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A Definite Approach Towards Smart Classroom Equipped with Proper Acoustical Treatment, HVAC, Structural Arrangement and Human Psychology.

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Abstract

Modern education can't be completed without smart classrooms, which improves learning through the use of technology and innovative design. However, a thorough strategy that considers the acoustics, heating, ventilation, and air conditioning (HVAC), structural layout, and human psychology is essential for guaranteeing the best performance and student comfort. Undesirable noise and echoes that can have a negative impact on the learning environment and outcomes must be reduced through acoustical treatment. In order to foster successful learning and cooperation, structural arrangement which includes room design, furniture placement, an appealing environment, and color is equally important. At last, a smart classroom may be designed to support motivation and engagement by taking into account human psychology and the influence of the physical environment on learning and behavior. The objective is to combine current engineering and technology to produce the best results from the classes, which would be done taking into account the fundamental human criteria and logical layout.

Keywords: *Innovative design; negative impact; structural layout; student success.*

1 Introduction

Smart classrooms enable presentation, student involvement, interaction, and atmosphere. Add attendance, testing, and quick replies (Saini and Goel 2019). Smart classrooms feature smart content, engagement, assessment, and environment. Smart classrooms need several things. Infrastructure must function. High-speed internet enables real-time communication, online information, and multimedia content delivery. Power and networking are required. Smart classrooms employ hardware. Interactive classrooms employ touch-screens or whiteboards. Projectors or smart displays deliver vivid pictures. Laptops provide students and instructors instructional tools, internet platforms, and digital material. Tablets aid learning. Real-time document cameras enhance visual learning. Classrooms require microphones and speakers. Smart classrooms require software. Content creation, classroom administration, and interactive learning are available. These tools assist teachers evaluate and present multimedia. Online content, cloud apps, and communication platforms need internet access. Student-teacher collaboration improves. Fast internet aids studies. Smart classrooms employ media. Videos, simulations, and online platforms may enrich classes. These aid in seeing, doing, and remembering. The smart classroom-based instructional approach displays learning contents, conducts learning activities, facilitates teacher-student interaction, and completes classroom instruction efficiently through the use of smart technologies (such as interactive white boards, IWBs; terminal IDs; cloud-based learning platform) (Shi et al. 2018). Students evaluated cloud-based learning assignments and resources. Instructors assign reading. Smart technology-based interactive demos may increase student-teacher engagement. The cloud-based learning tool lets students study course content and continue class discussions after class. Smart classroom students self-constructed knowledge and solved problems. This smart classroom incorporates TIDs, an interactive whiteboard, and a cloud-based learning platform. Teachers' notes, remarks, and student reactions. Figure 1 shows smart classrooms. Smart instructors may utilize the cloud-based learning platform, interactive whiteboard, and transformational instructional devices (TIDs) for problem-driven learning. This clever education technology helps teachers interact with pupils. Students may share IWB or TID learning resources. IWB and cloud-based learning platform instructors may evaluate and provide student's immediate feedback. Smart classrooms encourage self-learning via autonomy, collaboration, and curiosity. Smart classrooms teach, not impress. Engineers and architects can smarten any classroom with structural, HVAC, and mindset principles. Technology aids learning. Code compliance and assembly benefit the environment.

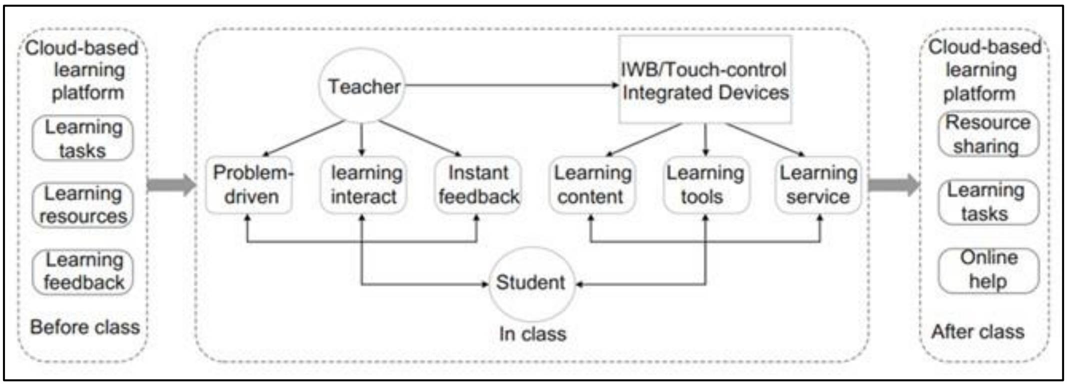

Figure 1. Framework of the smart classroom-based instructional approach (Shi et al. 2018)

