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Aligning ICT Ambitions with Reality: The Impact of Technology on Education in Saudi Arabia

Saad Alaklabi
Information Systems Department, College of Computing and Information Technology, Shaqra University
Email: salaklabi@su.edu.sa

Abstract The application of Information and Communication Technologies (ICTs) in academia is generally classified into three classes: ICTs as supporting tools, ICTs as subjects of study, and ICTs as drivers of transformation. The primary objective of the research was to assess and analyze the state of ICT resources in the Kingdom of Saudi Arabia (KSA) educational institutions. In light of Saudi Arabia's Vision 2030, which prioritizes digital transformation and the integration of technology into education as a foundation for building a knowledge-based economy. This research aimed to explore the objectives that academia had for incorporating ICTs into their teaching, to examine whether institutes possessed the essential ICT infrastructure to achieve these objectives, and to evaluate whether the actual use of ICTs aligned with these stated objectives. Furthermore, this study also sought to identify any discrepancies between private and government schools in their approach to ICT integration. To gather data, we employed a hybrid approach which involve interviews and surveys distributed digitally via email and messaging platforms. The findings revealed that while intermediate schools and a significant number of secondary schools claimed to support transformative or innovative applications of ICTs, the reality was different. Access to laptops, PCs, peripherals such as printers, scanners, projectors etc., and the Internet connectivity for Saudi students was largely adequate. The availability of software was largely confined to basic productivity tools, limiting the scope of ICT use primarily to equipping students with basic computer operational skills. Although private schools were found to be better equipped than public schools, the overall use of ICTs in education remained similarly constrained across both sectors. The research highlighted a gap between the potential transformative goals that some schools professed and the actual, more limited application of ICTs in practice.

***Index Terms*— ICT, Education technology, Schools education, Computers in Education, Saudi schools.**

I. Introduction

The application of information and communication technology (ICT) can be classified into three main classes i.e. ICTs as supporting tools, ICTs as subjects of study, and ICTs as drivers of transformation. ICTs are often used to assist educators in schools, colleges, and universities in traditional methods of teaching in subjects like languages, science, mathematics, business studies, economics, engineering and technology [1], [2], [3]. For example, teachers use digital projectors for presentations and spreadsheets for recording grades, whereas students use word processors for writing reports, and assignments [4], [5]. Computers are mostly used as calculators, grade books and typewriters [6]. Moreover, tutors employ drills and tutorials to enhance students' understanding and competence in a subject [7], [8]. When ICTs are studied as subjects then the primary focus remains on the technology itself. Students study about the history and components of computers, the principles of computer programming, and how to traverse user interfaces in order to gain proficiency in technology [9]. The transformative application of ICTs in education lies in their ability to redefine teaching and learning processes. By integrating ICTs into educational practices, one can optimize learning experiences and enhance the development of essential expertise such as critical thinking, independent and cooperative learning, and problem-solving. ICT integration is continuously shifting paradigm in education from teacher-centered, didactic approaches to student-centered, experiential learning. This shift emphasizes problem-solving, critical thinking, and collaboration. These approaches are interconnected, the most significant transformations in teaching and learning are realized when all three are integrated [10]. Saudi Arabia has actively pursued the integration of ICT into its educational strategies, particularly under the framework of Vision 2030 [11]. Initiatives such as the Tatweer Education Reform Program [12], the Madrasati e-learning platform [13], and the National e-Learning Center [14] have emphasized technology's role in enhancing teaching and learning. Earlier, the Future Gate project [15] introduced smart

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classrooms and digital content, laying the foundation for more advanced integration. Vision 2030 highlights the importance of ICT in preparing students for a knowledge-based economy and equipping them with digital skills. Despite the importance of ICT integration in education, the Saudi school system continues to face challenges, especially in ensuring equitable access to ICT resources. While many urban schools are equipped with smart boards, computer labs, and internet connectivity, some rural schools still experience disparities. Similar to global trends, the rapid integration of ICTs in Saudi education has outpaced the availability of quantitative data on its impact in classrooms. There remain concerns about whether ICT tools are being effectively utilized for transformative learning, as many teachers continue to rely on traditional methods and employ ICT primarily as a supportive tool. While the Ministry of Education has expanded ICT infrastructure, gaps in teacher training, curriculum alignment, and interactive classroom integration persist. This study investigates the integration of ICTs in schools in Saudi Arabia. It aims to approximate educators' ICT goals, assess the availability of ICT resources, evaluate the alignment between resource utilization and goals, and compare ICT integration between public and private schools. ICT applications were categorized as support tools, transformative catalysts or subject matter.

