



Smart Classroom Seat Allocation System Using IoT, Artificial Intelligence, Machine Learning and Optimization Techniques: A Review

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Abstract: The transformation of conventional classrooms into intelligent learning environments has created new opportunities for automating classroom management and improving student learning experiences. Among these challenges, student seat allocation is an important task because seating arrangements can influence accessibility, classroom interaction, student engagement, learning conditions and effective utilization of available space. Traditional seat allocation is predominantly performed manually and becomes increasingly complex when the number of students, classrooms and allocation constraints increases. A Smart Classroom Seat Allocation System can address these limitations by integrating the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML) and optimization techniques. This paper presents a comprehensive review of research published between 2020 and 2026 concerning classroom seating, intelligent seat allocation, smart classroom technologies, IoT-based monitoring and optimization-based allocation approaches. Existing studies have explored genetic algorithms, mathematical programming, graph-based heuristics, agent-based modelling, sociometric sensing, RFID, IoT devices and automated classroom management systems. Research findings indicate that seating position and proximity can affect student engagement, academic performance, peer interaction and social relationships. IoT technologies can further provide real-time information regarding seat occupancy and classroom conditions, enabling dynamic allocation and monitoring. However, existing approaches frequently address individual aspects of the problem, such as examination seating, social distancing, classroom interaction or occupancy monitoring, rather than providing an integrated allocation framework. Therefore, there is a significant opportunity to develop an adaptive system that combines student characteristics, classroom constraints, seat availability, accessibility requirements, learning preferences and real-time occupancy information within a unified optimization framework. This review examines existing approaches, identifies their limitations and research gaps and discusses potential applications and future directions for developing intelligent, flexible and scalable smart classroom seat allocation systems.

Keywords: Smart Classroom, Seat Allocation, Artificial Intelligence, Machine Learning, Internet of Things, Optimization, RFID, Student Management, Smart Education.

I. INTRODUCTION

The rapid advancement of Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, wireless communication and data-driven technologies is transforming conventional educational environments into intelligent and connected learning spaces. A smart classroom integrates digital infrastructure, sensors, connected devices, learning analytics and intelligent software to support teaching, learning and classroom administration. Such environments can continuously collect information from physical classroom infrastructure and use computational techniques to support timely and informed decisions.

One important area of smart classroom management is student seat allocation. In a conventional classroom, seats are commonly assigned manually by teachers or administrators. Although manual allocation may be adequate for small groups, it becomes increasingly difficult when classrooms contain a large number of students or when multiple allocation conditions must be considered simultaneously. Repeated manual changes can also result in inefficient use of classroom space, allocation errors and additional administrative effort.

The seat allocation problem becomes more complex when different types of constraints are introduced. For example, students may require specific seating locations because of accessibility requirements, visibility, hearing considerations



or proximity to the instructor. During examinations, students may need to be separated according to institutional rules. In collaborative learning environments, students may need to be placed within groups, while in other situations certain students may need to be positioned apart. Consequently, classroom seat allocation can be represented as a constrained optimization problem involving both hard constraints and soft constraints.

Hard constraints represent conditions that must always be satisfied. These may include assigning each student to at most one seat, ensuring that each seat is assigned to at most one student, maintaining classroom capacity and ensuring that required accessible seats are available. Soft constraints represent preferences or desirable conditions, such as maintaining an appropriate distance from the instructor, supporting group interaction, considering student preferences or improving classroom visibility. An intelligent allocation system can attempt to satisfy hard constraints completely while optimizing the satisfaction of soft constraints.

Recent research demonstrates that classroom seating is not merely a physical arrangement but can influence educational and social outcomes. Will et al. (2020) investigated classroom seating location and computer use among 1,364 students and reported an association between seating distance from the instructor and academic performance. Similarly, Faur and Laursen (2022) examined classroom seat proximity and friendship formation and reported that students seated closer to one another were more likely to develop friendships. These studies demonstrate the importance of considering seating arrangements as part of the broader learning environment.

