

RESEARCH PAPER

EDUCATION TECHNOLOGY

Impact of Smart Board Usage on Teachers' Health and Well-Being

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ABSTRACT

Teachers now use digital tools to improve their teaching methods which results in better student learning and teaching outcomes. The extended duration of teachers' technology use will create new health problems which teachers must address. The study evaluates how Smart Board usage affects teachers' health through research conducted with 150 educators from different age groups. The study shows that digital teaching methods can cause serious health threats which develop after extended periods of use. About 74.7 percent of teachers experienced high stress levels while 62.0 percent suffered from serious visual discomfort and 56.7 percent endured extreme body pain. The daily Smart Board usage results in strong visual strain and stress level increases according to the study which found statistical connections between these variables. The research results demonstrate that people who use Smart Boards more than five hours every day will experience their health symptoms start to intensify. The study shows that younger teachers use more visual resources than older teachers while older teachers deal with greater body pain from their seating position and body movement. The study demonstrates that educational technology implementation will lead to health consequences for students and teachers. Educational institutions must establish ergonomic standards and usage policies and wellness programs to ensure Smart Board technology benefits teaching while protecting teacher health.

Keywords: Smart Board, teacher health, visual strain, musculoskeletal disorders, occupational stress, digital teaching, classroom technology, ergonomics

Digital technologies have been integrated into educational spaces, which have created complete changes to teaching methods and learning experiences (Paul & Dangwal, 2014). The emergence of Education 4.0, supported by artificial intelligence and other advanced technologies, is further transforming educational practices and creating new possibilities for teaching and learning (Paul *et al.* 2026). Interactive Smart

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Boards have become essential tools for contemporary classrooms because they improve student involvement and enable multimedia educational experiences and interactive teaching methods. The Smart Board system enables teachers to use visual materials together with digital notes and live teaching materials which enhances classroom teaching effectiveness and student involvement. The emergence of immersive digital environments such as the metaverse represents a further development in technology-mediated education and teaching–learning practices (Paul, 2024). The increasing implementation of such technologies in educational institutions requires teachers to use digital displays during their teaching activities which makes Smart Boards essential for modern teaching methods. The development of cloud and fog computing technologies has further expanded the technological infrastructure supporting traditional and digital educational systems (Paul, 2024). Smart Boards present multiple teaching benefits but their extended use can create new health risks which educators need to address as part of their work requirements. Educators spend extended periods standing while they perform digital board interactions which requires them to move their arms repeatedly and keep their bodies in static positions. Digital board interactions create potential risks for musculoskeletal disorders (MSDs) which primarily impact neck and shoulder and lower back regions. The existing research shows that teachers experience work-related musculoskeletal pain because they need to stand for extended periods while performing repetitive teaching tasks according to studies (Kraemer *et al.* 2021; Cheng *et al.* 2016). Interactive technologies create additional hazards which increase classroom risks when schools fail to create suitable ergonomic environments.

The use of digital teaching tools creates a new problem which results in visual strain for students who watch digital screens for extended periods. People who use electronic displays without breaks will experience dry eyes together with headaches and blurred vision and visual fatigue. Research on digital board usage shows that teachers who teach with screens for extended periods face greater eye strain problems during their work hours (Shankar *et al.* 2022). The research about digital ergonomics shows that when teachers depend more on screen-based tools for teaching they will experience more visual health problems which will harm their ability to concentrate unless they take protective actions (Long & Richter, 2019). The growth of technology-based teaching methods has created major issues which link digital teaching equipment to health problems that educators will face in the future. Smart Board technology creates physical health problems for teachers while also generating psychological and cognitive stress through its usage in classrooms. The teachers need to manage digital teaching tools because they must handle three tasks which include technical work and teaching and classroom management. The increased brain activity requires teachers to work harder because technical problems show up during lectures and teachers must learn new digital teaching methods. Research on technology-supported instruction indicates that increased technological demands may contribute to occupational stress and instructional fatigue among educators (Seffah *et al.* 2021). The use of digital technologies in teaching results in improved instructional efficiency but creates additional mental demands which increase the burden on teachers (Paul *et al.* 2025).

The digital boards present environmental advantages through their implementation and provide occupational benefits for workers who use them. The system provides an advantage to educational institutions through its capacity to decrease chalk dust exposure, which creates respiratory health issues for educators who work with chalk materials. The use of digital displays instead of chalkboards will decrease respiratory health hazards and enhance the air quality of classrooms. The advantages provided by Smart Boards require assessment because they bring both beneficial features and potential health dangers which occur when users engage with digital displays for an extended period. Research evidence

indicates that teachers use technology according to their physical and psychological health conditions. Research studies on Smart Board implementation show that teachers who use digital teaching resources for more than two hours experience more visual disturbances and body pain and psychological pressure. The research shows that teachers who use Smart Boards for more than five hours per day experience more severe health problems especially eye fatigue and work-related stress. Younger teachers show higher visual strain from their technology use while teaching because their digital engagement patterns differ from older teachers who experience more musculoskeletal pain due to their teaching posture and ergonomic conditions.

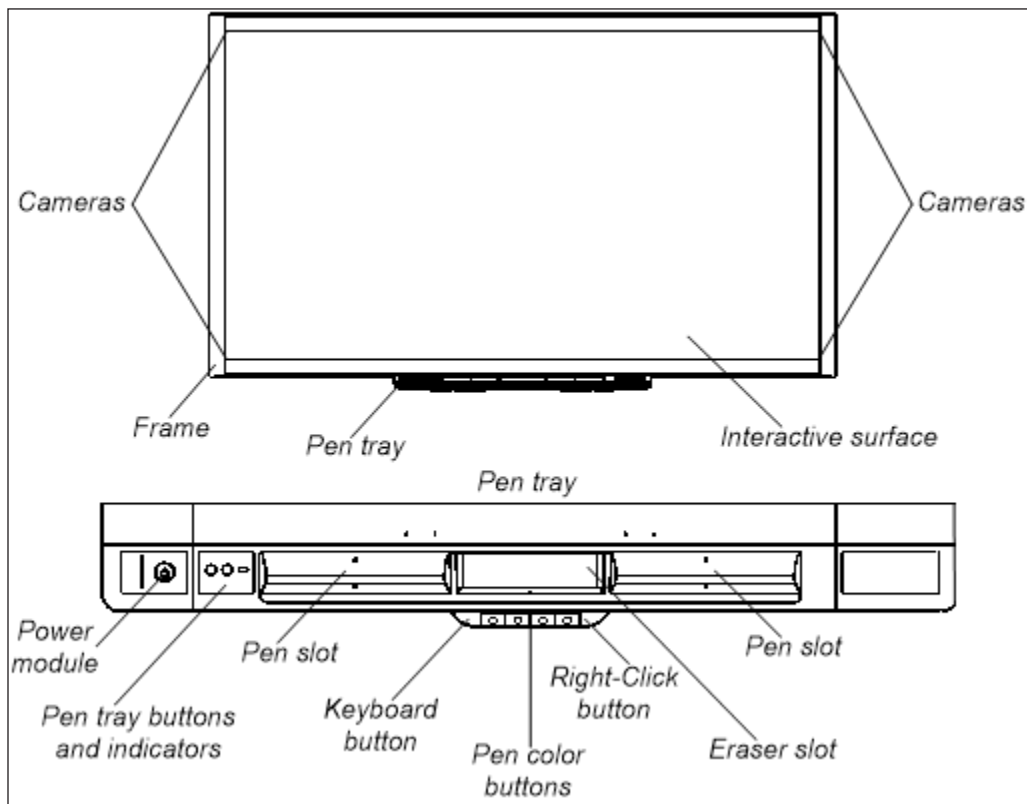


Fig. 1. Smart Board Design (Pal, 2025)

Researchers should study how Smart Board technology affects teacher health and wellness as more digital tools are used in education today. Standards for ergonomics at educational agencies and the professional development programs that implement those standards should address the affective nature of these tools plus provide professional development opportunities for educators.