II. RELATED WORKS

In Saudi Arabia, despite the Ministry of Education's large-scale investments under Vision 2030 [11] and programs such as Tatweer [12] and the Madrasati digital platform [13], ICT usage in classrooms often focuses on productivity tools rather than fostering deeper pedagogical innovation [15][22]. Teachers in KSA frequently report using ICT to reinforce existing instructional methods rather than transform them. This pattern, however, is not unique to the Kingdom. When new innovations are introduced in classrooms, many educators tend to adapt them to align with traditional teacher-centered approaches. Research from the U.S [16] shows that most teachers who integrate technology primarily focus on developing students' proficiency in word processing and similar applications. More advanced uses of ICT, such as higher-order reasoning, problem-solving, or critical thinking, remain less common. Instead of reshaping teaching practices, these tools often reinforce conventional methods. As a result, the educational reforms anticipated by policymakers, educators, and parents have not been fully realized, with goals such as improved learning outcomes, teacher productivity, and transformative educational practices remaining elusive. Larry Cuban [17] similarly argues that despite substantial investments in educational technologies, expected outcomes have yet to materialize. Supporting this view, [18] reported that 61% of teachers assigned word processing or spreadsheet-based tasks, while only 50% encouraged problem-solving or data analysis activities. This highlights a common trend where ICTs are employed more for maintaining traditional practices than driving innovation [19] [20]. Although technology has been widely introduced into schools, the anticipated transformation of teaching and learning has often lagged behind, with computers used mainly for routine classroom tasks. For instance, [21] observed that in the U.S., around 71% of teachers occasionally assigned computer-based tasks, but only a third did so regularly, with most usage confined to business, English, vocational, or computer science subjects. Similarly, in many contexts, computers were still used for drills and rote learning, rather than to encourage inquiry or independent learning. In both public and private Saudi schools, students are introduced to computer literacy at an early stage, but the focus remains largely on skill acquisition rather than higher-order applications such as simulations, modeling, or interactive STEM learning. A nationwide study in Saudi schools (e.g., Tatweer evaluation reports) has revealed that while digital platforms like Madrasati were widely adopted during and after the COVID-19 pandemic, much of their use was concentrated on delivering assignments, online lectures, and administrative tasks, with less emphasis on interactive, student-centered learning [23].

[24] explored the shift toward digital education in Saudi schools, examining its influence on student performance, teaching practices, curriculum alignment, infrastructure limitations, software effectiveness, and the viewpoints of educators and specialists. Data were collected from 476 respondents using a structured questionnaire and analyzed through SPSS. The study's distinctiveness stems from its holistic assessment of Saudi Arabia's digital education transition, integrating insights from both teachers and experts. By addressing academic, technical, and experiential challenges, it provides valuable understanding of the multifaceted nature of digital education implementation in the Saudi context. Qualitative research by [25] examines how AI supports emotional recognition, promotes socio-emotional growth, and tackles related challenges within Saudi Arabian schools. Using purposive sampling, 55 early childhood education teachers in Jeddah were interviewed, with data saturation reached after 50 interviews. The findings reveal that AI effectively personalizes learning according to individual needs and learning styles, nurtures empathy and peer interaction among children, and improves classroom management. Key challenges include data privacy, cultural relevance of AI tools, and equitable technology access. The study emphasizes the need for comprehensive teacher training, clear ethical standards, and strong policy frameworks to ensure responsible AI integration in Saudi education.

[26] utilized professional capital theory as a conceptual framework, emphasizing human, social, and decisional capital to examine educators' readiness, collaboration, and instructional decision-making. Results indicated notable contrasts in how school leaders developed their human

capital (HC) and how this subsequently affected social capital (SC) and decisional capital (DC) within both institutions. In the high-achieving school, leaders actively participated in professional growth, mentorship, and joint decision-making, promoting a culture of collective learning (SC). This cooperative setting allowed teachers to share effective teaching practices, thereby enhancing their capacity for evidence-based instructional choices (DC). Conversely, the low-performing school faced frequent leadership changes, causing loss of institutional knowledge and insufficient investment in leaders' human capital. Consequently, teachers encountered difficulties in applying innovative strategies, engaged in limited collaboration, and lacked consistent support. These contrasts underscore how disparities in leaders' human capital shape teachers' ability to implement new teaching methods effectively.

The Ministry's own reviews have also highlighted a persistent gap between ICT potential and its classroom application, particularly in subjects such as science and mathematics, where integration is limited. Similar to findings in other countries [27], ICTs in KSA are often perceived as supplementary supporting information access, assignment submission, and report generation rather than being fully embedded in subject-based pedagogy. This indicates that despite strong policy direction under Vision 2030 and substantial resource allocation, ICT in Saudi classrooms is still more aligned with traditional educational practices than with the transformative goals of digital learning. A stronger focus on teacher training, Arabic-language educational software, and subject-specific ICT integration remains necessary to bridge the gap between policy aspirations and classroom realities.

III. OBJECTIVE

The objectives of this study are given in the following:

1. To map the current state of ICT resources in Saudi intermediate and secondary schools and measure their adequacy for transformative learning.
2. To examine whether the actual use of ICTs aligns with the educational goals envisioned under Vision 2030.
3. To identify discrepancies between public and private schools in ICT integration strategies, infrastructure, and pedagogical application.
4. To highlight the barriers technical, financial, and pedagogical that prevent ICT from serving as a driver of educational transformation.

By connecting policy aspirations to ground realities, this research contributes a novel evaluative framework for assessing the effectiveness and equity of digital transformation in education, offering actionable insights for policymakers and educational planners in Saudi Arabia and other nations undergoing similar digital transitions**.**

IV. METHODOLOGY

We have employed a mixed methods approach to collect data such as Interviews, emails, and on-site visits. A stratified random sampling method was used to select a representative subset of Saudi intermediate and secondary schools, as surveying all schools was impractical. This approach ensured proportional inclusion across key categories school ownership (public/private), educational level (intermediate/secondary), and location (urban/rural) enhancing representativeness and precision over simple random sampling. Stratification minimized bias, enabled comparisons across contexts, and supported the study's mixed-methods design. Weighted statistics, based on student distribution, ensured appropriate influence of larger schools.

A. Population and Sampling

The target population included intermediate and secondary schools in Saudi Arabia, encompassing both public and private sectors. Given the extensive geographic distribution and diversity of institutions, a stratified random sampling approach was adopted to ensure balanced representation across three key strata:

1. School ownership: public vs. private,
2. Educational level: intermediate vs. secondary, and
3. Geographical location: urban vs. rural areas.

