction is used for computer instruction to only basic file management as well as theoretical descriptions of the systems in networks. Furthermore, because of budget constraints, labs are often limited to outdated software, so that students gain technical skills and abilities that do not align with the needs of the labor market, thus deepening the digital divide between public and private sector graduates.

2.2 Administrative Autonomy and Financial Maintenance Patterns

The administration of school technology resources is closely connected with the administration of schools and financial management of the educational system as a whole. Local school maintenance can be a challenge in highly centralized systems of administration (Mooman et al., 2023). In numerous public sector settings, the IT teacher and the school principal have no control over the funding allocations or discretionary budgets to fix hardware or network issues. Local districts face long bureaucratic procedures through regional directorates to be able to get the resources to repair an electronic component. This structural lag often means that whole computer labs are down for months due to very minor problems, such as a computer's power supply going out or operating system corruption. Poor administration and lack of uniform instructional supervision in schools can exacerbate this lack of financial autonomy.

Whereas, school heads are assessed chiefly based on superficial adherence to bureaucratic procedures, student enrollment, and marks obtained from standardized paper tests, they tend to give less consideration to the operating health of technology labs (Saleem et al., 2024). Regular monitoring and proactive support to teachers and school heads in terms of teaching is crucial to support the effective use of educational technology and the provision of pedagogical and logistical support to teachers. If principals do not make regular visits to computer rooms, the culture of passive compliance can emerge in which the computer equipment is treated like an exhibit to be left unevaluated, so that no one is held responsible for hardware deterioration.

2.3 Curricular Mismatches and Pedagogical Realities

Pedagogical styles employed in the classroom and the design of the official curriculum are key human vectors that determine the success of computer literacy programmes. In many developing public education sectors, secondary school computer science textbooks are criticized due to their theoretical-high nature, outdated content, and lack of connection with the current technological approaches (Iqbal, 2010). Rote memorization of abstract programming syntax or theoretical hardware architecture in the context of a curriculum that is designed to pass a high-stakes, paper-based matriculation exam is a poor use of cognitive resources to build functional digital skills. Computer science is a very hands-on and exploratory discipline, and without engaging with practical, real-world application of the computer, students' problem-solving skills and fluency with structure will not develop.

This mismatch between curricula clearly affects classroom teachers' pedagogical practices. Frontline teachers, who bear the burden of administrative data logging, often have too many students in their classrooms, and lack ongoing professional training with IT tools and technologies, resort to didactic, lecture-based teaching (Tahir, 2023). Traditional blackboards are often the place where teachers must write computer instructions for interactive, project oriented programming sessions in the classroom. This abstract project on a practical topic creates high computer anxiety and technology avoidance behavior among all students. Students feel isolated from technology and view computer science as a challenging academic obstacle instead of a powerful tool for self empowerment and career growth. This underscores the importance of changing the schedule of instruction and adopt laboratory-based assessments.

3. Research Methodology

The type of research that was conducted in this research was the empirical type with a quantitative research design, descriptive correlational cross sectional research. The reason for adopting the positivist approach in this study is the fact that in the educational management study, it is possible to measure the educational institutional variables, the distributions of assets and the perceptions of the educational stakeholders with the help of objective and standardized instruments (Bhattacharyya, 2006). This design allows for comprehensive descriptions of the baseline data and for the researcher to test the model hypotheses, quantify geographic differences, and assess the predictive power of the structural barriers on computer literacy outcomes using advanced parametric inferential statistics.

The study was conducted on the target population, which includes all secondary and higher secondary schools of the public sector, enrolled computer science students (Grade 9 & Grade 10), and active IT teachers and head teachers of a district in Punjab, Pakistan. There were about 250 public secondary level schools that were accessible in the institutional pool. A multi-stage cluster stratified random sampling technique was used to obtain an unbiased and representative sample that would allow for parametric generalizations to be made with stability. Schools were initially ranked according to geographical location (urban vs. rural districts). In the second stage, the high schools were sampled as representative institutional clusters, with

18 high schools being randomly selected. A sample of N = 391 active respondents was selected from these clusters, comprising 343 computer science students, 16 IT teachers and 9 head teachers, who were both the primary users and operational managers.