Optimization techniques provide an effective computational approach for solving complex allocation problems. Genetic Algorithms (GA), mathematical programming, graph-based heuristics and local-search methods can evaluate a large number of possible seating configurations and identify solutions according to predefined objectives. Dunder and Karakose (2023), for example, investigated classroom seat assignment models using optimization and graph-based approaches under distancing constraints. Such research demonstrates the potential of computational optimization for generating feasible seating arrangements more efficiently than manual approaches.

IoT technologies provide another important foundation for intelligent seat allocation. Sensors, RFID devices, microcontrollers and wireless communication technologies can be used to determine whether seats are occupied and transmit the information to a central application. Ojo et al. (2022) investigated an IoT-based real-time classroom monitoring and seat-allotment system and reported improvements in allocation time compared with conventional approaches. Real-time occupancy information can therefore complement optimization algorithms by allowing the system to respond to changes in classroom conditions.

Artificial Intelligence can further enhance the allocation process by analysing historical and real-time data. Machine Learning techniques may be used to identify patterns in student preferences, classroom occupancy and interaction, while optimization algorithms can use these patterns to generate suitable seating configurations. Combining AI with IoT can therefore transform seat allocation from a static administrative task into an adaptive decision-making process.

A comprehensive smart classroom seat allocation framework can be represented as an integration of four major components: student information, classroom information, intelligent optimization and real-time IoT monitoring. Student information may include academic or administrative identifiers, accessibility requirements and approved seating preferences. Classroom information may include seat positions, capacity and physical constraints. Optimization algorithms can determine appropriate allocations, while IoT devices can monitor real-time seat occupancy and update the system when changes occur.

Despite considerable research in classroom seating, smart classrooms and optimization, existing studies frequently focus on specific aspects of the problem. Some studies concentrate on examination seating, while others investigate social interaction, distancing, classroom monitoring or smart infrastructure. Few approaches attempt to integrate these dimensions into a unified intelligent seat allocation framework.

Therefore, this review examines existing research on smart classroom seat allocation and related technologies from 2020 to 2026. The study focuses on seating behaviour, optimization techniques, IoT-based monitoring, AI-assisted decision-making and intelligent classroom management. The objective is to identify existing approaches, compare their contributions and limitations, determine research gaps and establish directions for developing a flexible and adaptive smart classroom seat allocation system.

The remainder of this paper discusses the existing literature, problem formulation, system architecture, relevant algorithms, IoT and AI technologies, applications, research challenges and future research directions.



II. LITERATURE SURVEY

Smart classroom seat allocation has become an important research area with the development of Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), optimization algorithms and data-driven classroom management systems. Recent studies have shown that classroom seating can influence academic performance, student engagement, interaction, collaboration, social relationships and classroom management. Researchers have proposed different approaches including seating-layout analysis, mathematical optimization, Genetic Algorithms (GA), IoT-based monitoring, agent-based modeling and social-network-based seat assignment. Recent research also emphasizes the need for intelligent systems that consider student preferences, learning requirements, interpersonal relationships, classroom constraints and real-time information while generating seating arrangements.

Charytitsch and Nascimento (2026) introduced the Student Seat Allocation Problem (SSAP), focusing on conflict-aware seating arrangements in classrooms. The study developed a mathematical model to minimize interpersonal conflicts between students and proposed an Iterated Local Search (ILS) heuristic for solving the problem. Computational experiments were performed using real and artificial instances containing different levels of student conflicts. The results showed that the ILS approach performed effectively in more complex scenarios and provided an efficient alternative to a commercial optimization solver for larger and more conflict-intensive instances.

Inference: Conflict-aware optimization can improve automated seat allocation by preventing incompatible students from being placed close to each other.