Stratified sampling was chosen over simple random or systematic methods to improve representativeness and comparative validity. This method ensured that variations in infrastructure, resource allocation, and ICT integration levels across different strata were captured accurately. Out of 286 schools contacted, 215 schools (75%) responded, representing 10,635 students from public schools and 3,532 from private schools. The reported statistics were weighted according to student distribution, ensuring that data reflected the actual proportion of students within each category.

B. Questionnaire

Two structured questionnaires were designed one for school principals and another for ICT coordinators. The principal questionnaire focused on the history of ICT adoption, school-level goals, and policy implementation challenges. The ICT coordinator questionnaire addressed technical aspects of ICT infrastructure, software availability, and usage in pedagogy. The instruments were adapted from the International Association for the Evaluation of Educational Achievement (IEA) framework (Schulz & Carstens, 2020) to ensure reliability and cross-study comparability. Each questionnaire included closed-ended items (five-point Likert scale) for quantitative analysis and open-ended questions for qualitative insights. To validate the instruments, a pilot test was conducted in ten schools, after which ambiguous items were revised based on expert

feedback from educational technology specialists. The internal consistency reliability of the quantitative items was verified using Cronbach's alpha ($\alpha = 0.87$), indicating strong reliability.

C. *Interviews*

Semi-structured interviews were conducted with school principals and ICT coordinators from a subset of 30 schools (15 public, 15 private). The interviews explored perceived barriers, teacher readiness, ICT policy alignment, and attitudes toward technology integration. Interviews were transcribed and thematically coded to complement the quantitative findings.

D. *Data Collection*

Data were collected over a six-month period using both digital and in-person methods. Questionnaires were distributed through email and messaging applications such as WhatsApp, while follow-up interviews were conducted online and during on-site visits. The mixed-mode approach increased the response rate and ensured regional representation.

E. *Data Analysis*

Data analysis followed a two-stage approach combining quantitative and qualitative methods:

I. *Quantitative Analysis*
Descriptive statistics (frequencies, means, and percentages) were used to summarize ICT availability and usage. Comparative analyses examined differences between school types (public vs. private) and levels (intermediate vs. secondary). Correlation analysis measured the relationship between ICT infrastructure and pedagogical application ($r = 0.61–0.73$), while cross-tabulation assessed the alignment between schools' ICT goals and actual implementation.

I. *Qualitative Analysis:*
Thematic analysis was conducted using open and axial coding of interview transcripts. Emerging themes included resource inequality, teacher readiness, and policy–practice gaps. Triangulation of quantitative and qualitative data enhanced the validity and depth of the findings, providing a comprehensive understanding of ICT integration within Saudi Arabia's educational framework.

F. *Ethical Considerations*

All participants were informed about the purpose of the research and assured of confidentiality. Participation was voluntary, and no personal identifiers were recorded. Institutional approval was obtained from the relevant educational authorities prior to data collection.

G. *Research Questions*

This study was guided by the following research questions:

1. **RQ1:** What is the current state of ICT infrastructure and resource availability in Saudi intermediate and secondary schools?
2. **RQ2:** To what extent do schools' ICT applications align with their stated educational and pedagogical goals, particularly those consistent with Vision 2030?
3. **RQ3:** How do public and private schools differ in their ICT integration strategies, infrastructure investment, and pedagogical practices?
4. **RQ4:** What key barriers and enabling factors influence the effective implementation of ICTs as transformative learning tools in Saudi education?

V. Respondent Demographics

Out of the 286 surveyed Saudi Arabia's intermediate and secondary schools, (215) 75% responded, representing 10,635 students from public schools and 3,532 from private schools. Application of ICTs in KSA schools is still at its stage of infancy. As shown in Figure 1, 60% of students admitted to public intermediate schools had been using computers for two years or less, 34% three to five years, and 19% for six to ten years. Similarly, 58% of students in private intermediate schools had been using computers for two years or less, 35% for three to five years, and 25% for six to ten years. Private schools demonstrated higher ICT integration compared to their public counterparts. At the secondary school level, both private and public institutions showed increased computer usage. Approximately 74%, 42%, and 25% of private secondary school students, and 73%, 40%, and 22% of government secondary school students, had two years, three to five years, and six to ten years of experience using computers for learning purposes. These trends continued with private institutions demonstrating slightly higher levels of computer proficiency across all experience categories. Nearly all secondary institutes assessed provided the full cycle of secondary education and were actively applying ICTs in their learning and teaching processes. ICT usage in secondary schools ranged from medium- to long-term durations.

