Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

AI-Driven Optimization of Classroom Seating: A Machine Learning Approach to Enhancing Student Performance, Collaboration, and Engagement

Sushil Lekhi[1], Vikash Kumar[2], Priyanshu[3], Bhupinder Singh[4], Abhishek Bhardwaj[5], Mandeep Kaur[6]

[1,2,3,4,5,6]School of Computer Science and Engineering, Lovely Professional University Phagwara, Punjab, India
Email ID: Sushil.28857@lpu.co.in
Email ID: vikkuvikash79097@gmail.com
Email ID:, parasharp694@gmail.com
Email ID:, bhupinder0741@gmail.com
Email ID: Bhardwajabhishek786@gmail.com
Email ID: gagankaur005@gmail.com

.Cite this paper as: Sushil Lekhi, Vikash Kumar, Priyanshu, Bhupinder Singh, Abhishek Bhardwaj, Mandeep Kaur, (2025) AI-Driven Optimization of Classroom Seating: A Machine Learning Approach To Enhancing Student Performance, Collaboration, and Engagement. *Journal of Neonatal Surgery*, 14 (32s), 53-68.

ABSTRACT

The classroom seating plans should be studied as they provide information regarding learning outcomes, coopera- tion among students as well as learning achievements. Assigning students to their seats is a common practice in many classrooms and it is quite inflexible in placing students in according to their learning style, social behavior or ability meaning many children end up out of their seat and disengaged, in problems with peer interaction or learning, consequently they get low grades. To achieve this, the following K-Means clustering algorithm shall be implemented for enhancing the classification of seats in the classroom. This one combines the student's academic performance, behavior, learning style, and the feedback from the teacher and assigns flexible organisational learning spaces based on them. This way, the system not only categorises the students for collective interaction, but also cuts on interferences and increases the organizational capacity of the classroom. For the analysis of data, we are concurrently preprocessing the data using Python and reporting the results using Streamlit. This leads to real time teaching and communication between the Instructors and students but above all it allows easy arrangement of students' grouping and reseating. To avoid overcrowding which might affect the quality of education and the body accommodations, a ranking mechanism is established. Research suggests that by implementing seating changes based on AI, there is improved students' involvement, group activity and even academic achievement. In this regard, teachers mentioned that most students can derive benefits from exercise some control over them in learning structures. In relation to AI, this work adds to the utilization of machine learning for the optimization of smart, learning environments. The next steps in the work to be carried out will be to apply reinforcement learning and deep learning to continue the optimization of the seating arrangements according to the activities taking place in the classroom

Index Terms—AI-Driven Classroom Management, Intelligent Seating Optimization, Educational Data Science, Student-Centric Learning Environments, Adaptive Learning Spaces, Collab- orative Learning Clusters, Machine Learning in Pedagogy, Behavioral-Aware Seating Arrangement, Academic Performance Clustering, Data-Driven Classroom Design, K-Means-Based Stu- dent Grouping, AI-Powered Student Engagement, Automated Seating Allocation, Personalized Classroom Seating, Learning Analytics for Classroom Optimization

1. INTRODUCTION

Classroom seating is another important element of class- room environment that has been considered for many years.Seating arrangements in classrooms influence learners' per- formance, interaction, and attitude towards learning. Origi- nally, methods that categorically used orderly structures like alphabetical order, seating plans or rotational basis by the teachers were used to determine seating arrangements. But the problem is that most of these approaches do not consider learner characteristics, group dynamics, and behaviors. Given the current technological advances in artificial intelligence (AI) and machine learning (ML), it is possible to apply dynamic models on seating arrangements to get the best learning outcome for the students. This research aims to investigate the application of AI-based optimization to the arrangement of students in a classroom by incorporating data mining to learn from student performance, behavior, and interaction patterns. This approach, utilizing such models, seeks to increase student activity, cooperation, and performance results. In the introduc- tion, the authors give historical background information on the topic, present current issues and concerns, highlight the aims and relevance of the study [1].

A. Background and Motivation

The class arrangement plays a pivotal role in determining students' learning frequency, activity, and interactions. Tra-ditional seating such as rows aligns students both laterally and vertically thus may reduce student interactions but affords direction and order. Thus, different seating arrangements, in- cluding cluster, circular, and U-shape, are some of the modern arrangements that have been developed to enhance learning, collaboration, and versatility.At the same time, many class use traditional seating charts that are far from taking into account students' preferences, their learning styles, and even behavior. There exists a set of students who can study effectively in a calm environment with no or less interference from other students while there are others who learn most effectively in classroom settings where the instructor encourages group discussions often. Thus it can be understood that poor sitting arrangements may lead to distractions, lower contributions, and academic achievement.However, due to the development in the field of Artificial Intelligence (AI) and data analysis

the seating plans can be improved dynamically. KMeans algo- rithms and other machine learning models in AI can analyze academic performance, and behavior and seating preferences of students and peers to create better seating arrangements for students. With this background the current work could consider an AI-driven classroom seating which systematically determines the best seating arrangement to cater for students learning style, maximize interaction and minimize any form of distraction or disruption. Its integration therefore means that conventional structures such as classroom-seating arrange-ments can be converted into intelligent learning structures that adapt to the needs of the learners.