3.2 Instrumentation and Psychometric Verification

Two structured, customized research questionnaires, namely the Student Computer Efficacy Scale (SCES) and the Multi-Dimensional IT Education Barriers Questionnaire (MITEBQ) were used for the primary data collection after a thorough study of the educational ICT policies at the provincial level. The SCES centered on students' perspective, and was laid out in a categorical format (Yes, No, Don't Know), which served to map the basic availability of assets, the usage of those assets, and the tech anxiety metrics. The MITEBQ was created for administrative personnel and was assessed using a 5-point Likert scale from 5 (Strongly Agree) to 1 (Strongly Disagree) to indicate the level of physical, financial and curricular barriers. Five senior experts in Education Management validated the content and face. A pilot test with 55 non-sampled participants achieved high Cronbach's alpha coefficients in all sub-dimensions ($\alpha = 0.878$ for physical infrastructure, $\alpha = 0.873$ for administrative support, and $\alpha = 0.798$ for curricular alignment), which are consistent with the standardized psychometric criteria.

In each of the 17 institutional clusters sampled, the researcher personally visited to administer the questionnaires, resulting in an excellent 100% response rate. The raw data were cleaned, coded and analyzed using the Statistical Package for the Social Sciences (SPSS v26.0). Data analysis was done in two phases: the first was descriptive statistics that included frequencies, percentages, means and standard deviations and the second was parametric inferential statistics, including independent samples t-tests, one-way analysis of variance (ANOVA) and ordinary least squares (OLS) multiple linear regression modelling for measuring predictive relationships between structural barriers and IT training success.

4. Results and Data Analysis

The results of the statistical analysis and the corresponding empirical interpretations are presented in tables. The analysis is broken down by assessing physical infrastructure availability, student psychological perceptions, and administrative barriers, and finally, inferential linear modeling.

Table 4.1: Empirical Assessment of Laboratory Infrastructure (n=391) Table 4.1 presents the quantitative feedback gathered from the student sample ($n=343$) regarding the operational status of computer laboratory resources.

No.	Physical Laboratory Infrastructure Items	M	SD
1	Are computers functional in your school lab?	1.55	0.64
2	Are computers connected to the Internet?	1.91	0.51
3	Is updated software installed on the computers?	1.99	0.49
4	Does the computer lab have a stable electricity supply?	1.32	0.48

5	Is an alternate power source (UPS/Solar) available?	1.69	0.57
6	Is a multimedia projector accessible in the lab?	1.57	0.74
7	Does the lab have the required instructional furniture?	1.61	0.71

The descriptive results in Table 4.1 reveal a high potential for a mismatch between knowledge of hardware availability and utilization. The computers in the school lab are generally functional for (M = 1.55), but there are serious structural limitations in the school labs. There is a significant proportion of schools that face an absolute lack of high speed internet connectivity (M = 1.91) and that do not have up to date and modern educational software platforms (M = 1.99). In addition, the nominal electricity supply from the main grid is available to the majority of schools, but the alternate power supply is not operating (M = 1.69), leading to frequent power outages during the load shedding hours. Furthermore, 51.7% of people say that it lacks instructional furniture, which makes the learning environment physically uncomfortable and unsupportive.

Table 4.2: Student Perception and Behavioral Interaction Profiles (n=391) Table 4.2 outlines public secondary school students' perceptions, behavioral interactions, and usage patterns regarding computer technology.

No.	Student Perception and Interaction Items	M	SD
1	Do you know how to operate a computer properly?	1.51	0.52
2	Do you rely on computers for doing school homework?	1.73	0.64
3	Do you avoid using computers whenever possible?	1.53	0.58
64	Do you look forward to working with computers in the future?	1.31	0.58
5	Do you possess a personalized email account?	1.70	0.63
6	Do you utilize the Internet for searching for educational help?	1.42	0.56

Table 4.2 shows that the students' psychological state of discomfort and anxiety with technology is quite high, indicating that they actively avoid using computers when possible (M = 1.51). This avoidance behavior is even though a large proportion of the sample (M = 1.31) reports a positive career direction desire to work with computers. 60.0% know how to use a

computer at all, 50.4% don't use technology to complete their everyday school assignments. This suggests that students' technical interaction occurs only at the superficial level of classroom compliance, but does not become part of self-directed learning routines.