Objectives of the study

- ❑ To assess how Smart Board usage affects teachers' musculoskeletal health, specifically through the examination of neck and shoulder and lower back pain, which results from standing up for long periods and moving their arms repeatedly during digital teaching.

- ❑ To measure visual strain that teachers face during Smart Board teaching through the assessment of their eye fatigue and headaches and blurred vision which result from watching screens for extended periods.
- ❑ To examine how teachers' occupational stress levels relate to the time they spend using Smart Boards while teaching because the digital teaching technologies require their cognitive resources to manage.
- ❑ To investigate how teachers' physical and psychological health symptoms develop through their different Smart Board usage patterns.
- ❑ The another objective of this study is to evaluate the environmental and health benefits of using a Smart Board due to the reduction in respiratory ailments associated with chalk board use.
- ❑ The goal of the project will be to propose ergonomic solutions and institutional policies to minimize the health hazards associated with poor teaching environments while providing improved health for teachers who use technology in their classrooms.

Research Gap

Digital technologies which include Smart Boards and interactive white boards have become essential teaching tools because they enable teachers to deliver their lessons nowadays. The technologies support teaching methods while increasing student involvement and creating multimedia educational opportunities. Teachers face health risks because of their growing need to use these tools for work. Current research examines how Smart Boards affect teaching methods and student performance but it lacks information about the long-term health effects that teachers experience from using these technologies. The study shows that teachers who use Smart Boards for extended periods experience visual difficulties and musculoskeletal discomfort and work-related stress. Teachers experience work-related musculoskeletal disorders (WMSDs) at high rates because they must perform repetitive tasks and stand for long periods and adopt uncomfortable positions during classroom teaching (Kraemer *et al.* 2021). Research on posture analysis shows that electronic whiteboard use changes how teachers move their bodies which results in higher chances of experiencing neck and shoulder and back pain (Bogaert *et al.* 2016). Digital board and screen-based teaching research has found that students show increased hand and neck muscle activity, which indicates that digital teaching tools create an ergonomic burden (Shankar *et al.* 2022). Digital screens create two problems, which include digital eye strain and visual fatigue because users who spend long hours looking at screens suffer from these conditions which result in reduced educator performance and health (Gammoh, 2021; Straker & Howie, 2016).

The literature continues to have important research gaps which need to be addressed. Available studies specifically focus on computer or digital device like smartphone usage rather than specifically examining Smart Board usage in classroom settings. The scientific community currently lacks research which evaluates the three health aspects of physical health, visual health, and psychological health that teachers experience while using Smart Boards. Most available studies use cross-sectional study methods which restrict researchers from understanding how health effects develop over time and what leads to those health effects. Research that investigates how different demographic groups such as age and teaching experience and subject specialization compare to each other is still insufficient. The existing research

base contains no studies which develop complete ergonomic solutions or institutional policies that fit digital teaching environments. The multidisciplinary health effects of Smart Board usage need to be studied in depth because their effects on teachers require evidence-based ergonomic guidelines which will help teachers maintain their health while using digital teaching methods. More broadly, the transition toward Education 4.0 and AI-enabled educational systems has also generated ethical and responsible-use concerns, highlighting the need for appropriate institutional safeguards alongside technological adoption (Paul *et al.* 2026).

LITERATURE REVIEW

We did a contemporary and related literature review to complete this research. The details of the cited works are given in a chart form for better understanding.

Author(s) & Year	Title	Method / Sample	Key Findings	Research Gap
Kraemer & Moreira (2021)	Musculoskeletal pain and ergonomic risks in teachers of a federal institution	Cross-sectional survey of teachers	High prevalence of neck, shoulder and lower back pain among teachers due to poor ergonomic conditions and prolonged teaching posture.	Did not specifically examine digital board usage in classrooms.
Direksunthorn, Polpanadham & Summart (2023)	Electronic learning devices and work-related musculoskeletal disorders	Cross-sectional study among university students	Prolonged use of electronic devices significantly increases risk of musculoskeletal disorders.	Focused on students rather than teachers.
Shankar <i>et al.</i> (2022)	Impact of digital boards on hand and neck muscle activity during online teaching	Experimental study measuring muscle activity	Digital board usage increases muscle activity in neck and arm regions during teaching.	Limited sample size and short-term observation.
Gammoh (2021)	Digital eye strain and its risk factors among university students	Cross-sectional survey	Long screen exposure leads to symptoms such as blurred vision, dry eyes and headaches.	Did not investigate teachers or classroom technology specifically.
Long & Richter (2019)	Visual ergonomics in mobile work environments	Literature review	Poor visual ergonomics and continuous screen exposure increase visual fatigue and productivity loss.	Focused mainly on office environments.
Straker & Howie (2016)	Schools, health and productivity	Review of school ergonomic environments	Poor classroom ergonomics contribute to musculoskeletal problems and fatigue among teachers and students.	Limited empirical evidence on digital boards.
Seffāh, Kuhail & Negreiros (2021)	IT teaching labs: Innovations in a distance education era	Case study and review	Integration of digital technologies increases cognitive workload for instructors.	Focused on IT labs rather than classroom teaching tools.
Ramírez-García & Lluquay-Quispillo (2023)	Musculoskeletal disorders in primary school teachers	Observational study	Teachers experience high prevalence of musculoskeletal pain due to repetitive movements and prolonged standing.	Did not analyze technology-based teaching tools.

Author(s) & Year	Title	Method / Sample	Key Findings	Research Gap
Bakhmat, Artimonova & Malyshevska (2024)	Interactive whiteboards: A key tool for inclusive education	Qualitative educational research	Interactive whiteboards enhance student participation and inclusive learning.	Health impacts on teachers were not analyzed.
Amoakohene (2020)	Impact of ergonomic situations on the wellbeing of teachers	Survey study in schools	Poor classroom design and furniture increase physical discomfort among teachers.	Did not examine digital teaching technologies.
Pollock & Straker (2007)	Information and communication technology in schools	Ergonomic analysis	ICT integration in schools requires ergonomic adjustments to prevent visual and musculoskeletal problems.	Outdated relative to modern smart board technology.
Uyal & Umar (2022)	Classroom environment and musculoskeletal discomfort	Literature review and survey	Classroom design significantly influences musculoskeletal health.	Limited discussion on interactive teaching devices.
Singh <i>et al.</i> (2021)	E-learning methods in medical education during COVID-19	Survey of medical educators	Increased reliance on digital technologies during online teaching.	Health impacts of prolonged technology use were not deeply analyzed.
Medona, Punitha & Bhuvaneswari (2021)	Effects of mobile screen usage on digital eye strain	Interventional study among teacher trainees	Excessive screen exposure leads to digital eye strain and sleep disturbances.	Focused on mobile devices rather than smart boards.
Jaggi (2011)	Ergonomic designing of classroom furniture	Experimental ergonomic design study	Ergonomically designed furniture reduces physical strain and improves comfort in classrooms.	Did not consider digital classroom technologies.
Anagha (2022)	Creative and ergonomically designed classroom interiors	Design-based research	Ergonomic classroom environments improve comfort and learning outcomes.	No focus on teacher health outcomes related to digital teaching tools.
Francis, Sankaran & Kirthika (2022)	Views on virtual education during COVID-19	Survey study	Increased screen time during virtual education caused eye strain and fatigue.	Focused on students rather than teachers.
Kegel <i>et al.</i> (2026)	Computer work and musculoskeletal complaints among schoolteachers	Pilot occupational health study	Teachers using computers frequently reported shoulder, neck and eye fatigue.	Did not specifically analyze smart board usage.
Aljaradin, Almekhlafi & Alkaabi (2024)	Ergonomics in digital learning environments	Literature review	Proper ergonomic design can reduce physical strain and improve teacher health in digital classrooms.	Empirical studies on smart board usage remain limited.