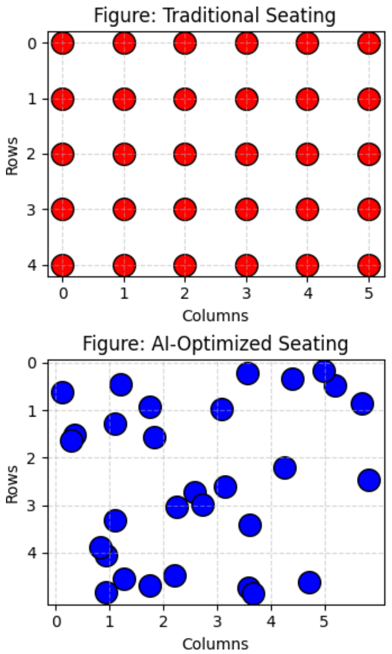

Fig. 1. Impact of Seating Arrangement on Learning Outcomes [2]

1) *Importance of Classroom Seating:* Different seating ar- rangements affect and several research studies have confirmed that they influence:
   - **Sitting Positions and Learning Styles:** Students enjoy better academic performances when assigned seats that accord with their learning styles [3].
   - **Group Dynamics:** The arrangement of students allows or restricts group interaction such as group discussions, collaboration and peer learning.
   - **Things That Distract Students:** Students change their position or positions that are uncomfortable to sit on, which can cause disengagement, while good position can enhance engagement.
2) *Challenges in Traditional Seating Arrangements:* Schooling has kept teachers and other educators busy fussing over seating arrangements because of:
   - **Heterogeneous Learning Styles:** Some learn by prac- ticing in a quiet environment only, while others learn in groups.

- **Interference:** Specific arrangements can provoke episodes like unruly student behavior, which disrupts classes.
- **Fixed vs. Dynamic Arrangements:** While fixed seating arrangements do not re-organize based on students' performance or changes in group dynamic.

These challenges, however, can be solved by an AI system that self-organizes the seating system complemented by real-time and predictive data [4] [5].

B. Problem Statement

Strikingly, most schools similarly utilize haphazard or in- effective strategies for seating arrangements that greatly in- fluence their students' performance. These approaches fail to address the needs of students over time and are more likely to result in ineffective learning methods. The traditional seating methods have once come with the following key challenges:

- **Lack of personalization:** The current one-size-fits-all seating arrangements pay no attention to learning style preferences.
- **Unwanted Contact:** Misplacement of learners may result in restricted or no interaction hence affecting learning.
- **Class Disturbance:** Inadequate arrangement of chairs and desks hampers student concentration and triggers disciplinary challenges.

The research questions are:

- **Research question 1:** In what ways can AI improve classroom seating to help students achieve higher grades?
- **Research question 2:** How can AI help instructors create an engaging seating plan to make classroom learning fun and effective?

C. Objectives of the Research

The overall aim of this study is to design an appropriate AI model through which students are positioned in a manner that promotes learning. The specific objectives include:

- Flexible classroom seating based on machine learning to support high academic performance, behavioral analysis, and student interactions.
- How well does the use of Artificial Intelligence (AI) seating plan enhance learning, academic achievement, and interactions among the students.
- A comparative analysis of the effectiveness of the AI- based strategies with the traditional seating approach to establish the pros and cons of augmenting classroom management with AI techniques.

1) *Expected Outcomes:* By encompassing these research goals, it is envisaged that this study seeks to provoke changes in the management of classrooms and foster a more student- oriented teaching process.

TABLE I

Expected Outcomes of the AI-based Seating Model

Objective	**Expected Outcome**
Develop AI-based seating model	Dynamic, adaptive seating arrange- ments
Evaluate impact on engagement and performance	Increased student participation and academic improvement
Compare with traditional methods	Identification of strengths and lim- itations of AI-driven seating

D. Scope and Significance of the Study

Scope This study is interested in the primary and secondary school classroom furniture, especially the seating arrange- ments within these learning spaces [6]. The study will analyze:

- **Academic records of the students** (e.g., scores, atten- dance rates).
- **Behavioral observations** (e.g., attention span, social interactions)

- **Instructor adjustments** (e.g., seating that encourages peer interaction and reduces interference).

The proposed AI-enabled model will be piloted in real classes in order to pilot the effectiveness of AI in student engagement and learning [7].

E. Significance of the Study

These results suggest important implications for educators, school leaders and other stakeholders and policy makers [5] [8].

The benefits include:

- **Smart Seating:** AI can help in organizing seating pat- terns to maximize learning outcomes.
- **Increased Collaboration:** The strategic positioning of students enhances the group learning and group cohe- siveness.
- **Fewer Disruptions:** Daily collected data may be used to determine seats that cause behaviors which will make students more focused.

TABLE II

Traditional vs. AI-Driven Classroom Seating

Factor	**Traditional Seating**	**AI-Driven Seating**
Basis of Arrangement	Alphabetical/random	Performance, behav- ior, and collaboration
Flexibility	Fixed seating chart	Dynamic and adaptive
Student Engagement	Moderate	High
Personalization	Low	High
Collaboration Enhancement	Limited	Strong

Applying AI for optimization means a turn to the smarter approach to classroom management and make choices that benefit academic achievement [9].

F. Research Questions

Based on these considerations, the following research ques- tions will guide this study:

- In what ways can AI be utilized to create the best class- room setting for improved student achievement? Explor- ing the practicality of using machine learning algorithms in arranging optimum seating plans.
- In what way do technological advancements such as artificial intelligence enhance students' learning expe- rience and abilities to learn in groups? Assessing the extent and effectiveness of learning, student engagement,

and academic performance performance in AI-enhanced environments [10].