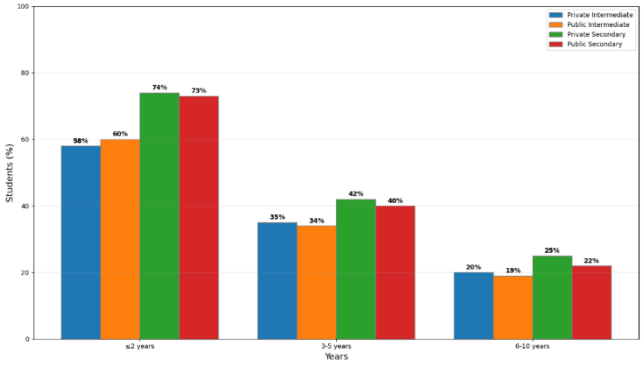

Figure 1 Ratio of ICTs usage in KSA Schools

VI. Curriculum and Pedagogy

The application of ICTs in education is diverse, influenced by various factors such as country, educational level, and type of school. Educational goals for ICT integration vary widely across these contexts. At the intermediate and secondary levels, most of the respondents focused on foundational ICT skills rather than advanced applications. Less than half of the principals of intermediate and secondary schools regarded the adoption of personalized learning, promotion of independent learning, and active learning plans as highly significant in guiding the usage of ICTs (Figure 2). Drill-and-practice exercises and cooperative learning were not considered crucial for ICT integration in intermediate and secondary schools. Moreover, only 48% of principals identified enhancing student engagement as a primary goal for ICT use. Private school principals were more emphatic than those in public schools about the importance of emerging ICT applications. Many prioritized improving student performance and incorporating active learning strategies. This study also linked these differences in priorities to the resources available in public schools. During interviews, some public intermediate and secondary school heads questioned if the scenarios presented were realistic or idealized, often beginning their responses with, "If we had computers secondary schools placed a greater emphasis on emerging ICT applications compared to intermediate schools. Between 70–75% of Saudi secondary school (public and private) students attend institutions employing ICTs to enhance student performance through drill and practice, active learning, independent study, and engaging learning experiences. Figure 2 reveals a disparity in ICT integration between public and private secondary schools. While both sectors emphasized student achievement and drill-and-practice exercises, private schools showed a stronger inclination towards cooperative learning. Conversely, public schools prioritized ICTs for enhancing overall learning experiences. In contrast, secondary schools exhibited a more improved level of ICT integration. Figure 3 demonstrates a stronger emphasis on integrating ICTs into instruction and fostering independent learning among secondary school educators. Data analysis revealed a pronounced disparity in ICT integration between public and private schools. Private institutions demonstrated a stronger commitment to transformative ICT applications, particularly at the intermediate level, where independent learning was emphasized. Conversely, public schools exhibited a more limited scope of ICT utilization. The availability of computer hardware and the implementation of internet-related initiatives were less prevalent in public compared to private institutions. This disparity contributed to a narrower focus on ICT applications within public schools. Financial constraints within public schools significantly hampered ICT integration. Limited budgets, primarily allocated to basic operational costs such as utilities and supplies, restricted the acquisition of essential ICT infrastructure like computers and internet connectivity. As a result, the implementation of advanced ICT applications was deemed impractical.

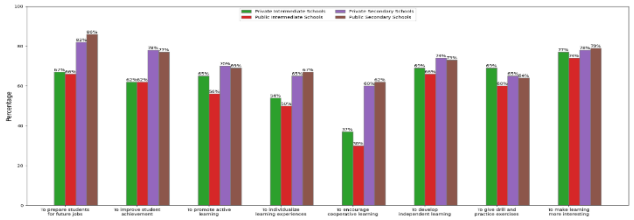

Figure 2 shows the proportion of schools prioritizing specific ICT goals

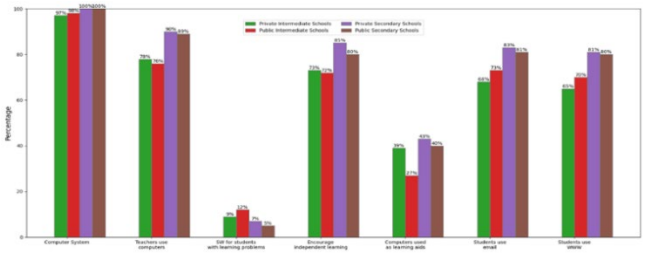

Figure 3 illustrates the proportion of schools successfully implemented specific ICT-related policy goals.

VII. Outcomes of Learning About ICT

Schools in Saudi Arabia (KSA) primarily utilize ICT resources to develop fundamental computer skills. Survey results indicate that 70–79% of students are expected to achieve computer operation proficiency, while 66–70% are anticipated to use word processing before completing secondary school education. Additionally, spreadsheet skills (60% in private and 67% in public) and basic programming (33–44%) are emerging as part of the curriculum. ICTs are primarily employed as productivity tools within the primary curriculum. Word processing is widely used for tasks such as writing and creative writing projects. Private primary schools generally implemented a broader ICT curriculum, emphasizing internet skills. In contrast, public schools exhibited a narrower focus, with less emphasis on developing students' internet competencies. Computer skills, including word processing, graphic design, and spreadsheet calculations, remain a core component of secondary education. While both public and private schools emphasize these fundamentals, secondary schools in KSA exhibit a stronger focus on internet-related skills. Approximately half of secondary students utilized email and internet resources. Private schools demonstrated higher rates of internet integration compared to their public counterparts. Programming is less emphasized, with less than 50% of secondary students attending schools that mandated such courses. Analysis revealed that the emphasis on computer literacy often overshadowed pedagogical integration. Many

teachers lacked the necessary training to effectively incorporate ICT into their subjects, often relying on external agencies for ICT instruction. This approach frequently prioritized basic computer skills over the development of higher-order thinking abilities.