Methodology & data collection process

This current research employed a quantitative survey-style research design to determine how Smart Board use affects teacher's health and wellness. The researchers needed primary data, so they developed a structured questionnaire to identify physical and psychological health symptoms that teachers experience when using digital learning technologies. Google Forms (G-Forms) were chosen to allow for easy data collection and distribution. The form required participants to answer questions about their demographic information which included their age and teaching experience and their Smart Board usage time and their

experience of health-related symptoms which included musculoskeletal discomfort and visual strain and occupational stress. Data collection was done both online and offline. The online survey link was sent out via digital communication platforms such as email and messaging apps, so that people could submit their answers electronically. Educators in local schools received printed questionnaires which required their answers to be manually recorded into the dataset for data completeness after the online method finished. The study focused on educators who worked in schools located in the Kolkata area of West Bengal India. The survey included 150 teachers who worked at different local schools throughout Kolkata. The study employed convenience sampling to select participants based on their availability and willingness to take part in research. Prior to collecting their answers, the researchers explained to participants the purpose of the study and that their consent was necessary for participation. The researchers kept participants' identities confidential by collecting data anonymously, meaning that any identifying information was removed.

Data Analysis

The collected data from 150 educators from local schools in the Kolkata region of West Bengal were analyzed using descriptive and inferential statistical techniques. The analysis aimed to examine the relationship between Smart Board usage and teachers' health outcomes, including visual strain, musculoskeletal pain, and stress levels.

Descriptive Statistics

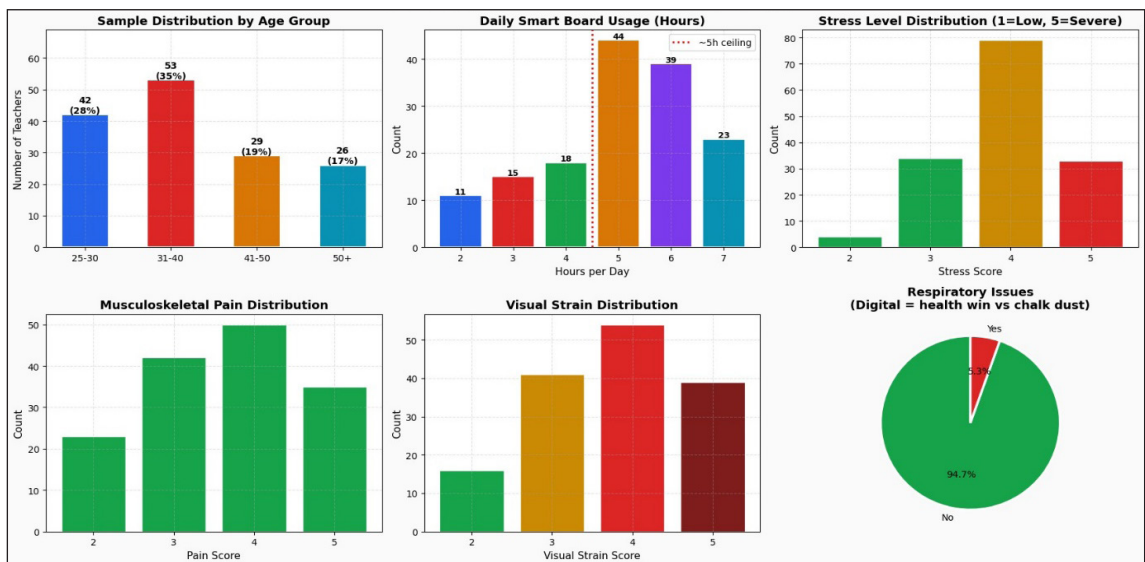


Fig. 2: Dataset Overview: Distribution of All Variables

Fig. 2 represents the dataset that consists of 150 responses with 14 variables, including demographic characteristics, daily Smart Board usage hours, and health-related symptoms. The average daily Smart Board usage among teachers was 5.03 hours ($SD = 1.44$), indicating that many educators spend a substantial portion of their teaching time interacting with digital boards.

The mean score for musculoskeletal pain was 3.65 (SD = 1.00) on a five-point scale, suggesting a moderate to high level of physical discomfort among respondents. Similarly, the mean visual strain score was 3.77 (SD = 0.96), indicating that eye fatigue and related symptoms are common among teachers using digital boards. The stress level reported by teachers had a mean score of 3.94 (SD = 0.74), reflecting relatively high occupational stress levels (Fig. 2).

The analysis further showed that 74.7% of respondents reported high or severe stress, 62.0% experienced severe visual strain, and 56.7% reported severe musculoskeletal pain. Approximately 41.3% of teachers were classified as power users, meaning they used Smart Boards for six or more hours per day (Fig. 2).

Respiratory problems were reported by only 5.3% of participants, suggesting that digital boards may reduce health issues related to chalk dust exposure compared to traditional chalkboards (Fig. 2).

Age-wise Analysis of Symptoms

The respondents were categorized into four age groups: 25–30 years ($n = 42$), 31–40 years ($n = 53$), 41–50 years ($n = 29$), and 50+ years ($n = 26$). Significant differences were observed across these groups (Fig. 3).

Teachers aged 25–30 years had the highest average Smart Board usage (5.95 hours/day) and the highest proportion of power users (66.7%). This group also experienced substantial visual strain, with an average score of 4.00, and 73.81% reporting severe visual symptoms (Fig. 3).

The 31–40 age group demonstrated the highest stress levels, with 86.79% reporting high stress and an average stress score of 4.25. This indicates that mid-career teachers may face significant workload pressures associated with digital teaching environments (Fig. 3).