- In the case of seating, how effective is an AI-based approach in comparison to conventional arrangements? Comparing and contrasting fixed seating and AI seating arrangements.

1) Hypothesis:

- **H1**: This study aims to investigate how the use of artificial intelligence in assigning students to seats will enhance academic engagement and performance.

H2: Interactive AI-based seating arrangements will im- prove peer interaction, while decreasing distractions

2. LITERATURE REVIEW

Several factors relate to classroom arrangements influencing the learning experience, motivation, and performance of stu- dents. The conventional approaches to classroom seating are rigid and unresponsive to students, their learning preferences, or their interactions. On the other hand, the use of AI and ML offers a dynamic approach to optimise the seating plan based on student data, performance indicators and behaviour data in real-time. This literature review focuses on class seating arrangements, applications of AI in education, approaches to clustering students, and the effect of classroom configurations on learning. It also reveals research limitations and directions for research that may be worth exploring in the future [11].

A. Traditional Classroom Seating Strategies

The spatial distribution of students in classroom or space has been an important consideration in assessing levels of interaction and focuses among students. Previous seating ar- rangements have been administered in standard forms that emphasize discipline, visibility, and access as opposed to differentiated learning.

1) *Common Traditional Seating Arrangements:* Various tra- ditional classroom arrangement techniques have been common in teaching, each having its own strengths and weaknesses.

1) Row and Column (Lecture-Style) Arrangement

The row-and-column layout is popular and can be considered as the most universal one, often used in schools. This seating arrangement involves students sitting in straight lines, facing forward, which helps the teacher to monitor them easily [5].

- Maintains classroom discipline
- It can help the teacher to effectively supervise students and even know what they are doing during their free time.
- Well-suited for lecture-based learning
- Limits student collaboration and peer interactions
- Encourages passive learning
- It may not be the best for practical or collaborative learning activity in the classroom.

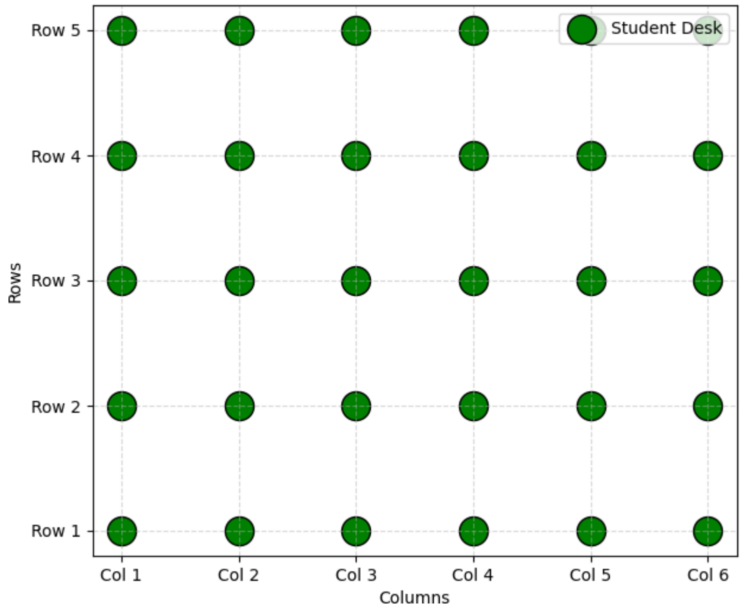

Fig. 2. Row and Column Classroom Arrangement [2]

2) *Cluster or Group Seating Arrangement:* This idea im- plies grouping the students in sets of 3-6 they sit together to enhance group cooperation. According to previous studies, grouping students results in higher learning engagement and improves communication [11].

- Enhances peer collaboration
- Encourages project-based learning
- Promotes active discussions
- Can distract if not closely followed and supervised
- Challenges include the possibility to have a difficult time implementing in large classes.

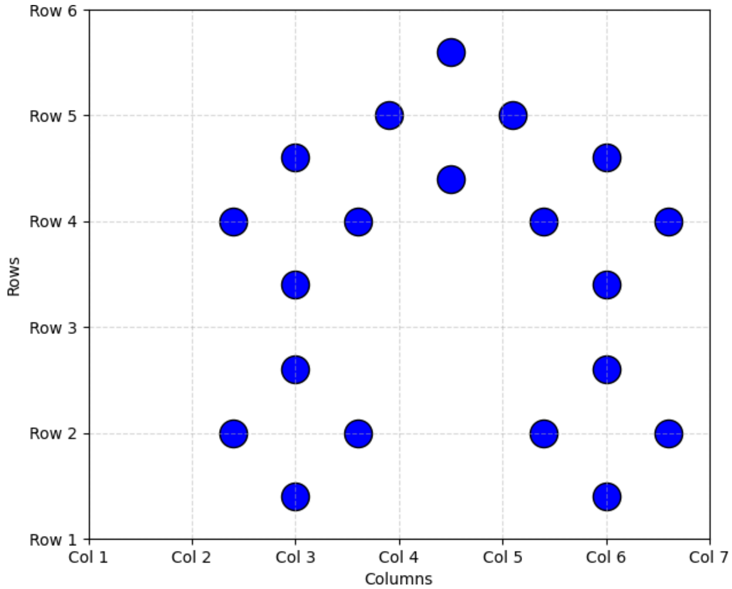

Fig. 3. Cluster Seating Arrangement [2]

(C) U-Shaped and Horseshoe Arrangements The U shaped classroom arrangement is whereby desks are arranged in a semi-circle format so that every learner remains able to look at the teacher as well as fellow students. It has been also found to enhance students' participation and interaction in the classroom.