The literature from 2020 to 2026 shows that classroom seat allocation has evolved from simple fixed seating arrangements toward intelligent, constraint-based, IoT-enabled and optimization-driven systems. Earlier studies mainly examined the effects of seat position and classroom layout on academic performance, engagement and interaction. Later studies introduced IoT-based automation, Genetic Algorithms, mathematical optimization, social-network modeling and conflict-aware optimization. However, many existing systems focus on only one objective, such as examination seating, social distancing, engagement or conflict reduction. A comprehensive system that simultaneously considers student preferences, academic requirements, interpersonal conflicts, teacher proximity, classroom capacity, accessibility and real-time seat availability remains an important research opportunity.

Inference: Future smart classroom seat allocation systems should integrate multiple student, classroom and environmental constraints within a unified intelligent optimization framework.

The comparative analysis demonstrates that existing studies use different approaches such as experimental seating analysis, IoT automation, Genetic Algorithms, mathematical optimization, agent-based modeling and social-network analysis. However, no single approach completely addresses all practical requirements of a smart classroom seat allocation system.

Hill et al. (2025) proposed a new class of social classroom seating assignment problems in which students are assigned seats to increase opportunities for interaction with unfamiliar peers. The problem was formulated using students' social networks, physical classroom seating structures and the likelihood of forming new connections. The authors developed integer programming formulations and fast heuristics based on network centrality measures. Experiments were conducted on 320 realistic instances involving classrooms with up to 200 students. The study also considered instructor preferences and special student requirements.

Inference: Social-network information can be incorporated into optimization-based seat allocation to improve student interaction and networking opportunities.

Ibrahim et al. (2024) developed an IoT-based electrical control system for smart classrooms. The system used IoT and Arduino technologies to support automated classroom electrical control and improve classroom management. The work demonstrated the integration of hardware, sensors and connected technologies in a smart classroom environment. Although the study was not specifically focused on student seat allocation, its architecture provides a foundation for integrating automated classroom infrastructure with intelligent management systems. The study also demonstrates the importance of IoT-based infrastructure in developing connected classroom environments.

Inference: IoT classroom infrastructure can provide the technological foundation required for integrating automated seat allocation with smart classroom management.

Dundar and Karakose (2023) proposed mathematical optimization models for classroom seat assignment during the COVID-19 pandemic. The study considered social distancing requirements and classroom area constraints while assigning seats. Optimization models and graph-based heuristic approaches were developed to generate feasible classroom layouts. The researchers showed that heuristic methods could produce suitable seating patterns much faster



than solving the complete optimization model for the tested instances. The study mainly focused on physical distancing requirements rather than academic performance or personalized student characteristics.

Inference: Optimization and heuristic algorithms can efficiently generate classroom seating arrangements under physical and spatial constraints.

Nehyba et al. (2023) examined the influence of seating arrangement on student interaction during group reflective practice. The study involved 58 university students and collected 153 repeated measurements using wearable Sociometric badges. Two seating configurations, namely rows and circles, were compared. The researchers measured interaction intensity using speech rate and average speaking segment length. The results showed differences in interaction between seating arrangements, with the effect also depending on the students' field of study and facilitator involvement. The study demonstrated that seating arrangement can affect communication and group interaction.

Inference: Seat allocation should consider interaction requirements because different seating arrangements can influence student communication.

Lu et al. (2023) investigated the influence of seating factors and motivational factors on student engagement and satisfaction in smart classrooms. The longitudinal study included 113 pre-service teachers from three university courses. The researchers used experience sampling, surveys, hierarchical linear modeling and regression analysis. The results showed that the distance of a student's seat from the classroom center predicted situational engagement. Student engagement was also found to be an important predictor of final course satisfaction. The study confirmed that seating continues to have an influence even in technology-enhanced smart classrooms.

Inference: Smart classroom seat allocation should consider seat location because physical seating position can influence student engagement.