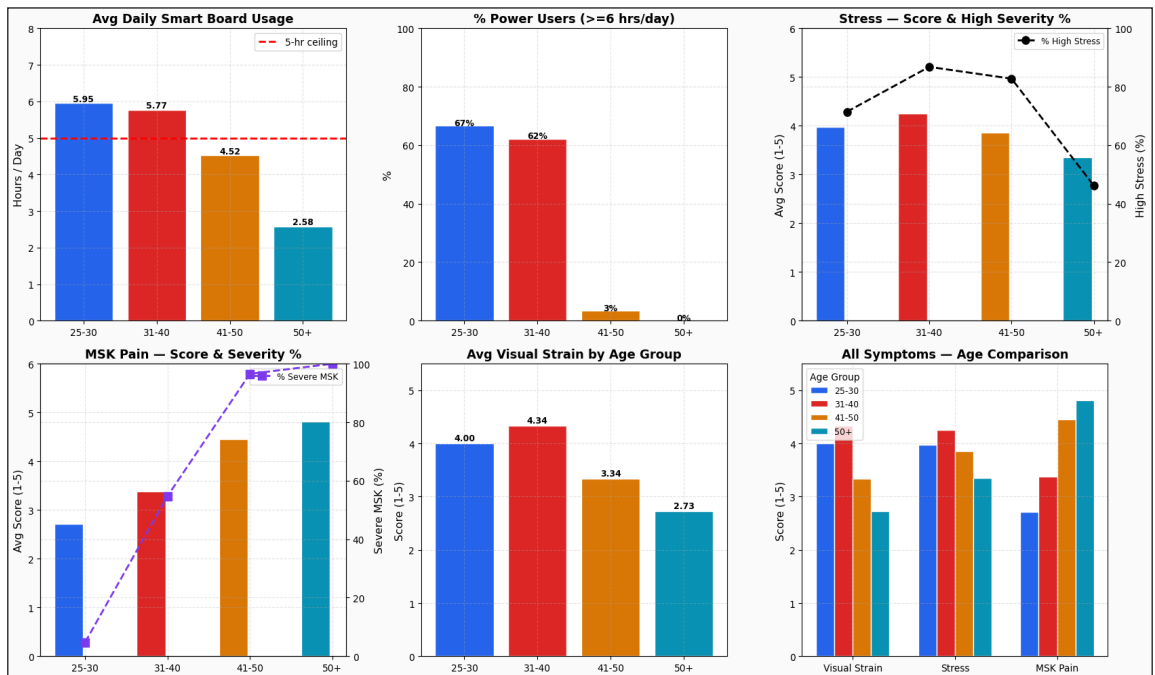


Fig. 3: Age-Wise Symptom Profiles

In contrast, the 41–50 and 50+ age groups reported higher levels of musculoskeletal pain. The mean musculoskeletal pain score was 4.45 for teachers aged 41–50 years and 4.81 for those aged above 50 years, suggesting that age and physical strain are major contributors to musculoskeletal discomfort (Fig. 2).

Correlation Analysis

Pearson correlation analysis was conducted to examine the relationship between Smart Board usage and health symptoms.

The results revealed a strong positive correlation between daily usage and visual strain ($r = 0.84$, $p < 0.001$), indicating that longer exposure to Smart Boards significantly increases eye fatigue among teachers. A moderate positive correlation was also observed between usage and stress levels ($r = 0.66$, $p < 0.001$), suggesting that prolonged digital teaching may contribute to higher occupational stress (Fig. 4).

Interestingly, the correlation between usage and musculoskeletal pain was negative ($r = -0.77$, $p < 0.001$). This suggests that musculoskeletal discomfort may be more strongly influenced by age, posture, and ergonomic factors rather than solely by the duration of Smart Board usage (Fig. 4).

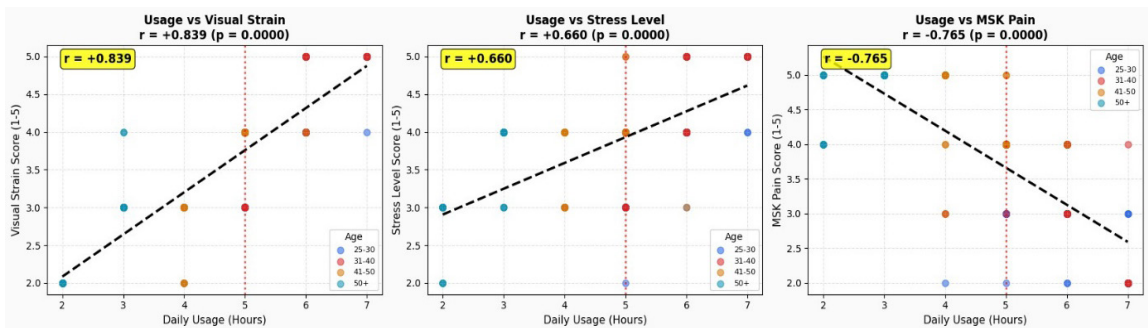


Fig. 4: Proof of Digital Transformation Strain: Usage vs. Symptoms

Analysis of Usage Threshold

Further analysis categorized Smart Board usage into three groups: low usage (≤ 3 hours/day), moderate usage (3–5 hours/day), and high usage (5–7 hours/day).

The results demonstrated that teachers in the high usage category experienced significantly higher levels of visual strain and stress compared to those in the lower usage groups. Visual strain increased from an average score of 2.73 in the low usage group to 4.61 in the high usage group, representing a 69% increase in symptoms.

A one-way ANOVA test confirmed that these differences were statistically significant ($F = 111.01$, $p < 0.001$), indicating that health symptoms increase sharply when Smart Board usage exceeds approximately five hours per day.

Independent t-test Analysis

Fig. 5 shows independent t-tests were conducted to compare health symptoms between younger teachers (25–30 years) and senior teachers (50+ years).

The results indicated a significant difference in musculoskeletal pain levels, with senior teachers reporting much higher pain scores (Mean = 4.81) compared to younger teachers (Mean = 2.71). The difference was statistically significant ($t = -16.72, p < 0.001$) with a large effect size (Cohen's $d = -4.17$) (Fig. 5). Conversely, younger teachers experienced significantly higher visual strain, with a mean score of 4.00, compared to 2.73 among senior teachers ($t = 6.44, p < 0.001$). Stress levels were also higher among younger teachers (Mean = 3.98) compared to older educators (Mean = 3.35) (Fig. 5). These findings suggest that younger teachers are more vulnerable to visual strain due to higher digital engagement, while older teachers are more susceptible to musculoskeletal problems due to age-related physical strain (Fig. 5).

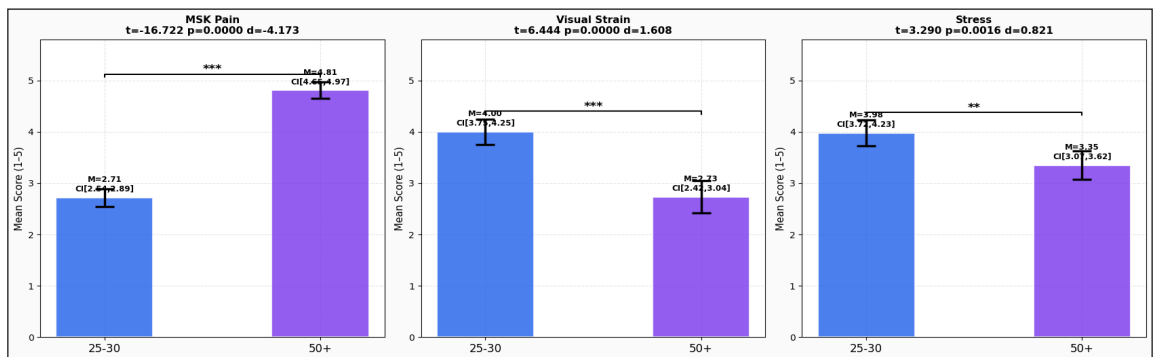


Fig. 5: t-Test Results: 25–30 vs. 50+ with 95% Confidence Intervals

One-Way ANOVA Results

A one-way ANOVA was conducted to examine whether symptom scores differed significantly across the four age groups.