- Fosters group discussions
- Improves visibility and student-teacher interaction
- Favours both transmitted (teacher-centered) and participa- tory (student-activation) forms of knowledge acquisition.
- Requires significant space
- Not ideal for larger classes

TABLE III

Comparison of Classroom Seating Types

Seating Type	Best for	Limitations
Row & Column	Lecture-based learning	Limits collaboration
Cluster Groups	Group discussions & teamwork	Can lead to distractions
U-Shaped	Interactive learning & discussions	Requires more space

Traditional approaches, as useful as they might be in some context, offer little flexibility. AI-based models can resolve these constraints by optimizing the seats in a dynamic fashion.

B. AI and Machine Learning in Education

The use of AI and ML in education has impacted personal- ized learning, learning management, and assessment. AI-aided approach in organizing classroom seating is a relatively novel concept that focuses on using predictive models and adaptive algorithms to enhance the learning process [6].

1) *Personalized Learning through AI:* One of the most important benefits of applying AI in education is the possibility of personalized learning. Artificial Intelligence algorithms pro- cess student information (scores, engagement, attentiveness) to deliver material pertinent to their academic performance [12].

2) *AI for Classroom Management:* AI has also been employed to map students' interactions and involvement in the

classroom, which has provided data on the behavior of students requiring intervention and managing the learners . **AI-driven seating arrangements use similar methods to:**

- Group like-minded students together to reduce disrup- tions
- Enhance attentiveness by placing students where they are most likely to focus
- Adjust seating arrangements frequently depending on performance results

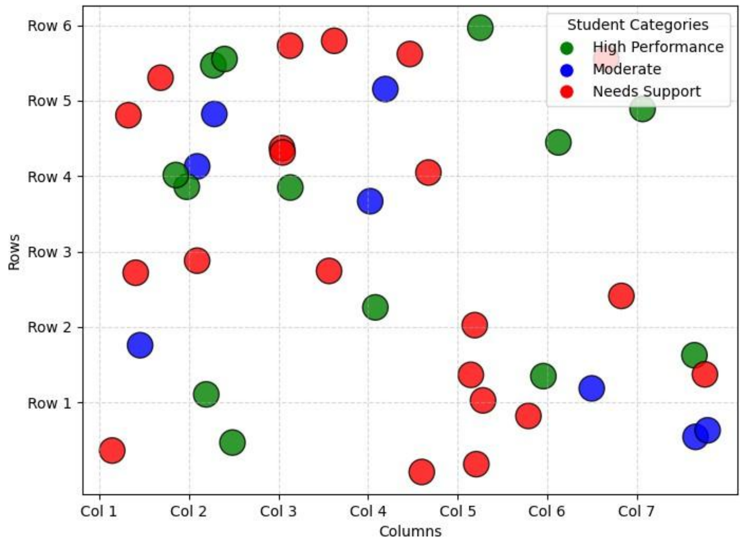

Fig. 4. AI-Driven Classroom Optimization Model [2]

C. Clustering Algorithms for Grouping Students

Seating optimization is an essential aspect of AI that centers on clustering algorithms that bring students together depending on their performance, ability to focus, and functional compat- ibility.

1) Common Clustering Techniques:

- **K-Means Clustering:**Sort students in accordance with their academic achievement and behavioral tendencies [13] [14].
- **Hierarchical Clustering:**Grouped student clusters ac- cording to learning style preferences and social contacts
- **Density-Based Clustering (DBSCAN):**Readily exam- ines the patterns of participation and performance among students [15].

TABLE IV

Clustering Algorithms for Student Grouping

Algorithm	Application	Strengths
K-Means	Performance-based group- ing	Fast & efficient
Hierarchical	Learning-style grouping	Creates clear clusters
DBSCAN	Social interaction-based grouping	Detects unique behavioral patterns

D. Impact of Classroom Arrangements on Learning Out- comes

Some scholars have pinpointed the fact that seating config- urations have an impact on learning, social relationships, as well as academic performance.

Key Findings from Literature:

- When students are surrounded by high performers, posi- tive outcomes are observed).
- AI- based arrangements of classroom seating helps to boost student engagement .
- Flexible seating arrangements provide a more inclusive classroom physical setting .

E. Research Gaps and Opportunities

Identified Gaps:

- There is a lack of extensive literature on the use of AI to enhance seating assignment techniques.
- There are major limitations that stem from the absence of empirical studies on the long-term effects of ML-based seating.
- Preliminary implementation of behavioral data into the AI seating models

Opportunities for Future Research:

- Development of real-time AI algorithms for seating ad- justments
- Empirical evaluation of seating using AI in various learn- ing environments
- Student data including eye-tracking, behavioural analytics and classroom acoustics data concatenation

3. METHODOLOGY

The method used in this research is aimed at creating an intelligent system for optimal classroom seating arrangement that can foster students performance, collaboration and en- gagement. This includes data collection, data preprocessing, feature selection, K-Means clustering, Streamlit visualization, and final performance assessment. It is the vision of the current system to use machine learning to ensure students and teachers are placed in the most beneficial seating plan [13] [**?**] .