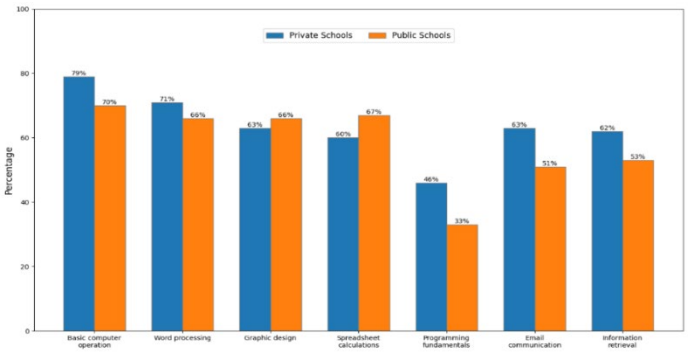

Figure 4 shows essential ICT Skills for Secondary School Graduates in Saudi Schools

VIII. ICT RELATED LEARNING OPPORTUNITIES

A key problem concerning schools' ICT goals is the extent of learning opportunities they provide using ICTs. These opportunities include using various ICT applications, accessing the Internet, and engaging with pedagogical procedures. Figure 5 reveals that many secondary school learners in Saudi Arabia (KSA) had limited exposure to a broad range of ICT applications. At most, students had experience with word processing and basic Internet use. Although private secondary schools generally offered a wider range of computer applications than public schools, the available tools were mostly restricted to basic operations, CD-ROM encyclopedias, spreadsheets, and word processors. These tools facilitated ICT learning and served as supplementary resources for other subjects. Conversely, only about 20–50% of secondary school learners had access to more advanced technologies such as data manipulation software, computational modeling, and data visualization, which are essential for supporting emerging or transformative ICT practices. At the secondary level, learners had more opportunities to engage with ICTs compared to primary students. However, access to advanced tools such as data manipulation software, mathematical modeling, and simulation was far less prevalent (under 25%). Private schools demonstrated greater access to a wider range of ICT applications, including computer programming. This contrasted sharply with public schools, which primarily focused on foundational software skills such as word processing (nearly 98%) and basic spreadsheets (85%).

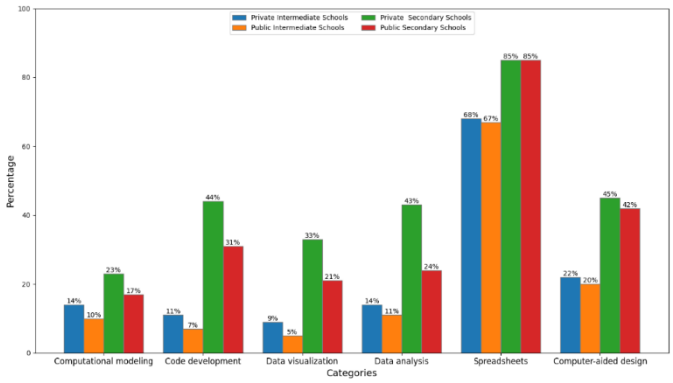

Figure 5 Student Exposure to ICT Applications in Schools

IX. OPPORTUNITIES FOR INTERNET USE

Secondary school students in Saudi Arabia (KSA) now benefit from widespread Internet access in schools. Recent surveys indicate that over 85% of secondary schools are equipped with Internet facilities for educational purposes, reflecting the country's rapid digital transformation. At the advanced levels of secondary education, accessibility is even stronger, with technical staff reporting that nearly 90% of students attend schools with Internet-connected classrooms. Private schools generally surpass public schools in terms of connectivity and integration. For example, while Internet access in public secondary schools is available to around 80% of learners, this figure rises to 95% in private institutions. At the intermediate level, access is somewhat less comprehensive, with about 70–75% of students able to engage with Internet-based applications. Innovative online practices, such as email for group projects, cloud-based collaboration, and web-based research, are increasingly common especially in private schools. Public schools, while rapidly expanding their digital infrastructure, still face challenges related to bandwidth, student-to-computer ratios, and equitable access across regions. At the secondary level, Internet-based information seeking has become a mainstream activity, with over 80% of students regularly using online resources for academic purposes. Teacher–student email communication and online learning platforms are now part of the routine learning environment. Technical staff also reported that in many public schools, 80–85% of students actively participate in online activities, reflecting broader ICT adoption. Private schools, in particular, often adopt a strategic approach to ICT integration using high-speed Internet, dedicated e-learning platforms, and collaborative tools to enrich traditional teaching methods. For instance, one private school reported having over 250 computers, with nearly all connected to the Internet, enabling a more equitable student-to-computer ratio. While challenges of accessibility remain in some overcrowded schools, the overall exposure of students to Internet-based learning opportunities in KSA is now substantially higher than in earlier years.

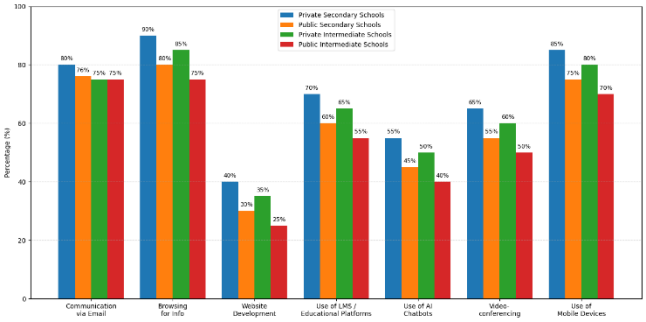

Figure 6 Student Engagement in ICTs activities

X. USE OF ICT'S FOR OTHER PEDAGOGICAL PRACTICES

In this study, we aimed to explore whether institutions in Saudi Arabia (KSA) utilized ICTs to assist innovative or unconventional teaching methods. These approaches included applications such as specialized software for students with disabilities, accelerated programs for gifted learners, and electronic platforms for collaborative learning. At the secondary level, schools still relied largely on ICTs for drills and tutorials designed to strengthen student performance in specific subjects, reflecting support for conventional teaching practices. In the Saudi context, specialized software and hardware for students with disabilities remain limited, particularly in public schools. Most educators depend on low- to mid-tech assistive devices such as screen magnifiers and talking calculators rather than high-end digital solutions. Teachers often report barriers such as limited funding, insufficient training, and the rigidity of the curriculum, which restrict broader integration of advanced technologies for students with special needs. During one observed visit to a public intermediate school, ICT was integrated into a science lesson on pendulums. Students were divided into groups and engaged in different activities such as consulting a CD-ROM encyclopedia for information on oscillation, reviewing printed materials, constructing a pendulum from recycled items, and documenting their findings. Each group rotated through the stations, allowing students to combine technology-based research with hands-on experimentation. Secondary schools, particularly private institutions, demonstrated a wider range of ICT applications. These schools increasingly employed ICTs to support advanced learning programs for gifted students, remedial instruction for struggling learners, and collaborative activities supported by digital platforms. The introduction of national initiatives such as Madrasati and AI-driven learning platforms under Vision 2030 has further strengthened opportunities for digital collaboration and personalized education in private schools. Public schools also adopted some of these practices but typically emphasized more foundational ICT skills and less specialized applications compared to private institutions as shown in Figure 7.