Seet et al. (2022) investigated the effect of seating distance and orientation on student engagement in team-based learning classrooms. The study involved 160 undergraduate medical students in Singapore, including novice and experienced learners. Students were assigned different seating distances from the tutor and different orientations toward the tutor. Engagement was measured using classroom engagement instruments before and after seating changes. The results indicated that seating distance influenced engagement, particularly among novice learners, while seating orientation did not show a significant effect. Students generally preferred seating arrangements that allowed them to face the tutor.

Inference: Seating distance from the instructor can influence engagement, especially for students who have less learning experience.

Faur and Laursen (2022) investigated the relationship between classroom seat proximity and friendship formation. The study included 235 students from grades 3–5 who reported their friendships at two different time points. Teachers provided information about classroom seating arrangements. The results showed that students sitting next to or near one another were more likely to become friends and develop reciprocal friendships. Longitudinal analysis also showed that changes in seating proximity were associated with the formation of new friendships. The study demonstrates that seat assignment can influence students' social relationships.

Inference: Intelligent seat allocation can consider social relationships to encourage positive peer interaction and collaboration.

Ojo et al. (2022) developed an Internet-of-Things-based real-time monitoring system for smart classrooms. The proposed system used IoT technology to automate classroom seat allotment and de-allotment and enabled remote monitoring through connected devices. The system was experimentally compared with traditional seat allocation methods. The authors reported that IoT-based seat allotment reduced allocation time by approximately 30%–50% and achieved higher accuracy compared with traditional allocation. The system demonstrated how IoT can reduce manual effort and improve classroom seat management.

Inference: IoT technology can automate seat allocation and reduce the time and manual effort required for classroom management.

Kaur et al. (2022) presented a comprehensive survey of smart classroom research covering Information and Communication Technology, Machine Learning, sensor networks, cloud computing, hardware, image recognition and other technologies. The review emphasized that smart classrooms require integration of multiple technologies rather than isolated systems. The authors highlighted the importance of developing common frameworks and identifying research challenges across different technological areas. The study also identified opportunities for integrating sensing, communication, automation and intelligent learning environments.



Inference: A smart seat allocation system should be integrated with other classroom technologies instead of functioning as an isolated application.

Chandra et al. (2022) compared different Genetic Algorithm operators for the examination seat allocation problem. The researchers focused on automatically allocating students to examination seats while reducing manual effort, allocation errors and opportunities for malpractice. Different Genetic Algorithm operators were evaluated for the permutation-based seat allocation problem. The study suggested that suitable genetic operators can improve the effectiveness of automated examination seating. However, the work mainly focused on examination seating and did not extensively consider learning preferences, student relationships or real-time classroom conditions.

Inference: Genetic Algorithms can be used to solve complex seat allocation problems involving multiple constraints.

Dong et al. (2021) developed an agent-based model to investigate the influence of teacher-student proximity, teacher feedback and near-seated peer groups on classroom engagement. The model was constructed using previous empirical research and was used to simulate changes in student engagement. The results showed that increased positive teacher feedback improved classroom engagement, particularly for students located closer to the teacher. The engagement level of nearby peers also influenced individual student engagement. The study demonstrated that both physical proximity and peer influence can interact with teacher behaviour to affect classroom engagement.

Inference: Seat allocation should consider teacher proximity and nearby peer influence to support student engagement.

Braun et al. (2020) investigated the effects of a seating-chart intervention on classroom social relationships. The study was conducted with 1,573 students from 59 fifth-grade classrooms in the Netherlands. A randomized controlled trial was used in which students with negative relationships were placed closer together. The researchers examined the effects of the seating intervention on both target and non-target students. The results showed that students in intervention classes reported higher overt aggression and lower cooperation than students in the control condition. The authors suggested that seating changes may initially create tension before social relationships adapt. However, the study demonstrated that seating arrangements can influence classroom social dynamics.

Inference: Seating allocation should consider interpersonal relationships because inappropriate seat assignments may negatively affect classroom interaction.