The results indicated statistically significant differences in musculoskeletal pain ($F = 81.38, p < 0.001$), visual strain ($F = 30.72, p < 0.001$), and stress levels ($F = 10.24, p < 0.001$). The effect sizes (η^2 values) for all three variables were large, indicating that age is a major factor influencing health symptoms associated with Smart Board usage.

Confidence Interval Analysis

Confidence interval analysis was conducted to estimate the population parameters. The 95% confidence interval for musculoskeletal pain ranged from 3.48 to 3.81, while the 95% confidence interval for visual strain ranged from 3.62 to 3.93. For stress levels, the 95% confidence interval ranged from 3.82 to 4.06 (Fig. 6).

These intervals confirm that the average symptom levels among teachers fall within the moderate-to-high severity range, reinforcing the conclusion that digital teaching technologies may significantly influence teacher health (Fig. 7).

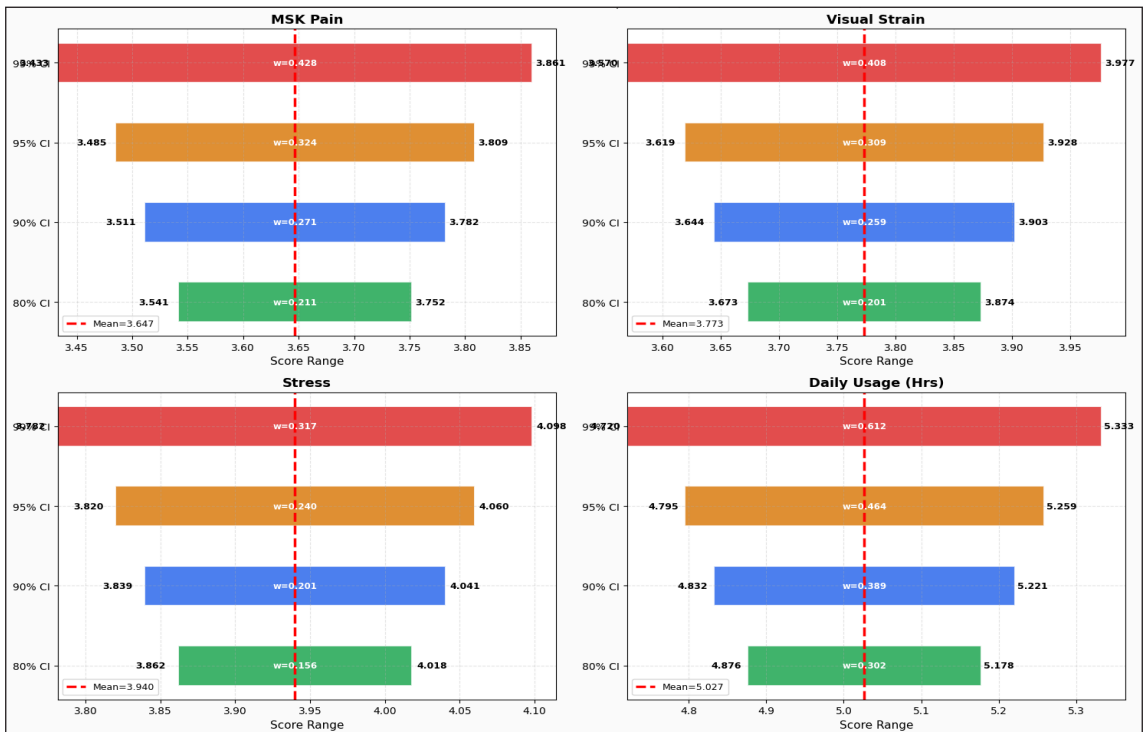


Fig. 6: Confidence Interval Width Comparison (80% / 90% / 95%)

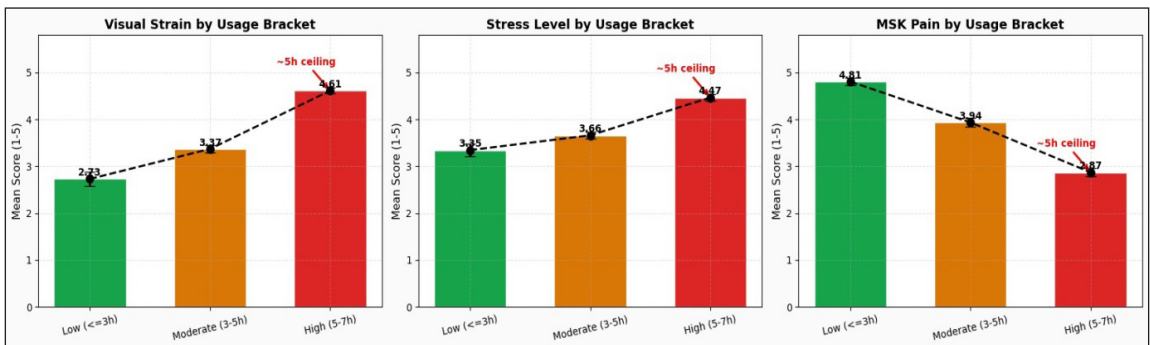


Fig. 7: Proof of the 5-Hour Usage-Strain Ceiling

Summary of Key Findings

The analysis highlights several important findings:

1. A large proportion of teachers experience high stress (74.7%), visual strain (62%), and musculoskeletal pain (56.7%) associated with Smart Board usage.
2. Smart Board usage exceeding five hours per day significantly increases health-related symptoms.

3. Younger teachers experience greater visual strain, while older teachers experience more severe musculoskeletal pain.
4. Age and ergonomic posture appear to be major predictors of physical discomfort.
5. Digital teaching technologies may reduce respiratory issues related to chalk dust but introduce new health risks related to prolonged screen exposure.

Overall, the statistical analysis demonstrates that while Smart Boards enhance digital teaching, their prolonged use may lead to significant occupational health challenges for educators, highlighting the need for ergonomic guidelines and digital wellness policies in schools. The graphs are given below.