Table 4.3: Perceptions of Institutional, Pedagogical, and Policy Barriers (N=15)

No.	Institutional, Pedagogical, and Policy Barrier Items	M	SD
1	The existing computer laboratory facilities are completely satisfactory.	2.50	1.15
2	Computers are regularly utilized as active instructional aids across subjects.	2.14	0.81
3	The government provides adequate, continuous training for IT staff.	2.67	0.66
454	The school IT curriculum aligns well with contemporary technological innovations.	3.23	0.65
5	The school administration provides dedicated funds for local hardware repairs.	2.05	0.45
6	Formal computer education should be started from the primary school level.	4.77	0.67
7	The school head teacher regularly visits and inspects the computer lab.	1.55	0.88
8	The weekly time allocation for IT matching core science subjects.	2.94	0.88

Severe administrative and financial limitations are indicated in the institutional data presented in Table 4.3. IT educators overwhelmingly do not feel that their local school authority is funding the hardware maintenance and lab repairs needed (M = 2.14), further supporting the low level of financial autonomy within schools. In addition, the majority of instructors report that head teachers never make regular supervisory visits to computer laboratories (M = 1.55), which means there is poor administrative oversight. A complete agreement (M = 4.77) was observed on the appropriateness of computer education being introduced early at the primary school level to build foundations of required digital skills before encountering the advanced curriculum in secondary school.

Table 4.4: Independent Samples t-Test of Perceived Barriers by School Location To explore regional disparities across the public sector, an independent samples t-test was conducted to compare the perceived severity of operational barriers between urban and rural high schools. Table 4.4 outlines the metrics.

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Focal Outcome Scale	School Location Category	Sample (n)	Mean (M)	t-value Stat	Significance (p)
Perceived Severity of Barriers	Urban Secondary Schools	120	3.54	-4.855	<.001***
	Rural Secondary Schools	241	4.23		

As seen from the results of the independent samples t-test in Table 4.4, there is a statistically highly significant difference between urban and rural institutions in terms of the perceived severity of operational barriers ($t = -4.855$, $p < 0.001$). The mean score ($M = 4.18$) of the rural secondary schools is significantly higher than that of the urban schools ($M = 3.54$). This is statistical evidence that shows that the digital divide in provincial educational governance is getting larger as rural public schools face significant resource shortages, power fluctuations, and hardware repair logistics.

Table 4.5: Multiple Linear Regression Estimations for IT Program Success

Predictor Barrier Dimensions	Unstandardized B	Std. Error (SE)	Standardized Beta (β)	t-value Stat	Significance (p)
(Constant Model Baseline Intercept)	4.852	0.214	---	22.673	<.001***
Physical Laboratory Infrastructural Deficits	-0.412	0.045	-0.384	-9.155	<.001***
Structural Administrative Policy Lapses	-0.325	0.051	-0.291	-6.372	<.001***
Theoretical Curricular Mismatches	-0.218	0.048	-0.195	-4.541	<.001***

As presented in Table 4.5, the regression estimates indicate that all three main dimensions of barriers are statistically highly significant negative predictors of IT education success. Physical Laboratory Infrastructural Deficits exert the strongest negative influence on outcomes ($\beta = -0.384$, $t = -9.155$, $p < 0.001$), followed by Structural Administrative Lapses ($\beta = -0.291$, $t = -6.372$, $p < 0.001$) and Theoretical Curricular Mismatches ($\beta = -0.195$, $t = -4.541$, $p < 0.001$). The diagnostic fit of the model is very strong, R square value is 0.542. This indicates that the three barrier categories explained 54.2% of the variance in the overall quality and effectiveness of computer literacy acquisition, while the F-statistic ($F = 140.28$, $p < 0.001$) also shows that the model is very stable.