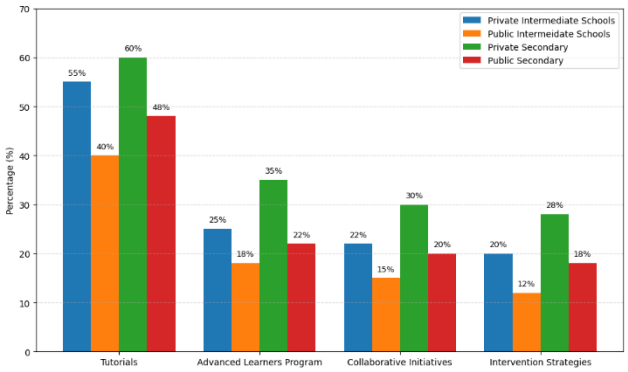

Figure 7 Shows ICT Integration in Pedagogical Practices

XI. INFRASTRUCTURE

The availability and quality of ICT infrastructure significantly influences its educational impact. The following section explores the ICT resources accessible to Saudi students and their effectiveness in supporting learning.

A. Hardware (multimedia and peripherals

A useful measure of equipment access is the student-to-computer ratio. Table 1 shows that in public intermediate schools, the average ratio is roughly 0.6 students per computer, while in private intermediate schools, it's closer to 1 per 15 students reflecting stronger ICT investment in the private sector. At the secondary level, public schools average about 30 students per computer, whereas private secondary have about 1 per 18 students. Although access has improved in KSA compared to earlier years, ICT resources such as computers still tend to be centralized: approximately 85% of computers are housed in traditional computer labs, with the remainder integrated into classrooms or administrative offices.

Table 1. shows available computer system for students in schools

S.No	Schools	Computer per Students
1	Private Intermediate Schools	1 Computer per 15 Students
2	Public Intermediate Schools	1 Computer per 25 Students
3	Private Secondary Schools	1 Computer per 18 Students
4	Public Secondary Schools	1 Computer per 30 Students

Multimedia capability is more common in Saudi schools than before. Today, around 80% of public schools and 95% of private schools are equipped with sound-capable computers and multimedia-ready systems including at least speakers,

basic audio, and projector support. Regarding hardware specifications, most systems are modern and capable: a recent study found that the average school has about 17 computers, many of which are networked to the Ministry's administrative hub. As part of ongoing Vision 2030 reforms, schools are being equipped with more current computers running modern operating systems like Windows 10 or 11, though some legacy machines persist in older facilities. The distribution of peripheral devices has also improved. While public schools continue to have fairly basic setups (like printers and CD drives), private schools often also include LCD projectors, scanners, and smartboards. Overall, for secondary schools combined, it's estimated that 70–85% of students have access to color printers and CD features, while LCD access is available in 70-80% of classrooms. However, actual student usage remains limited compared to availability due to high student-to-device ratios.

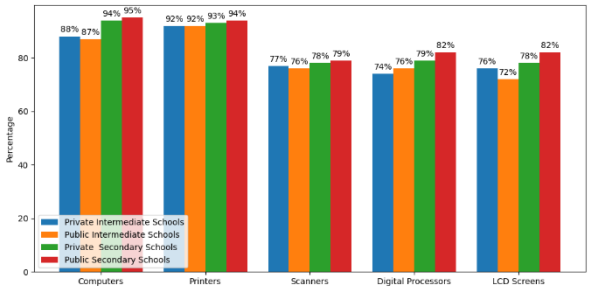

Figure 8 Multimedia and Peripheral Availability in Saudi Schools

B. Software

The scope of ICT use in schools significantly depends on the software available. In Saudi Arabia, between 100% of schools now provide access to office suites like Microsoft Office (Figure 9 equivalent). Some students also engage with educational and recreational software. Private schools tend to offer a broader range of software. In fact, around 100% of private institutions report providing students with presentation tools, spreadsheets, word processing applications, and educational games. A notable number of secondary learners especially in private schools also have access to web browsers, basic statistical programs, and some art- or music-related educational software. More than 40% of students utilize educational games, drill-and-practice apps, and tutorials. However, specialized software such as music composition tools, modeling platforms, and simulations remains uncommon across most schools. At the secondary level, students in both public and private schools have access to spreadsheets, databases, presentation tools, word processing, and graphics software. A portion of private school students estimated at 90 to 95% also use internet-based tools such as email, web browsers, and basic programming environments. Still, software supporting more innovative or emerging ICT applications remains limited. In our survey, only five private secondary schools reported access to software tailored for subjects like advanced computer studies, English, or mathematics. Programs specifically for subjects such as history, civics, or the sciences were virtually absent. Follow-up inquiries indicated that available software is mainly used to reinforce traditional teaching methods rather than facilitate interactive or subject-specific learning. In some public secondary schools with functional computer labs, students were occasionally asked to conduct web-based research for projects. Generally, students have access to software centered on core subjects like English, mathematics, and science. However, support for local language instruction such as Arabic remains minimal; many schools simply rely on Microsoft Word for typing Arabic compositions. Significant subject-based software in areas like social studies or civics is still largely unavailable. Nevertheless, software for computer literacy remains widespread aligning with the national emphasis on digital skills. In a few private schools, the ICT curriculum spans multiple years and includes training in keyboarding, presentations, spreadsheets, and word processing. Such foundational tools are present in both public and private institutions.