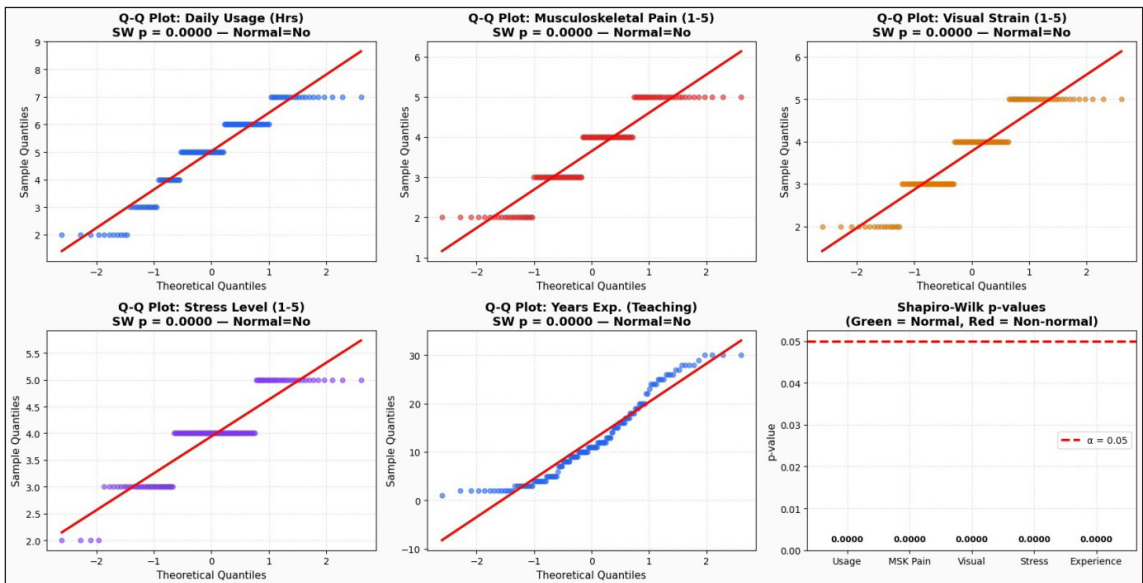


Fig. 8: Normality: Q-Q Plots & Histograms with Normal Curve

The Q–Q plots and Shapiro–Wilk tests indicate that none of the five variables follows a normal distribution. Daily Usage, Musculoskeletal Pain, Visual Strain, Stress Level, and Years of Teaching all show noticeable deviations from the diagonal reference line in their respective Q–Q plots. The Shapiro–Wilk tests produced p-values of 0.0000 ($p < .001$) for all variables, which are below the significance level of 0.05. Therefore, the null hypothesis of normality is rejected for all variables. These findings indicate a violation of the normality assumption, suggesting that appropriate non-parametric statistical tests may be considered for subsequent analysis (Fig. 8).

The correlation matrix shows several important relationships among the study variables. Age and experience have a very strong positive correlation ($r = 0.973$), indicating that older participants generally have greater work experience. Age and musculoskeletal pain are positively correlated ($r = 0.780$), while experience and pain also show a strong positive relationship ($r = 0.732$). Daily usage has a strong negative correlation with musculoskeletal pain ($r = -0.765$). Visual strain and stress show a strong positive association ($r = 0.726$). Overall, the findings indicate substantial associations among variables, although correlation alone cannot establish causation (Fig. 9).

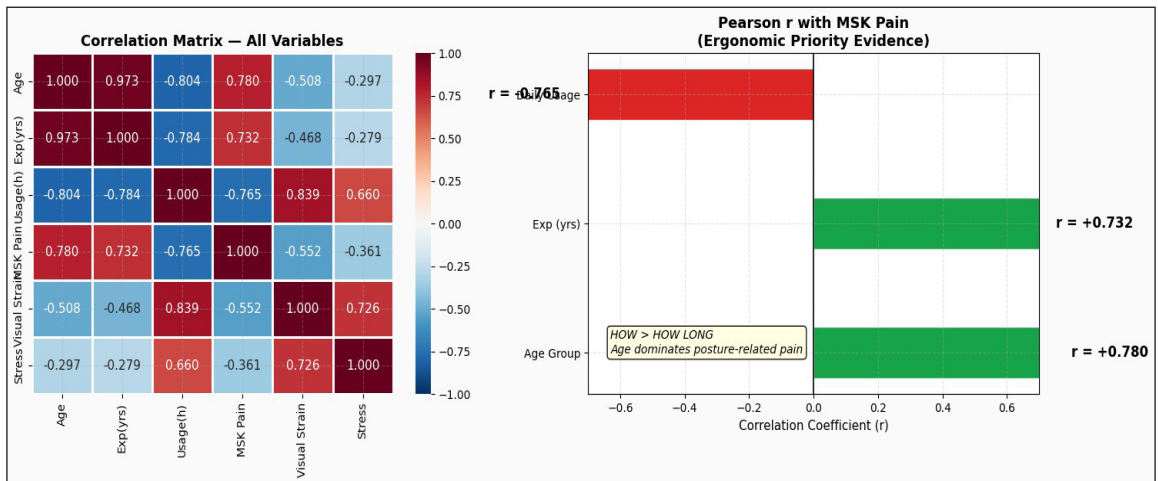


Fig. 9: Proof of Ergonomic Priority: Correlation Analysis

Strategic recommendations

1. Enforce 5-hr daily usage ceiling with Digital Wellness SOP
2. Mandatory ergonomic training--prioritise 41+ cohort
3. Anti-glare screens + adjustable mounts as standard Capital Expenditure
4. Annual PLI health audits to measure intervention ROI (Return on Investment)
5. Stress & retention programme for 31-40 mid-career teachers
6. Shift: Equipment Procurement → User Wellbeing Management

DISCUSSION

The current research study examined how Smart Board technology affects the physical health and mental well-being of teachers who work at schools in Kolkata, West Bengal. The study results showed that there exists a strong connection between digital teaching technologies and multiple health conditions which include visual strain and musculoskeletal disorders and occupational stress. The health effects of technology used in educational settings have been confirmed through these findings which match earlier research studies. The results of our study represented that there is significant visual strain for teachers. Whereas, on a positive note, respiratory issues are less common among teachers. The analysis of correlations showed that daily Smart Board usage correlates with visual strain, which means that people who spend more time using digital screens will develop greater eye fatigue and other symptoms. Gammoh (2021) found that people who watch digital screens for extended periods will develop symptoms which include blurred vision and headaches and dry eyes. According to Aljaradin, Almekhlafi, and Alkaabi (2024), using more digital devices in educational institutions create significant eye problems among teachers as well as students.

The study concluded that teachers had increased psychological and visual strain when using Smart Boards over 5 hours per day. Once they exceed the established time frame of usage, there was a significant

increase in visual strain as indicated by ANOVA analysis. Research has shown that prolonged use of computers or screens could lead to potential health problems. Huygens (2013) pointed out that students who do dedicated screen time for long periods without taking breaks and using appropriate ergonomics will experience visual fatigue and musculoskeletal disorders. The study discovered that teachers face elevated work-related stress, which particularly affects teachers between 31 and 40 years old. Research on teacher motivation also indicates that teachers' job satisfaction and effectiveness are influenced by intrinsic factors such as recognition, professional growth, autonomy, and supportive working environments, suggesting that institutional conditions may play an important role in maintaining teacher motivation and well-being (Pal, 2025). The results showed that nearly 74.7% of teachers reported high stress levels, suggesting that the adoption of digital technologies may increase cognitive workload and job-related pressure. The research conducted by Seffah, Kuhail, and Negreiros (2021) found that teachers need to manage the technical aspects of online teaching along with their teaching duties, resulting in increased levels of stress and mental workloads for these educators. In a study performed by Moses and Sadiq (2026) concluded that technological advancements in the classroom improve student outcomes, but they also create more difficulties for teachers as they need to be tech savvy and it has complexed their teaching activities. Also, the results of these studies indicate that teachers who are older than 50 experience higher rates of musculoskeletal pain than any other age group. The researchers concluded that age is a better predictor of pain than the amount of time a teacher has used Smartboards.

The research supports the findings from Kraemer and Moreira (2021), showed that teachers experience neck and shoulder and lower back pain because they need to repeat movements and stand for long periods and use incorrect postures while teaching. Poor classroom ergonomic conditions lead to major musculoskeletal health issues which educators experience according to Kundra Jha and Dhiman (2024).