Will et al. (2020) examined the relationship between classroom seating position, computer usage and academic performance. The study included 1,364 students and approximately 3,000 observations from five introductory psychology courses. The researchers analysed the effect of students' distance from the instructor and computer usage on academic grades. The results showed that sitting farther from the instructor was associated with a decrease of approximately 0.75 percentage points in grades per row, while computer use was associated with a decrease of approximately 3.88 percentage points. The effects of seating position and computer use were additive.

Inference: An intelligent seat allocation system should consider seat position and distance from the instructor when assigning students.

Rogers (2020) studied the effect of different classroom seating layouts on student participation and assessment performance. The study involved 23 fourth-grade students in a Louisiana elementary school. Three seating layouts, namely small groups, horseshoe and pairs, were evaluated through three two-week research periods using mixed-method approaches. According to three of the four data sources, the horseshoe arrangement was the most effective arrangement among the layouts tested. The study demonstrated that classroom layout can influence student participation and learning outcomes. However, the research was conducted with a small group of students in a single school.

Inference: Different classroom layouts can produce different learning outcomes, indicating the importance of selecting suitable seating patterns.

Author & Year	Dataset / Participants	Feature / Method	Result / Outcome	Key Limitation
Charytitsch & Nascimento (2026)	Real and artificial seat-allocation instances	Mathematical model + Iterated Local Search	Effective for conflict-heavy allocation problems	Focuses primarily on interpersonal conflicts
Hill et al. (2025)	320 simulated instances, up to 200 students	Integer programming + network heuristics	Optimized social interaction opportunities	Computational/social objective may not cover all classroom



Author & Year	Dataset Participants	Feature / Method	Result / Outcome	Key Limitation
				needs
Ibrahim et al. (2024)	Smart classroom system	IoT + Arduino automation	Demonstrated connected classroom control	Not specifically focused on seat allocation
Dundar & Karakose (2023)	Classroom layout instances	Optimization + graph heuristics	Fast feasible seating under distancing constraints	Mainly focused on COVID-19 distancing
Nehyba et al. (2023)	58 university students	Rows vs. circles + Sociometric badges	Seating arrangement influenced interaction	Small academic sample
Lu et al. (2023)	113 pre-service teachers	Smart classroom seating + engagement analysis	Seat distance from center predicted engagement	Single university context
Seet et al. (2022)	160 medical students	Seating distance + orientation	Seating distance affected engagement, especially for novice learners	Specific to team-based medical learning
Faur & Laursen (2022)	235 students, Grades 3–5	Seating proximity + friendship analysis	Near-seated students more likely to form friendships	Focused mainly on social relationships
Ojo et al. (2022)	Smart classroom prototype	IoT + automated seat allotment	Approximately 30–50% reduction in allocation time	Limited classroom-scale validation
Kaur et al. (2022)	Smart classroom literature	ICT/ML/IoT/sensor/cloud survey	Identified need for integrated smart-classroom systems	Review study; no experimental allocation model
Chandra et al. (2022)	Examination seat allocation problem	Genetic Algorithm operators	GA operators supported automated seat allocation	Mainly focused on examinations
Dong et al. (2021)	Simulated classroom model	Agent-based modeling	Teacher proximity and peer engagement influenced engagement	Simulation-based study
Braun et al. (2020)	1,573 students, 59 Grade-5 classes	Seating-chart intervention / RCT	Changes in aggression and cooperation were observed	Social effects may initially be negative
Will et al. (2020)	1,364 students	Seating distance + computer use	0.75 grade-point decrease per row; computer use –3.88 points	Limited to psychology courses
Rogers (2020)	23 Grade-4 students	Small groups, horseshoe, pairs	Horseshoe was most effective among tested layouts	Small sample and single school

III. RESEARCH GAP

Although several studies have investigated classroom seating arrangements, smart classroom technologies and automated seat allocation, several research gaps remain unresolved. Most existing studies focus on only one aspect of seating, such as academic performance, student engagement, social interaction, examination seating, or conflict reduction. For example, classroom studies have demonstrated that seating position can influence academic performance and engagement, while optimization studies mainly focus on satisfying spatial or operational constraints.