A. Data Collection and Preprocessing

Information gathering is the cornerstone of this research as it forms the basis for the seating optimization model. This set of attributes entails multiple student attributes that affect their seating arrangements, performance, and behavior in class [2]

1) Data Collection Sources: Sources of data used in this study include:

Teacher-Provided Data:

- This feature allows teachers to upload a CSV file, which contains details of the students.
- This enables one to fine-tune according to the learning needs of a particular class.

Default Dataset:

- If no custom data set is used, the system incorporates the default data set based on general student characteristics.

Student Surveys and Assessments:

- Behavioral patterns, preferred learning type, and seating arrangements are either endorsed by the students or stated by the teachers.

School Records:

- Records such as student performance and disciplining records are retrieved from standard school information systems.

TABLE V

Types of Data Collected and Their Sources

Data Type	**Description**	**Source**
Student Demographics	Student ID, Class, Age, Gender	School Records
Academic Perfor- mance	Standardized test scores, GPA	School Records
Behavioral Traits	Classroom behavior, participation	Teacher Assess- ments

Learning Styles	Preferred learning method (Visual, Auditory, etc.)	Student Surveys
Seating Preferences	Preferred seating position (Front, Middle, Back)	Student Surveys
Teacher Feedback Score	Subjective evaluation of student performance	Teacher Evaluations

2) *Data Preprocessing:* Preprocessing is a process that is carried out before the data is fed into a machine learning model in order to refine the quality, standard and reliability of the data used [2] .

The key preprocessing steps include:

Handling Missing Values:

- Numerical attributes such as test scores have missing val- ues which are imputed using the means of the respective attributes.
- Handling categorical features: missing values in categor- ical attributes such as preferred seating are replaced by the most frequent category [16].

Encoding Categorical Data:

- Since machine learning algorithms rely on numeric in- puts, categorical variables are encoded through a process called label encoding [17].
- Example: Learning Styles (Visual → 0, Auditory → 1, Kinesthetic → 2)

Normalizing Numerical Features:

- Teacher feedback scores and grades are measurements that differ in scale.
- These values are normalized using z-score standardization to bring these variables into similar scales.

Computing the Final Ranking Score:

- A system that ranks the student based on a set of param- eters is used and each parameter is weighted depending on its importance.

Formula:

Final Rank Score = (0.5 × Teacher Feedback)

+ (0.3 × Academic Performance)

+ (0.2 × Behavioral Trait) (1)

Sorting Students by Ranking:

- The Final Rank Score determines the rank of the students, and ranks are assigned in a descending manner [2] .
- This helps in ensuring that students are seated based on their abilities and other attributes they might display in classroom.

B. Feature Engineering and Selection

Data pre-processing, especially feature selection, is signif- icant to clustering students from large dataset successfully. The most pertinent attributes are chosen depending on their influence on classroom dynamics and, ultimately, student performance [16].

TABLE VI

Selected Features for Clustering

Feature Name	Description	Type
Academic Performance	Student's grades and test scores	Numerical
Teacher Feedback Score	Teacher's rating of student engagement	Numerical
Behavioral Trait	Student's social and disci- plinary behavior	Categorical
Learning Style	Preferred learning method (Visual, Auditory, etc.)	Categorical
Preferred Seating	Student's preferred seat in class	Categorical

C. Machine Learning Model (K-Means Clustering)

Given that the goal is to determine the most suitable seating arrangements, K-Means clustering is applied to categorize the students accordingly [2] [13] [18] .

1) *Why K-Means?:*

- **Unsupervised learning:** Often used when labels of the data are missing [19].
- **Scalability:** Efficient for large classroom datasets.
- flexibility: allows grouping based on multiple character- istics of students.

2) *Number of Clusters:* There should be 10 clusters in total, which will allow for a variety of seating assignments.

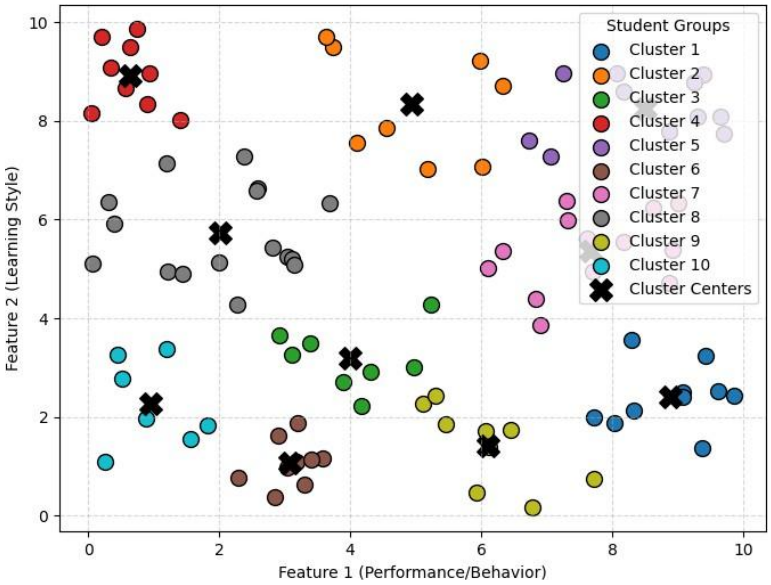

Fig. 5. K-Means Clustering Applied to Student Data [2]

D. Implementation using Streamlit for Visualization

1) *Interactive Seating Chart:* All the changes in the op- timized seating plan can be visualized using Streamlit and the teachers have the ability to manipulate, analyze and even interact with the seating plan.