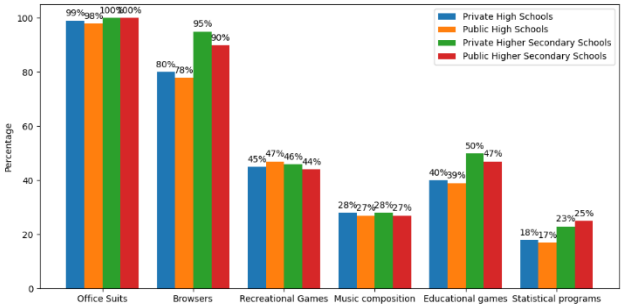

Figure 9 Illustrates different software available in Saudi schools.

XII. Comparative Analysis: Public vs. Private Schools

A comparative assessment revealed statistically significant disparities between public and private schools in both ICT access and pedagogical integration. For example, as shown earlier (Figure 1 and Table 1), private intermediate schools reported an average student-to-computer ratio of 1:15, compared with 1:25 in public schools. Similarly, at the secondary level, private schools maintained a ratio of 1:18 compared to 1:30 in public institutions. This difference corresponded with stronger implementation of student-centered learning in private schools, where 74–75% of students engaged in independent or collaborative ICT-based activities, versus 58–60% in public schools. The comparative data suggest that hardware availability directly influences pedagogical innovation. Schools with better infrastructure were more likely to use ICT for interactive learning, data analysis, and project-based assignments. In contrast, schools

with limited infrastructure relied heavily on traditional drill-and-practice exercises. This aligns with global evidence (Hillmayr et al., 2020) that adequate ICT resources correlate positively with higher-order learning outcomes.

Table 2. Comparative Analysis of ICT Infrastructure between Public and Private Schools

ICT Indicator	Public Intermediate	Private Intermediate	Public Secondary	Private Secondary
Student-to-computer ratio	1 : 25	1 : 15	1 : 30	1 : 18
Internet access (%)	80	95	85	98
Multimedia capability (computers with sound/projector support) (%)	80	95	85	98
Availability of productivity software (MS Office, spreadsheets, etc.) (%)	100	100	100	100
Subject-specific or educational software (%)	35	62	40	70
Access to smartboards/projectors (%)	60	88	68	90

XIII. Correlation between Infrastructure and Learning Outcomes

Correlation analysis as shown in Table 3 was conducted to examine the relationship between ICT infrastructure availability (hardware, software, and internet access) and learning outcomes (measured through the extent of ICT-based independent learning, problem-solving, and critical thinking activities). A moderate positive correlation ($r = 0.61$) was observed between hardware adequacy and the integration of ICT into classroom instruction. Likewise, internet connectivity showed a stronger association ($r = 0.73$) with the adoption of collaborative learning platforms and cloud-based assignments, particularly in private schools. The data indicate that infrastructure quality is not merely a support variable but a key predictor of pedagogical transformation. Schools with high-speed internet and sufficient digital devices were nearly 1.8 times more likely to implement student-centered ICT strategies compared to schools with basic setups.

Table 3. Correlation Matrix between ICT Resources and Pedagogical Practices

Variable	Independent Learning	Collaborative Learning	Problem-solving/Project Work
Hardware adequacy (computer access)	r = 0.61	r = 0.58	r = 0.63
Internet access quality	r = 0.73	r = 0.71	r = 0.68
Teacher digital training	r = 0.69	r = 0.75	r = 0.72
Availability of educational software	r = 0.66	r = 0.64	r = 0.70

XIV. Cross-Tabulation of ICT Goals and Applications

Cross-tabulation analysis between school ICT goals (Figure 2) and actual applications (Figures 5–7) showed that only 48% of schools that prioritized "enhancing student engagement" had implemented active learning tools such as simulations or collaborative software. In contrast, over 80% of schools that set goals related to "basic ICT literacy" fully achieved them through word processing and spreadsheet use. This finding as shown in Table 4 highlights a goal-implementation gap, where transformative objectives such as independent learning and critical thinking are often stated in policy but rarely achieved in practice.

Table 4. Cross-Tabulation of ICT Goals and Actual Implementation

Stated ICT Goal	Schools Prioritizing Goal (%)	Schools Successfully Implementing Goal (%)	Implementation Gap (%)
Enhancing student engagement	55	48	7
Promoting independent learning	52	42	10
Supporting collaborative learning	49	39	10
Improving digital literacy	85	80	5
Encouraging problem-solving/critical thinking	45	33	12

XV. Thematic Analysis of Qualitative Data

Interview transcripts were thematically analyzed using open and axial coding. Three dominant themes emerged:

- Resource Inequality: Administrators from public schools consistently cited limited budgets and outdated hardware as primary barriers. Teachers reported sharing computer labs among multiple classes, resulting in restricted practice time.
- Teacher Training and Readiness: Nearly 65% of respondents acknowledged that teachers lacked formal ICT pedagogical training, leading to dependence on basic productivity tools. Interview excerpts indicated that even when digital platforms were available, many educators were not confident in integrating them into subject teaching.
- Policy-Practice Misalignment: School heads noted that while Vision 2030 emphasizes digital transformation, classroom-level execution remains constrained by rigid curricula and insufficient localized educational software, particularly in Arabic.