Another important research gap is the limited integration of multiple student characteristics into a single seat allocation system. Existing approaches may consider seating distance, interpersonal conflicts, or social relationships independently. However, a practical smart classroom system should simultaneously consider academic performance, learning preferences, student relationships, accessibility requirements, teacher proximity and classroom capacity. The integration of these factors can make seat allocation more personalized and effective.



A further gap exists in the integration of real-time IoT information. Some smart classroom projects have demonstrated the use of sensors for occupancy estimation and automatic seat allocation, including infrared sensors for counting students and RFID for examination seat allocation. However, many such systems are prototype-level implementations and do not provide advanced optimization based on individual student characteristics.

Another research gap is the limited use of intelligent optimization techniques for dynamic classroom seating. Genetic Algorithms, mathematical optimization and heuristic methods have been applied to examination seating, social distancing and conflict-aware seating. However, these approaches are often designed for a specific objective and may not simultaneously optimize several classroom requirements. Recent conflict-aware research has introduced the Student Seat Allocation Problem as an optimization problem, demonstrating the potential of intelligent search techniques for complex seating environments.

The lack of real-world validation is also a significant gap. Many studies are conducted using small groups of students, simulated classroom instances, or specific educational environments. Consequently, their effectiveness across different classroom sizes, educational levels, teaching methods and student populations remains uncertain. Large-scale evaluation in real classrooms is required to determine the reliability and scalability of intelligent seat allocation systems.

Finally, few systems provide continuous adaptation of seating arrangements according to changing classroom conditions. Student attendance, classroom occupancy, learning activities, teacher requirements and interpersonal relationships may change over time. Therefore, future systems should provide dynamic and adaptive seat allocation using IoT sensors, optimization algorithms, student information and real-time classroom data.

IV. CHALLENGING ISSUES

Despite significant advancements in artificial intelligence, IoT and optimization techniques, several challenges hinder the practical implementation of smart classroom seat allocation systems.

Multiple Constraint Management: Classroom seat allocation involves several constraints, including classroom capacity, student preferences, teacher visibility, accessibility, interpersonal conflicts and seating availability. Satisfying all constraints simultaneously is computationally challenging.

Student Preference Management: Students may have different preferences regarding front-row seats, center seats, proximity to classmates, visibility of displays, or distance from the instructor. A system must accommodate these preferences without negatively affecting other students.

Academic and Learning Factors: Seating position may influence student engagement and performance. Research has reported relationships between seating location and academic outcomes, while smart-classroom research has also found associations between seat location and situational engagement.

Dynamic Attendance: Students may be absent or enter and leave the classroom at different times. The system must update seat availability dynamically without creating unnecessary reassignment.

Real-Time Occupancy Detection: Accurate detection of occupied and vacant seats requires reliable sensors or other identification technologies. IoT-based classroom systems have demonstrated the use of sensors and RFID for occupancy and seat allocation.

Optimization Complexity: As classroom size and the number of constraints increase, the number of possible seating combinations becomes extremely large. Exact optimization methods may therefore require significant computational resources.

Fairness in Allocation: The system should avoid repeatedly assigning the same students to preferred seats. Fairness mechanisms are necessary to distribute desirable seats among students.

Privacy and Security: Student information such as academic performance, attendance, preferences and interpersonal relationships is sensitive. Appropriate security mechanisms are required when storing and processing this information.



Real-Time Adaptation: Classroom conditions may change during a semester. A static seating plan may therefore become unsuitable when students' requirements, classroom activities, or attendance patterns change.

System Integration: A smart seat allocation system should ideally integrate with existing student databases, attendance systems, classroom management platforms and IoT infrastructure.