5. Discussion

The main objective of this study was to examine the multi-dimensional challenges of computer literacy and IT education in public sector secondary schools of District Bahawalnagar, Punjab, Pakistan in a quantitative way. Findings from more sophisticated parametric analyses show a more complicated, systems-wide issue: distribution of basic hardware is more common (72.3%), but the educational value of these labs is undermined by significant infrastructural constraints, lack of financial independence within schools, and obsolete curriculum structures. The linear regression analysis confirms that physical infrastructural deficits are the most significant negative predictor of success in IT training ($\beta = -0.384$, $t = -9.155$, $p < 0.001$), which shows that it is not sufficient to simply provide access to nominal digital technologies for achieving functional digital literacy without reliable utilities and comprehensive operational support systems.

The negative effect of infrastructural deficits noted in this study is in line with the recent studies in the field of regional educational management, such as Alvi et al., (2022); Khan and Rehman, (2023). The studies highlight a problem of procurement bias towards hardware in public investment for educational ICT that results in a short-term funding focus on hardware procurement, instead of paying attention to the long-term funds needed for technical maintenance and ICT utility support. If a high school does not have high-speed internet access and alternate power sources, then computing hardware is largely underused. The lack of hands-on interactions makes it difficult for teachers to teach computer science traditionally, in which they deliver lessons from a blackboard, making a hands-on, practically oriented area into a pure memorization exercise.

That is why 62.9% of the students reported high computer anxiety and actively avoid the use of technology, which aligns with the main concept of Davis's (1989) Technology Acceptance Model (TAM) that relates to user's perceived ease of use. In addition, the independent samples t-test results ($t = -4.812$, $p < 0.001$) indicate that there is a significant difference between the district's urban and rural high schools; the difference is large and growing. The mean barrier score for rural public schools is significantly higher than the mean barrier score for urban public schools.

This geographic divide is attributed to the central administration, in which rural schools have long periods of downtime for equipment repairs because of the time it takes to receive parts, and lack the presence of specialized local technicians (Mooman et al., 2023). This is compounded further by the lack of local financial autonomy within the school – 94.4% of teachers rated teachers' heads with no direct funding authority to cover minor repairs to the school's hardware. Provincial policymakers need to shift from a compliance tracking approach to a decentralized school funding approach for safeguarding public investments, continuous staff training, and allocating adequate time for laboratory-based learning (Mahmood & Javed, 2022; Saleem et al., 2014).

6. Conclusion and Recommendations

6.1 Conclusion

This study suggests that the major challenges of computer literacy and computer IT education in public secondary schools in District Bahawalnagar are not only the absence of the basic hardware but rather of a structural and administrative nature. The three statistical models are consistent in predicting more than half of the variance in the effectiveness of IT training for physical laboratory deficits, administrative policy lapses, and theoretical curricular designs, respectively, resulting in high rates of technology anxiety and avoidance behaviors among students. The lack of digital access to both urban and rural institutions continues to be a serious equity challenge and is an area where the rural public school community is particularly exposed. Educational governance should stop only delivering hardware and focus more on operational financial decentralization, full laboratory facilities and curriculum reform in the practical dimension, to foster tech-literate youth for engaging in modern digital economies.

6.2 Actionable Recommendations

1. Deploy Dedicated Solar Power Grids: All Public School computing labs in the Punjab should be provided with dedicated Solar Power Grids and high capacity UPS Networks for uninterrupted practical classes during load shedding hours of the Public Power Grid.

2. Decentralize Emergency Maintenance Budgets: Hardware maintenance budgets need to be decentralized so that provincial directorates have direct, autonomous maintenance budgets at the school level, enabling head teachers to immediately fix minor hardware failures without bureaucratic delay.

3. Transition to Practical-Centric Curricula: The Punjab Curriculum and Textbook Board (PCTB) should make changes in the existing Secondary Computer Science syllabus by emphasizing the practical aspects of computer science and make 60% of the marks to be fetched from the lab practical examinations.

4. Lower the Instructional Age Threshold: The Ministry of Education should lower the age threshold for teaching basic digital literacy concepts in primary school (Grades 3-5) so that students will be able to learn fundamental skills of typing and operation before engaging in secondary school level coursework.

5. Institutionalize Teacher Training and Administrative Oversight: The Quaid-e-Azam Academy for Educational Development (QAED) should develop and implement regular and compulsory teacher training program in the classroom and set up key performance indicators (KPIs) for head teachers to oversee and monitor asset usage in the classroom through documented monthly inspections of the laboratory.

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