Younger teachers reported visual strain because they used digital devices more while older teachers suffered from stronger physical discomfort. Straker and Howie (2016) found that teachers develop musculoskeletal problems because their physical workload and age-related factors determine their working capacity. Therisa and Sony 2016 [33] established that educational institutions must implement ergonomic workplace design to protect teachers from musculoskeletal stress. Through this study, we found that different age groups experience distinct health symptoms. The age group between 25 and 30 years produced the highest number of Smart Board users who studied Smart Board usage and visual strain, while older teachers dealt with more serious physical problems. The different technological effects on educators show how technology use changes with age. Yalman and Basaran (2021) explained that younger educators use digital technologies more frequently which leads to increased.

The study demonstrates how ergonomic designs of classrooms serve as a solution to stop technology-related health problems which students face in educational institutions. Several scholars have shown that educational spaces which lack proper design make students experience physical distress and decrease their ability to study. Akuh (2024) showed that educators face higher chances of developing musculoskeletal disorders because of incorrect arrangement of classroom furniture and display items. Anagha (2022) concluded that ergonomic classroom design enables teachers to experience greater comfort which enhances their teaching performance. The study also proved how physical and visual health problems affect both teacher productivity and institutional performance. The economic impact model developed in this research suggests that health problems related to digital teaching technologies may lead to productivity loss, absenteeism, and increased staff turnover. Moreover, Mrugalska, Karwowski, and Ahram (2026) stated

that it is important for educational institutions to mitigate both ergonomic and health problems created by digital technology, as these issues impact the performance of teachers as well as institutional productivity.

The research demonstrates that digital board technology reduces respiratory problems which it replaces from conventional chalkboard use. The data shows that only a few respondents experienced respiratory issues which demonstrates that digital teaching methods decrease chalk dust exposure. Previous research established that technology-based teaching tools enhance classroom environmental conditions which this observation confirms (Ocaña Gomez & Rodríguez Leonel, 2015). The research results show that Smart Board technology delivers educational benefits but it creates health risks when educators use the technology. The combination of digital tools and educational methods helps students learn better but it creates new health risks which educators must manage. Classroom technology needs assessment because Sawlani (2025) explained that all educational environments need ergonomic solutions with health considerations to operate long term. The research results add new insights about teacher health within classrooms which use modern technological systems. The research demonstrates that extended Smart Board usage leads to higher visual discomfort and stress levels but musculoskeletal pain results from both ergonomic conditions and chronological age. Schools need to implement institutional regulations and ergonomic standards and digital wellness programs which help protect teacher health while they use educational technology.

Business and Economic Insights

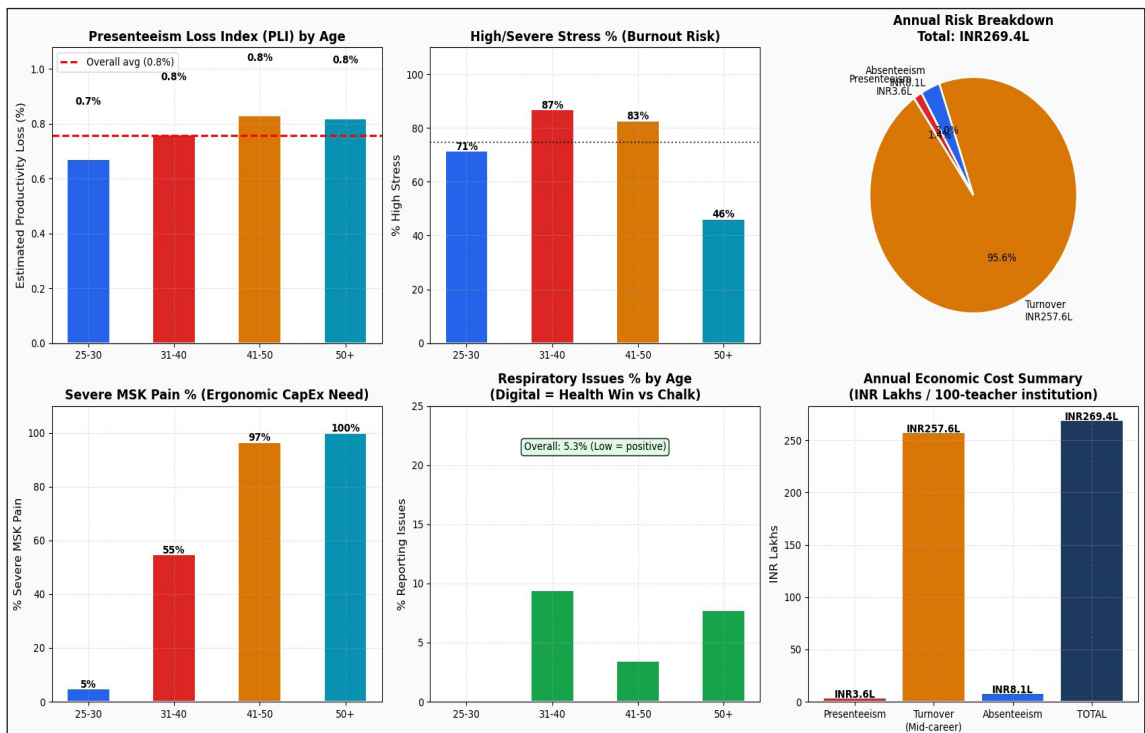


Fig. 10: Business & Economic Insights

Data collected from 150 Kolkata school teachers were analyzed and found to show that Smart Boards present health challenges to teachers and financial challenges to educational institutions. The data show both the physical and psychological effects of Smart Board use on teachers, as well as the costs incurred by the organizations in terms of lost productivity, staff absenteeism and staff turnover. The economic model developed as part of this study provides a financial estimate to a typical organization with 100 teachers for those costs. The results indicate that the total annual risk related to technology-associated health issues may reach approximately INR 269.4 lakhs per year. The economic burden of this situation arises from three primary components which include turnover costs and absenteeism and productivity decline resulting from employees working while unwell (Fig. 11).