V. MOTIVATION

Classroom seating is an important component of the learning environment because the physical position of students can influence academic performance, engagement, communication and social interaction. Research has shown that students' distance from the instructor can be associated with academic performance, while seating factors can also influence engagement in smart classrooms.

Traditional classroom seat allocation is generally performed manually by teachers or administrators. Manual allocation requires considerable time, becomes difficult when the number of students is large and may not adequately consider multiple student requirements. Random or fixed allocation may also result in unsuitable seating arrangements when students have specific accessibility, learning, or interpersonal requirements.

The rapid development of Artificial Intelligence, Machine Learning, optimization algorithms and Internet of Things technologies provides opportunities to automate this process. IoT-based systems can detect classroom occupancy and automate seat assignment, while optimization algorithms can identify suitable seating arrangements under multiple constraints.

Furthermore, smart classrooms increasingly use interactive displays, connected devices, sensors and digital learning platforms. A smart seat allocation system can utilize this infrastructure to create adaptive seating arrangements according to classroom requirements.

These technological developments motivate the development of an intelligent seat allocation system capable of generating efficient, personalized, fair and conflict-aware seating arrangements while reducing the workload of teachers and administrators.

VI. SCOPE OF THE STUDY

The scope of Smart Classroom Seat Allocation System research includes the application of Artificial Intelligence, Machine Learning, optimization algorithms, IoT and data analytics for automated classroom seating.

The study covers different seat allocation techniques, including Genetic Algorithms, mathematical optimization, heuristic algorithms, constraint satisfaction, graph-based approaches and intelligent decision-making methods. These techniques can be used to generate seating arrangements while satisfying classroom capacity, student preferences, teacher proximity and interpersonal constraints.

The study also considers the integration of IoT technologies for real-time classroom monitoring. Sensors can be used to determine classroom occupancy and identify available seats, while RFID or similar identification technologies can support student identification and automated allocation. Existing IoT classroom research has demonstrated the feasibility of occupancy estimation and automatic seat allocation.

Furthermore, the scope includes student-centered factors such as academic requirements, engagement, social relationships, learning preferences and accessibility. Research has shown that classroom seating can influence student engagement and academic performance, making these factors relevant to intelligent allocation.

The proposed research can be applied to schools, colleges, universities, training institutions, examination halls, laboratories and other educational environments. The system can support both static seating plans and dynamic seat reassignment based on real-time classroom conditions.

The study also provides a foundation for future integration with attendance systems, student information systems, smart classroom platforms and cloud-based educational management systems.



VII. APPLICATIONS OF SMART CLASSROOM SEAT ALLOCATION

Artificial intelligence-based classroom seat allocation systems have numerous applications in modern educational environments.

Automated Classroom Seating: The system automatically generates suitable seating arrangements without requiring teachers to manually assign every seat.

Examination Seat Allocation: Intelligent algorithms can assign examination seats while considering student distribution, classroom capacity and separation requirements.

Conflict-Aware Seating: Students with known interpersonal conflicts can be assigned to suitable locations to reduce classroom disruption. Recent research specifically investigates conflict-aware student seat allocation.

Real-Time Occupancy Monitoring: IoT sensors can identify occupied and vacant seats and provide real-time classroom occupancy information.

Teacher Proximity Management: Students can be assigned to appropriate locations based on teacher visibility and classroom interaction requirements.

Accessibility Support: Students requiring special accessibility arrangements can be assigned seats that provide convenient movement and classroom access.

Smart Classroom Management: Seat allocation can be integrated with smart boards, classroom sensors, attendance systems and other educational technologies.

Dynamic Seat Reallocation: When students are absent or classroom conditions change, the system can automatically regenerate an appropriate seating arrangement.