2 Methodology

The major purpose of this piece of writing is to establish the concept behind what is known as the smart classroom. In order to accomplish this goal, a survey was carried out with the assistance of google forms, and the data that was gathered from that survey was afterwards analyzed. Following that, a suggestion was made for a classroom with the objective of including all of the requirements and based it on the findings of the survey. The graphs and charts were generated with the help of a piece of software known as IBM SPSS, and the model was crafted with the assistance of SketchUp and AutoCAD. Every single one of the measurements was adjusted to meet the requirements of the standard.

3 Noise Parameters and Measurement in Classroom

Research reveals noise (dB-dBA) is most significant. It impacts kids' and instructors' health and learning (Tiesler, Machner, and Brokmann 2015). RT and STI assess classroom listening. These two argue classroom acoustics. Acoustic measurements are most often reverberation. Understanding the instructor (Tiesler et al. 2015). Clarity impacts learning. Static, pulsating, and semantic noise exist. Background noise or student activities caused classroom noise. HVAC and other electronics are inside, while traffic, halls, and playgrounds are outside. The classroom is noisy regardless of activity. Background noise affects students and teachers (Waye et al. 2019). Students talk, touch, move, and rearrange furniture. discovered that subject, number of students, age, and teaching approach affect classroom volume. The WHO (2015) recommends 35-dBA community noise during courses. Over-40-dB classroom noise disturbs (Hadzi-Nikolova et al. 2013). Acoustics affect schooling. These traits affect student engagement, communication, and attention. Acoustics assist students hear lectures. Noise reduction. Acoustics help kids understand and recall speech. Sound improves attention and reduces fatigue. Classroom acoustics may aid learning. Acoustics affect classroom comfort. Auditory verification often requires many steps. Long-term viability. Sound balance expands space. Noise and sound are equally unpleasant since noise is the main issue. Thus, classroom noise must not interfere. Job-specific equipment and diffusers reduce noise and echo. Student learning will be difficult without proper acoustical treatment. Inappropriate classroom noise. Acoustics silent classrooms. 500 Hz is loudest (Krü and Zannin 2004). Meaningful noise. Student or outside noise may trigger it. These produce classroom noise without action. Noise affects teachers and pupils. Students converse and move seats and tables. Student numbers, ages, and subjects affect activity noise. The WHO (2015) recommends 35 dBA neighborhood noise for teaching. 40+ dB classroom noise (Anon n.d.). The performance in the classroom as well as the communication between the instructor and students is enhanced when speech is clear. The clarity of instruction in the classroom is essential to audience comprehension. It's possible that late ideas will ruin your speech. Echoes blur. When it comes to the intelligibility of classroom speech, direct sound far outweighs reflected sound. The direct sound is amplified by early reflections, but the quality of later reflections is diminished. The behavior of the students might improve. The audibility of speech can be affected by frequency. The highest-frequency speech was the easiest to understand. Clarity from low frequencies 125–2000 Hz (Mogas Recalde, Palau, and Márquez 2021)

4 Evaluation of Thermal Control in Classroom

Good learning environments analyze students' thermal comfort. Temperature affects mood. Body temperature, relative humidity, airflow, and garment insulation may affect this reaction. Equipment measures air velocity, radiant temperature, humidity, and temperature. Measurements accurately evaluate classroom temperature. PMV and PPD data predict thermal comfort. These models calculate comfort from several parameters. Student temperature votes. ASHRAE's (American Society of Heating, Refrigerating and Air-Conditioning) seven-point thermal sense scale shows these ranks. Mean thermal feeling vote evaluates temperature comfort. Surveys may provide thermal comfort indices. Predicted percentage of Unsatisfied (PPD) and Adaptive thermal comfort model include occupants' adaptive behavior and garment insulation. Comparing data may determine classroom thermal comfort. This estimate includes objective metrics, survey responses, and generated indices. ASHRAE Standard 55 or ISO 7730 (Krü and Zannin 2004) may evaluate your results. Standards show. Assessments may boost thermal comfort. HVAC, insulation, window coverings, and other changes may enhance thermal comfort. Use fan heaters. Continuous temperature comfort monitoring. Satisfaction and feedback may measure changes. These technologies let schools accurately assess classroom thermal comfort and make adjustments for a pleasant learning environment. Meeting school needs.