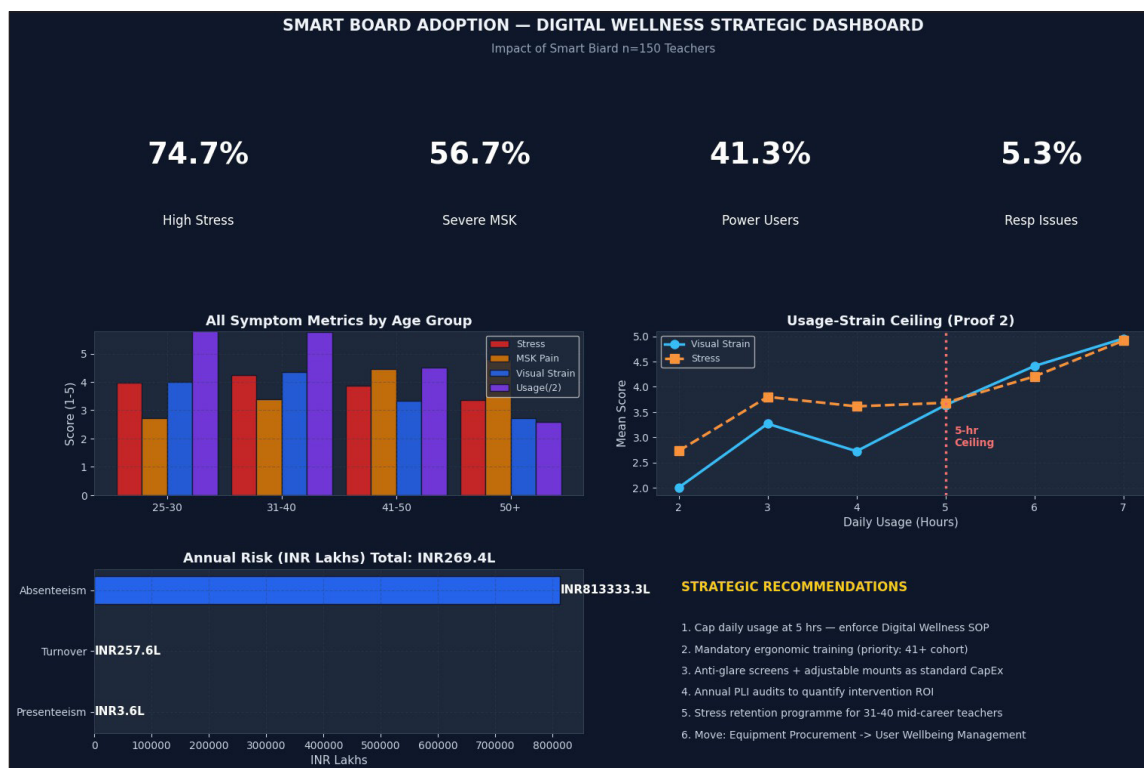


Fig. 11: Smart Board Adoption – Digital Wellness Strategic Dashboard

Presenteeism and Productivity Loss

The term presenteeism describes the situation when employees work through their health issues, which results in decreased work performance. The analysis shows an average Presenteeism Loss Index (PLI) of approximately 0.8% across all age groups. The total impact of this small percentage becomes significant when applied to an entire organization. The 25-30 age group of teachers achieved a 0.7% PLI, while the 31-40, 41-50, and 50+ age groups of teachers experienced a productivity decline of approximately 0.8%. The research signifies that younger educators appear to adapt more effectively to using digital tools; however, they tend to exhibit poorer work performance if they engage in using technology for an extended

time frame. The cost to the economy due to presenteeism leads to an estimated annual productivity loss of INR 3.6 lakhs billion per 100 of these professionals. The smallest economic component contributes to the total impact, yet it matters because it shows hidden productivity costs, which institutions often neglect during their planning process (Fig. 10).

Absenteeism Costs

Teachers need to take unpaid time off from their jobs because they experience health issues which include musculoskeletal pain and visual fatigue and stress-related conditions. The research results show that health problems which teachers experience from digital teaching will result in absenteeism costs of approximately INR 8.1 lakhs for every 100 teachers. The research shows that older teachers they experience musculoskeletal disorders while younger teachers they experience visual strain which leads to absenteeism. The research findings support occupational health research which shows that technology-related physical strain causes both increased sick leave and decreased workforce availability (Fig. 10).

Staff Turnover and Replacement Costs

The economic risk which this research study considers to be most important involves teacher turnover because teachers aged 31 to 40 experience the highest stress levels which 87 percent of them report as high. Mid-career teachers who experience high occupational stress will develop increased chances of career changes and burnout. The estimated annual turnover cost is approximately INR 257.6 lakhs per 100 teachers which constitutes 95.6 percent of the total economic risk that this analysis discovered. The costs cover all expenses which occur during the recruitment and training processes and during the periods when staff members need replacement their instructional quality decreases. Educational institutions face significant financial risks because teacher burnout and stress from digital teaching environments create long-term financial obligations (Fig. 10).

Age-wise Economic Risk Distribution

The economic analysis shows that different age groups show different levels of financial risk. The age group of 31 to 40 year old teachers creates the highest institutional risk because they face high stress and burnout threats. The age group of 41 to 50 year old teachers and teachers who are 50 years old and above face a higher risk of developing musculoskeletal issues which will lead to increased medical expenses and missing work days. Teachers between 25 and 30 years old demonstrate high digital teaching technology use because they experience visual problems instead of developing long term musculoskeletal disorders. Their economic risk remains lower than that of mid-career and senior educators because their economic risk is linked to their profession (Fig. 10).

Positive Environmental Impact of Digital Boards & Strategic Implications for Educational Institutions

The Smart Board implementation created one beneficial result because it decreased respiratory problems which were linked to chalk dust exposure despite the study's health issues. Only 5.3% of respondents reported respiratory problems, which indicates that digital boards create a healthier classroom environment than traditional chalkboards. The study demonstrates that digital technologies introduce new ergonomic

and visual challenges, which existence leads to reduced environmental health risks throughout classroom spaces. Institutional strategic analysis shows that educational institutions require effective health management systems to handle their technology-based classroom environments. Educational institutions should move beyond focusing solely on technology procurement and instead adopt a broader approach that prioritizes teacher well-being and sustainable technology use.

The economic insights from this study demonstrate that educational institutions need to develop health management strategies for their technology-enabled classroom systems. Educational institutions should move beyond their current practice of purchasing educational technology to create a better system which protects teacher health and promotes responsible technology practices.

The following strategic measures exist to minimize economic threats:

1. The establishment of a daily Smart Board usage limit which restricts usage to five hours will help prevent users from experiencing visual discomfort.
2. Teachers need to receive mandatory ergonomic training which focuses on their specific needs especially for teachers who are above 40 years old.
3. The installation of anti-glare screens together with adjustable Smart Board mounts will help users decrease visual fatigue and physical discomfort.
4. Educational institutions will perform digital wellness assessments each year to track their teachers' health status and work efficiency.
5. Mid-career teachers who face the highest burnout risk will benefit from programs which teach them stress management techniques and help them stay at work. Educational Institutions can lower their technology-related health expenses through institutional policy implementation of these measures while research demonstrates that Smart Board technology brings educational advantages.

CONCLUSION & FURTHER SCOPE OF RESEARCH

The research studied how Smart Board technology affects health and well-being of teachers who work in 150 educational institutions located in Kolkata, West Bengal. The study results show that Smart Boards improve digital teaching methods but ongoing Smart Board use leads to serious health problems which include visual distress and body pain and work-related tension. The research demonstrated that daily Smart Board usage above five hours results in greater symptoms for users while younger teachers faced increased visual fatigue and older teachers experienced increased body pain. The research demonstrated how organizational factors lead to decreased productivity and increased staff absenteeism and higher chances of teacher turnover. The implementation of digital boards has led to decreased respiratory problems which stem from chalk dust exposure although the system faces several difficulties. Future researchers must extend this research by evaluating multiple participants from a wider variety of geographic and educational backgrounds. Then we can make a concluding remark about the impact of smart boards on long-term health outcomes, ergonomics, and institutional policies on digital health and sustainability in classroom settings.

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors

developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

Limitations

Although this study provides valuable insights into the health and economic impacts of Smart Board usage among teachers, several limitations should be acknowledged. The study was limited to 150 educators from schools in the Kolkata region, which may restrict the generalizability of the findings to other geographical areas or educational contexts. Data were collected primarily through self-reported questionnaires, which may introduce response bias or subjective interpretation of health symptoms. Additionally, the study focused mainly on short-term health indicators and did not examine long-term medical outcomes related to prolonged digital technology use. Future research should incorporate larger, more diverse samples and include clinical or ergonomic assessments for more comprehensive analysis.

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