VIII. CONCLUSION

Classroom seating is an important factor in creating an effective and well-organized learning environment. Traditional manual seat allocation methods are time-consuming and generally cannot consider the large number of constraints present in modern classrooms. Recent research has demonstrated that seating position and classroom layout can influence academic performance, student engagement, interaction and social relationships. (PLOS)

This review examined recent research from 2020 to 2026 related to classroom seating, smart classrooms, IoT-based seat allocation, optimization algorithms and intelligent classroom management. Traditional seating studies have primarily investigated the relationship between seating position and learning outcomes, while newer research has introduced automated and optimization-based approaches.

IoT technologies provide opportunities for automatically detecting classroom occupancy and available seats. Sensor-based and RFID-based systems have demonstrated the feasibility of automating classroom seat allocation and monitoring. (DSpace Repository)

Optimization approaches such as Genetic Algorithms, mathematical programming and heuristic search can solve complex seat allocation problems involving multiple constraints. Recent research on conflict-aware seating further demonstrates that student relationships can be incorporated into mathematical seat allocation models. (ScienceDirect) Smart classroom research also indicates that seating continues to matter in technology-enhanced learning environments. A 2023 longitudinal study found that seating distance from the classroom center predicted situational engagement, showing that technological improvements do not completely eliminate the influence of physical seating. (MDPI)

Despite these advancements, important challenges remain, including constraint management, fairness, privacy, real-time adaptation, large-scale optimization and integration with existing educational systems. Therefore, future systems should combine IoT sensing, intelligent optimization, student-centered information and real-time classroom data.

Overall, the development of a Smart Classroom Seat Allocation System provides an opportunity to automate classroom management while supporting personalized, efficient, fair and adaptive learning environments.

IX. FUTURE RESEARCH DIRECTIONS

The rapid development of artificial intelligence, IoT and smart education technologies presents several opportunities for improving classroom seat allocation systems. Future research should focus on the following directions:

Development of Adaptive Seat Allocation: Future systems should dynamically update seating arrangements based on attendance, classroom activities, student requirements and real-time environmental conditions.



Integration of Multiple Optimization Objectives: Future research should combine academic performance, student engagement, social interaction, conflicts, accessibility, teacher proximity and fairness within a single multi-objective optimization framework.

Artificial Intelligence-Based Prediction: Machine learning models can be investigated to predict suitable seating positions based on historical academic performance, engagement, attendance and classroom interaction data.

IoT-Based Real-Time Monitoring: Future systems should integrate occupancy sensors, RFID, cameras where appropriate and other IoT devices to continuously monitor classroom seat availability and student presence.

Fair Seat Allocation: Future systems should implement fairness mechanisms so that desirable seats are distributed fairly among students rather than repeatedly assigned to the same individuals.

Personalized Learning Environments: Seat allocation should consider individual learning requirements, accessibility, preferred seating locations and engagement patterns.

Group and Collaborative Learning: Intelligent systems should automatically create seating groups based on project requirements, learning activities, or collaborative learning objectives.

Cloud-Based Smart Classroom Platforms: Cloud computing can enable centralized management of student information, classroom layouts, seating plans and IoT data across multiple classrooms.

Privacy and Security: Future systems should apply secure data storage, access control, anonymization and privacy-preserving techniques when handling student information.

Explainable Seat Allocation: AI-based systems should provide understandable explanations for why a particular student was assigned to a particular seat, especially when multiple constraints are involved.

Integration with Educational Systems: Future seat allocation systems should integrate with student information systems, attendance management, learning management systems, examination systems and classroom scheduling platforms.

Large-Scale Real-World Validation: Future research should evaluate proposed systems in real classrooms involving different educational levels, classroom sizes, teaching styles and student populations.

Advanced Optimization Algorithms: Future studies can investigate Genetic Algorithms, Particle Swarm Optimization, Reinforcement Learning, Graph Neural Networks and hybrid optimization methods for large and dynamic classroom seating problems.

Smart Classroom Digital Twins: A digital twin of the classroom could be developed to simulate different seating arrangements before applying them in the physical classroom.

Sustainable Classroom Management: Future systems can also consider room utilization, energy consumption, classroom resources and efficient space management when generating seating plans.

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