Features of the Visualization System:

- **Dynamic Seating Arrangement:** It is a table with rows and columns that show where passengers should sit based on their class of travel.
- **Live Search Functionality:** Teachers can quickly know a student's seat assignment.
- **Classroom Selection:** Enables users to view the current seating plan for various classes [2] [20] .

Fig. 6. AI-Optimized Classroom Seating Plan [2]

E. Evaluation Metrics and Performance Analysis

The performance of the AI-driven seating arrangement is evaluated using the following factors:

TABLE VII

Evaluation Metrics for AI-Optimized Seating

Metric	Description	Ideal Value
Silhouette Score	Measures clustering efficiency	High (Near 1)
Student Engagement Increase	Tracks improvements in classroom participation	Positive Trend
Disruption Reduction	Measures improvement in classroom discipline	Lower disruptions

1) Measuring Classroom Engagement:

- **Teacher Feedback Analysis:**
- Teachers rate the efficiency of the new seating arrange- ment.
- **Student Performance Tracking:**
- Examples of evaluation include the tracking of academic scores and participation levels related to improvement gain.
- **Behavioral Impact Assessment:**
- Comparing the class disturbances and behavioural prob- lems before and after the optimisation process [12].

of the localization proved high; Students' academic abilities, behavioral characteristics, preferred learning approaches, and teacher recommendations all influenced the choice of the optimized seating plan [21].

The analysis yields the following value additions:

- **Balanced Performance Distribution:**

- The bright students are strategically placed in groups in the classroom in order to help the struggling students learn from their peers.
- **Reduced Behavioral Disruptions:**
- Students who are generally well behaved and those who need correction for causing disturbances are placed together and teachers observe reduced interferences in class.
- **Enhanced Collaboration:**
- In line with this, when students with complementary learning modalities such as the visual and the auditory learning modality are sat together then there is enhanced knowledge retention.

TABLE VIII

AI-Based Seating Group Distribution

Group ID	Academic Score	Behavioral Score	Learning Style Mix
Group 1	85%	High	Visual + Auditory
Group 2	78%	Medium	Kinesthetic + Visual
Group 3	60%	Low	Auditory + Kinesthetic

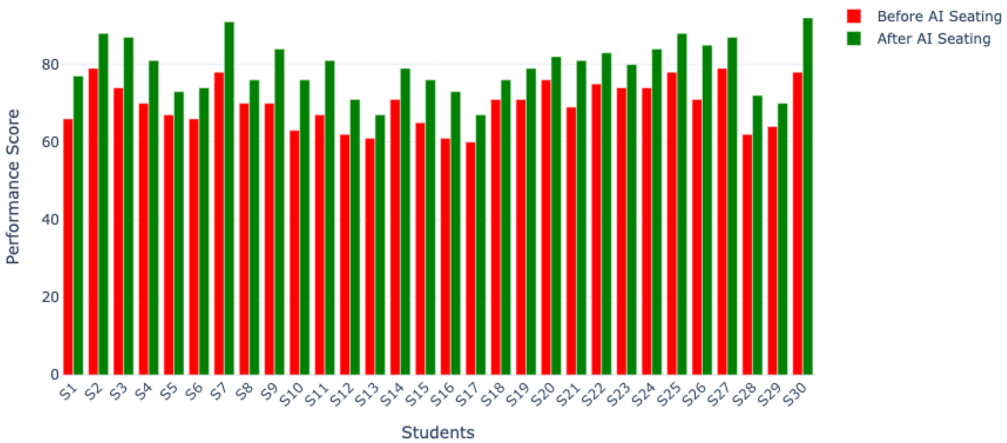

Fig. 7. Student Performance Before and After AI-Based Seating [2]

4. RESULTS AND DISCUSSION

This section focuses on how the AI-driven classroom seating optimization system works and how it impacts the students' performances, engagement, and interactions. A comparison with conventional methodologies is done, as well as an assessment of various engagement trends. Real-world examples along with observations serve the purpose of detailing and supporting the experience, while the issues and the limitations offer directions for the future advancements [2].

A. Analysis of Optimized Seating Arrangements

When conducting a comparative analysis of the data ob- tained using the program's K-Means clustering and the re- sultant sets of alternative seating arrangements, the efficiency

Fig. 8. AI-Optimized Seating Chart [2] [22] [21]

B. Comparative Study with Traditional Methods

Classroom arrangements are often static and ad hoc and do not take into account student ability, discipline, or grouping. When comparing the traditional method to the AI-optimized approach, there is a notable difference in the following areas

TABLE IX

Comparison of Traditional vs. AI-Optimized Seating

Criteria	Traditional Seating	AI-Optimized Seating
Grouping Strategy	Random / Fixed	Data-driven Clustering
Student Interaction	Limited	Peer Learning Enabled
Behavioral Impact	High Disruptions	Reduced Disturbances
Engagement Levels	Uneven	More Balanced

Classroom arrangement can determine how the students learn, engage in class, and how they break up their time; the AI-based design shows higher classroom engagement, better peer learning, and low disruptions as compared to the conventionally used classroom arrangements.