5 Evaluation of Luminist Control in Classroom

Thermal and auditory comfort affect student learning, but luminous comfort affects energy usage in schools, which employ artificial lighting.

Table 1. Energy profile of commercial and public buildings with and without HVAC system

End use	With HVAC system (%)	Without HVAC system (%)
Illumination	24	70
Air conditioning	46	-
Elevators	15	14
Office equipment	15	16
Total	100	100

Given the high energy usage of artificial lighting, effective use of daylight can be a crucial energy-saving tactic in schools, provided it lessens the need for artificial lighting. The following actions are suggested to lower energy consumption (Krü and Zannin 2004; Yang et al. 2018):

- Better use of daylight,
- Minimization of light bulbs use,
- Minimization of the installed power, by using more efficient energetic components, electronic reactors and more efficient light bulbs.

A good lighting project uses existing lighting systems and natural light to provide task-specific lighting levels while conserving energy.

6 Teacher Student Relationship in a Smart Classroom

Smart classrooms provide a broad number of possibilities that the interactors may simply employ to establish a multidimensional medium of transferring information. This would assist them in having a relationship with one another that would persist for a much longer period of time. The following category describes the types of interactions that can take place within a smart classroom:

- teacher-student interaction.
- Student-student interaction.
- Teacher-media interaction.
- Student-media interaction.

It is possible that SCs are differentiated from traditional classrooms by the fact that they enable teacher-student contact through the use of smart terminals and mobile learning platforms. Whereas teachers in TMCs are required to rely on their own teaching expertise and intuition, teachers in SCs are able to use smart terminals and learning analytics to quickly and accurately assess students' academic progress and make necessary pedagogical adjustments to meet students' needs. This is in contrast to the situation in TMCs, where teachers are not given these tools. The resource platform of SCs may store learning materials in an organized format and utilize log data to evaluate students' academic progress. It is possible that one way that SCs enable increased learning is through the provision of online assignments, questions and answers, and learning tools. It is feasible that the teaching response system will also collect input from students on activities that are taking place in the classroom, so making interactions more precise and uncomplicated.

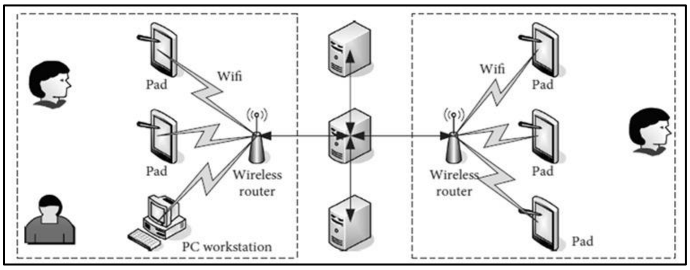

Figure 2. The system structure of IoT based smart classroom (Nai 2022)

7 Smart Physical Surroundings

The efficiency of a classroom can be impacted by a variety of elements, including the quality of the air, the lighting, the temperature, the humidity, the noise, and the radiation. Table 2 details classroom essentials. It's possible that the air quality in the classroom will suffer due to the cramped conditions and the high number of people there.

Table 2. Parameters of Physical Surroundings (Kaur, Bhatia, and Stea 2022)

Major Physical Surrounding Factors	Required	Control Procedure
Temperature	24 to 26 Celsius	Advanced air conditioning systems control air temperature.
Humidity	40% to 60%	GSM-based system, humidity dehumidifier, ventilation
Radiation	None (except sunlight)	Insulating the origin of radiation or the classrooms
VOCs	Below 200 g/m^3	Mainly ventilation systems
NO_2	Annual average below 0.03 ppm, hourly average below 0.14 ppm	Ventilation systems
CO_2	Below 800 ppm	Mainly ventilation systems
Sound level	24 dB above noise level	Noise detection and audio volume monitoring are automated.
Audio noise level	Below 48.7 dB	Sound insulation
Lighting	1400–3000 Lux	Automatic lighting monitoring
CO	Below 25 ppm per hour	Mainly ventilation systems

9 Proposed Design Considerations

While conducting the brief survey, several considerations were kept such as finding out the HVAC requirements by the students, drawing out the classroom considerations, keeping all the multimedia element involved, finding out near what more was needed, and after all that, the designs were proposed according to the context of our country. Furthermore, each class was considered to have several segments such as multimedia corner, group study area, content related library etc.