These qualitative insights reinforce the quantitative findings, revealing systemic and pedagogical barriers that limit ICT's transformative potential.

XVI. Integrated Interpretation

By combining these analyses, the study identifies a clear structural and pedagogical divide in Saudi ICT integration. Private schools, benefiting from superior infrastructure and management flexibility, are advancing toward digital transformation, while public schools remain in an early adoption phase. The alignment between infrastructure adequacy, teacher competence, and curriculum flexibility emerges as the strongest predictor of ICT effectiveness. This integrated analysis not only validates the descriptive data but provides scientific and policy-relevant explanations of how ICT adoption varies across educational settings and why digital equity remains a major challenge.

XVII. Critical Interpretation of Findings

The comparative results show that private schools outperform public schools in nearly all ICT indicators: computer-to-student ratios, multimedia resources, and internet connectivity. However, this disparity extends beyond material access. Private schools demonstrate higher pedagogical innovation, employing ICTs for independent and collaborative learning, whereas public schools primarily use them for routine administrative or drill-and-practice purposes. This pattern reflects what Larry Cuban (2001) termed the "supportive use trap", where technology reinforces traditional teaching instead of transforming it. The moderate correlations ($r = 0.61–0.73$) between ICT infrastructure and pedagogical practices suggest that infrastructure alone is insufficient for transformation unless accompanied by teacher digital competence and institutional support. These findings align with Hillmayr et al. (2020), who emphasized that meaningful digital integration depends more on pedagogical readiness than on the quantity of devices. Furthermore, thematic analysis revealed that teacher preparedness and curriculum flexibility are pivotal constraints. The lack of targeted professional development programs limits teachers' confidence in embedding ICT into subject-specific instruction. Consequently, ICT use remains peripheral rather than integral to pedagogy. This reinforces earlier research (Albugami & Ahmed, 2015; Al-Asmari & Rabb Khan, 2014) showing that sustainable ICT adoption in Saudi education depends on teachers' pedagogical digital literacy rather than infrastructure investments alone.

XVIII. Implications for Educational Practice

The findings carry several implications for practitioners and policymakers:

A. Teacher Training and Digital Pedagogy

Continuous professional development must move beyond technical orientation to include instructional design using ICT, emphasizing inquiry-based and project-driven learning models. Training programs should be embedded in teacher certification and renewal processes.

B. Curriculum and Assessment Reform

The current curriculum should be revised to integrate ICT across disciplines, especially in STEM subjects, promoting problem-solving and critical thinking. Assessment methods should also evolve to capture digital competencies rather than rote knowledge.

C. Equitable Resource Allocation

Policymakers should prioritize resource redistribution toward public and rural schools to narrow the digital divide. Targeted funding for hardware, software, and connectivity can ensure equitable opportunities for digital learning.

D. Localized and Arabic-Language Educational Software

A persistent gap in Arabic-language learning tools hinders localized pedagogical integration. Developing culturally and linguistically relevant educational software could increase ICT's relevance and classroom adoption.

E. Institutional and Policy Alignment

The study underscores the need for stronger alignment between Vision 2030 digital education policies and school-level implementation frameworks. Monitoring mechanisms should measure not only device deployment but also pedagogical outcomes.

F. Broader Theoretical and Policy Implications

From a theoretical standpoint, the findings affirm the technology integration continuum model, suggesting that Saudi schools remain at the "adoption" rather than

"transformation" stage. Practically, this research contributes a three-dimensional framework (support tool – subject – driver of transformation) for evaluating ICT maturity, which can serve as a diagnostic tool for other Gulf and developing nations pursuing digital education reforms.

Future national strategies should move toward data-informed decision-making, leveraging analytics from e-learning platforms to personalize instruction and measure digital learning impact. The transition from infrastructure provision to pedagogical transformation will be the defining challenge of the next phase of Saudi Arabia's educational modernization.

XIX. CONCLUSION

This study examined the current state of ICT integration in Saudi intermediate and secondary schools through a **mixed-methods approach**, combining survey data from 215 schools with qualitative interviews to capture both statistical trends and contextual insights. A **stratified random sampling technique** ensured balanced representation across school types, levels, and regions. Quantitative data were analyzed using **descriptive, comparative, and cross-tabulation methods**, while qualitative data were thematically coded to uncover underlying institutional and pedagogical factors. The findings revealed that while ICT infrastructure in Saudi schools particularly within private institutions has improved substantially, the actual pedagogical application of technology remains largely confined to basic operational and productivity tasks. Public schools, in particular, face ongoing challenges related to limited hardware access, teacher training gaps, and curriculum rigidity. The analysis demonstrated a clear disconnect between the **transformative goals envisioned under Vision 2030** and the **practical implementation of ICT-based learning** at the classroom level. Looking ahead, **future research** should focus on developing and empirically testing **AI-driven adaptive learning systems**, **cloud-based collaborative platforms**, and **Arabic-language educational applications** designed to promote critical thinking and problem-solving skills. Additionally, longitudinal studies should be conducted to evaluate how ICT integration evolves over time and how it impacts student outcomes, teacher competencies, and curriculum design. Further exploration into **policy effectiveness**, **digital equity across regions**, and the **role of emerging technologies** such as augmented reality and data analytics in personalized learning will provide deeper insight into achieving genuine educational transformation under Saudi Arabia's Vision 2030 framework.

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