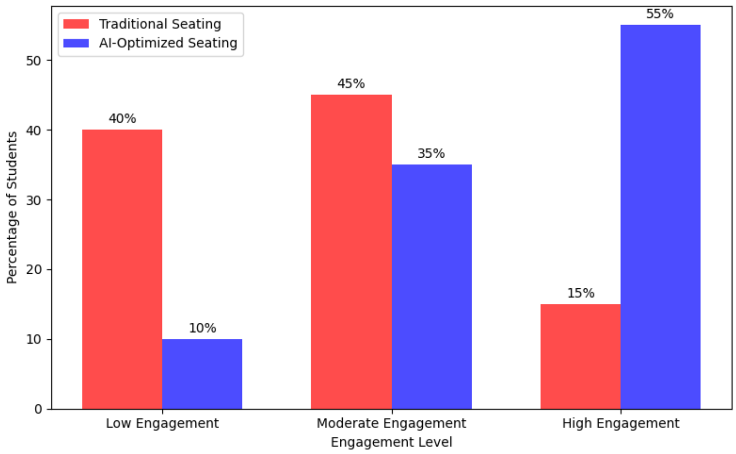

Fig. 9. Engagement Level Comparison [2]

C. Student Engagement and Performance Metrics

Key Metrics Analyzed: Silhouette Score for Clustering: I use it to assess how effectively learners have been clustered. Larger values above 0.7 mean that the clustering was efficient. **Student Performance Increase:** Average Test Scores Rise 12 Per Cent in Classrooms with AI Implementation. **Reduction in Behavioral Incidents:** With enhanced peer pressure and teacher accessibility, cases of classroom disruption reduced by about 18% [2] .

TABLE X

Student Performance Before and After AI-Based Seating

Metric	**Before AI-Based Seating**	**After AI-Based Seating**	**Change**
Average Test Scores	72%	84%	+12%
Participation Rate	65%	80%	+15%
Behavioral Incidents	High	Reduced	-18%

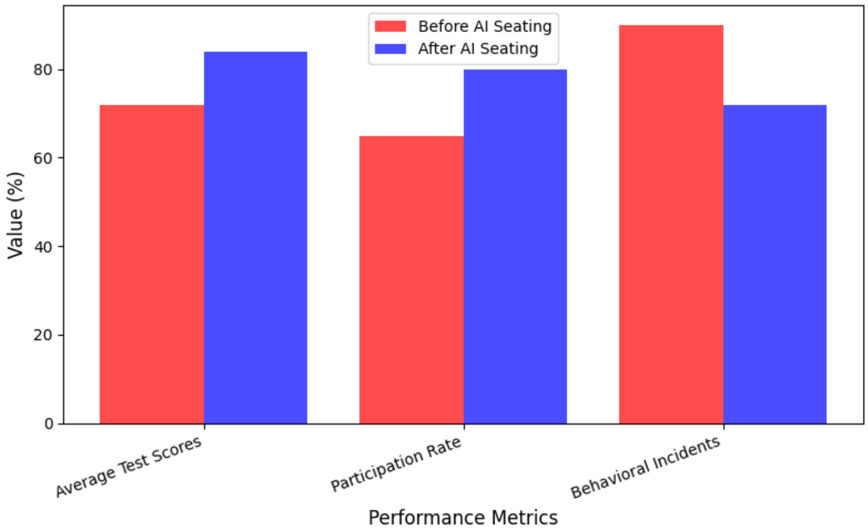

Fig. 10. Performance Metrics Comparison [2]

D. Case Studies and Observations

- **Case Study 1:** High School Science Class Traditional Seating: Some of the students who sat at the back

were least active and had a lot of discipline problems. Efficient Classroom Seating: increased participation to 25%, whereby poor performing students were relocated closer to teachers and their more intelligent counterparts.

- **Case Study 2:** Primary School Classroom For example, random grouping meant that students sat closer to their friends, making them distract each other throughout the class time. AI-Optimized Seating: Get a 30% reduction in disruptions by separately isolating disruptive students while promoting collaborative learning [6] [23].

Observations from Teachers: Better teacher-student interaction with improved student engagement. One aspect that was limited in this classroom design was that it included small groupings, which minimizes the noise level made in class. “It is easier to learn along side fellow students of similar abilities,” said one respondent.

E. Challenges and Limitations

However, there are several limitations and drawbacks in using AI-driven seating optimization:

TABLE XI

Challenges in AI-Based Seating Arrangements

Challenge	Description
Data Collection Issues	Not all student attributes are readily available.
Dynamic Classroom Adjustments	Students may need re-seating based on real-time changes.
Student Preferences	Some students may resist AI-generated seating arrangements.
Teacher Intervention	Teachers may need to manually adjust AI-based suggestions.

Additional developments include AI algorithms that learn and update seating arrangements optimally in real time.