Our survey found that on average, a class with inadequate space has almost 30 students.

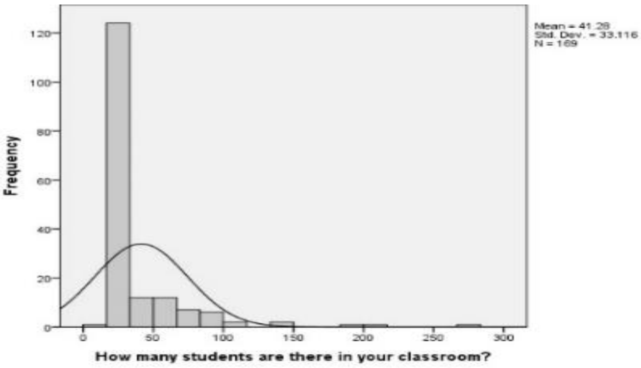

Figure 3. Survey data of number of students.

These classes lack multimedia facilities and here, in order to obtain a smart classroom, we must follow several considerations leading to technology and innovation.

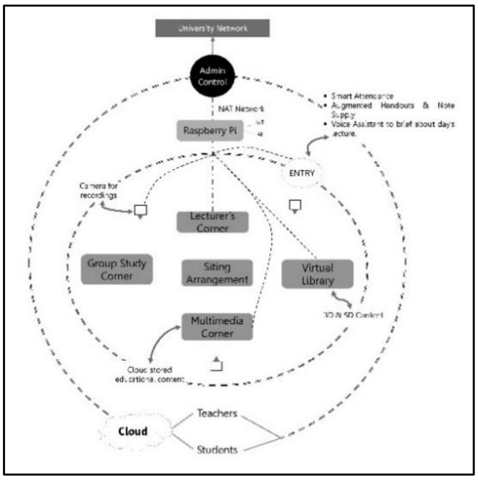

Figure 4. Prototype based on which the design was implemented.

The prototype was followed in order to establish a smart classroom. Here, the classes are designed with Iot, NAT network, digital attendance system, virtual library and ample space for the students to learn and to aspire.

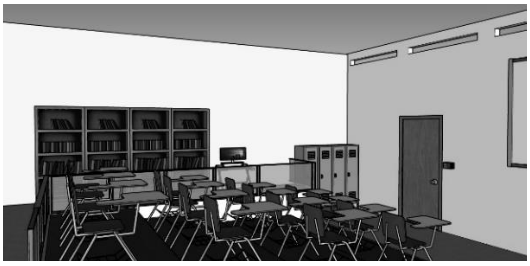

Figure 5. Coursed based material library inside the classroom.

The multimedia and group study corner will have all the digital materials needed for a smart education process. The classroom dimension is set as 25′×35′.

Figure 6. Multimedia corner at the back which will provide all digitilized content of related course materials.

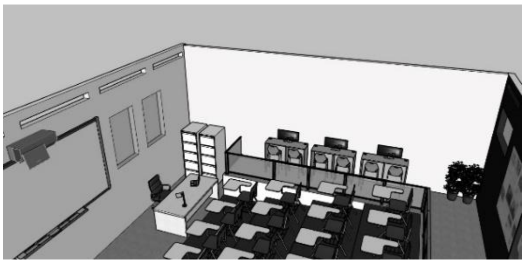

Figure 7. Group study corner and internet access facilities for obtaining proper IoT facilities.

10. Conclusion

The way that education is delivered is on the verge of undergoing a profound transformation as a result of rapid technological advancement. In order to get the most out of what the modern world has to offer, we need to learn in classrooms that are as technologically advanced as possible. It is imperative that the layout of a smart classroom adhere to all relevant engineering and architectural standards in order for it to be both reliable and productive.

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