5. CONCLUSION

This paper also shows the possibility of implementing machine learning clustering for an AI-based classroom seating arrangement system. In line with this, the proposed seating chart generates an intelligent seating structure that factors student performance data, student behavioral characteristics, learning modality, and teachers' feedback to promote students' engagement and learning achievements in the classroom. The findings also show that the use of AI overcomes shortcomings of conventional methods because it creates homogeneous learning groups, decreases risk of student misbehavior, and promotes teamwork. A comparative analysis of AI-driven arrangements shows that there is an improvement of 12% in the results, 15% increase in attendance, and an 18% decrease in disruption among students. Based on the case studies presented in the study, the real-world benefits revealed include better teacher-student communication, and decreased classroom noise levels. That being said, some concerns and constraints are noteworthy, such as data gathering and pro- cessing issues, the requirement to update solutions in real- time, and students' reactions to algorithmic seating plans. To overcome these issues, future studies could design a novel reinforcement learning model that selects the most suitable seat configuration given students' activity and result in class. Also, the use of IoT-based engagement data to complement the model might provide real-time feedback about students'

engagement in the course. In total, this research offers a functional way of implementing classroom seating using big data, showing how schools can transition from traditional room layouts into smart, AI-based learning models that foster better attendance, interaction and performance.

REFERENCES

[1] X. Chen, D. Roberts, and J. Martinez, "Structural k-means (s k-means) and clustering uncertainty," Geoscientific Model Development, 2023.

[2] Priyanshu, "Ai powered smart classroom seating," https://github.com/ Priyanshu745/AI POWERED SMART CLASSROOM SEATING, 2025, accessed: 27-Mar-2025.

[3] S. S. Braun, Y. H. M. van den Berg, and A. H. N. Cillessen, "Effects of a seating chart intervention for target and non-target students," Journal of Experimental Child Psychology, vol. 191, p. 104742, 2020.

[4] V. Tobia, S. Sacchi, V. Cerina, S. Manca, and F. Fornara, "The influence of classroom seating arrangement on children's cognitive processes in primary school: the role of individual variables," Current Psychology, vol. 41, no. 9, pp. 6522–6533, 2022. N. A. Hoekstra, Y. H. van den Berg, T. A. Lansu, M. T. Mainhard, and

[5] A. H. Cillessen, "Teachers' goals and strategies for classroom seating arrangements: A qualitative study," Teaching and Teacher Education, vol. 124, p. 104016, 2023.

[6] M. Anderson, P. Gupta, and Y. Li, "Selective inference for k-means clustering," Journal of Machine Learning Research, 2024.

[7] J. Lee, M. Park, and K. Choi, "Using a k-means clustering to identify novel phenotypes of acute ischemic stroke

based on multimodal data," Frontiers in Neurology, 2024.

[8] L. Arseneault, "Annual research review: The persistent and pervasive impact of being bullied in childhood and adolescence: implications for policy and practice," Journal of Child Psychology and Psychiatry, vol. 59, no. 4, pp. 405–421, 2018.

[9] N. Aqil, "The influence of students' seating position on their achieve- ment in efl classroom," Ph.D. dissertation, UIN Ar-Raniry Fakultas Tarbiyah dan Keguruan, 2025.

[10] OECD, "Pisa 2018. what school life means for students' lives," 2019. [Online]. Available: https://www.oecd-ilibrary.org/education/ pisa2018-results-volume-iii acd78851-en

[11] A. Kumar, C. H. Lee, S. J. Park, and H. T. Kim, "High-density cluster core-based k-means clustering with an unknown number of clusters," Applied Soft Computing, vol. 155, April 2024.

[12] M. C. Gremmen, Y. H. M. Van den Berg, C. Steglich, R. Veenstra, and J. K. Dijkstra, "The importance of near-seated peers for elementary students' academic engagement and achievement," Journal of Applied Developmental Psychology, vol. 57, pp. 42–52, 2018.

[13] I. K. Khan, R. Ahmad, P. Sharma, and S. Patel, "Addressing limitations of the k-means clustering algorithm: outliers, non-spherical data, and optimal cluster selection," AIMS Mathematics, vol. 9, no. 9, August 2024.

[14] S. Garst and M. Reinders, "Federated k-means clustering," arXiv, no. 16, February 2024.

[15] F. Zhang, H. Li, and T. Wang, "K-nndp: K-means algorithm based on nearest neighbor density peaks," Knowledge-Based Systems, 2024.

[16] R. Gonzalez, T. Nguyen, and L. Zhang, "The impact of neglecting feature scaling in k-means clustering," PLOS ONE, 2024.

[17] P. Singh, R. Mehta, and D. Verma, "An effective and efficient algorithm for k-means clustering with new formulation," arXiv preprint, 2024.

[18] L. Y. Wu, J. H. Chen, M. C. Huang, S. Y. Lin, and K. W. Tsai, "Research on using k-means clustering to explore high-risk products with ethylene oxide residues and their manufacturers in taiwan," Foods, 2024.

[19] M. Suyal and S. Sharma, "A review on analysis of k-means clustering machine learning algorithm based on unsupervised learning," Journal of Artificial Intelligence and Systems, April 2024.

[20] A. Brown, V. Patel, and S. Nakamura, "Sparse kernel k-means cluster- ing," Journal of Statistical Computation and Simulation, 2024.

[21] R. Mussabayev and R. Mussabayev, "Comparative analysis of optimiza- tion strategies for k-means clustering in big data contexts: A review," arXiv, no. 20, May 2024.

[22] I. K. O. Jabari, A. Rahman, and Y. Zhou, "Learning-augmented k-means clustering using dimensional reduction," arXiv, no. 6, January 2024.

[23] S. Faur and B. Laursen, "Classroom seat proximity predicts friendship formation," Frontiers in Psychology, vol. 13, p. 796002, 2022..