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Original Research Article

Enhancing Student Performance through PTM and Attendance Monitoring Using a Machine Learning Approach

Article History:

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Abstract: This study explores the application of machine learning models to predict student attendance and Parent-Teacher Meeting (PTM) participation, with a focus on factors such as academic performance, socio-economic background, and historical attendance patterns. The aim is to develop predictive models that can assist educational institutions in optimizing attendance management and increasing parental involvement in PTMs. By utilizing supervised learning techniques, the study trains models on student data to predict attendance trends and PTM participation, followed by evaluating the models on test sets to assess their performance. The results highlight the potential of machine learning to identify at-risk students, predict absenteeism, and enhance PTM scheduling, offering actionable insights that can improve student engagement and parent-teacher relationships. The findings contribute to the theoretical understanding of data-driven approaches in education and provide practical recommendations for educational institutions seeking to improve attendance management and parental involvement. Future research could further improve these models by incorporating additional factors such as student behavior and applying more advanced algorithms to enhance prediction accuracy and facilitate real-time interventions.

Keywords: Parent-Teacher Meeting, machine learning, academic performance, PTM

INTRODUCTION

Background

Parent-Teacher Meetings (PTM) and attendance tracking are fundamental components of the educational system. PTMs provide a critical platform for parents and teachers to communicate regarding the academic progress, behavior, and overall development of students. These meetings enable teachers to discuss student performance, offer feedback, and suggest strategies for improvement, while parents can address concerns and collaborate with teachers on how best to support their child's learning journey. However, despite the significance of PTMs, traditional methods of scheduling and tracking attendance often face multiple challenges. These include low engagement, miscommunication, and inefficiency in the scheduling process, especially in schools with a large number of students and parents. As a result, the full potential of PTMs is often not realized, and important issues may go unnoticed until it's too late.

Similarly, attendance tracking in schools, which is a key aspect of student management, has traditionally relied on manual systems. Teachers record attendance in class registers or mark attendance on paper forms, often without real-time data or sufficient tools to monitor trends effectively. The manual process is prone to errors, can be time-consuming, and fails to provide actionable insights into attendance patterns. Furthermore, absenteeism, whether due to illness, personal issues, or lack of motivation, is often not addressed until it becomes a significant problem. As a result, early intervention to improve attendance rates

is often delayed, leading to issues like disengagement or even student dropout in extreme cases.

In recent years, technology, particularly machine learning (ML), has shown great promise in addressing these challenges. Machine learning techniques allow for the analysis of large datasets uncovering patterns, predicting outcomes, and automating various aspects of the education system, including attendance management and PTM scheduling. With ML, schools can better predict when students are likely to miss classes or PTMs, and make data-driven decisions to improve engagement and attendance. By automating attendance tracking and providing real-time insights into student behavior, machine learning can enhance the effectiveness of PTMs and create a more personalized learning experience for students (Kurni et al., 2023). Thus, the application of machine learning in education is becoming increasingly essential, transforming traditional practices into more efficient, accurate, and scalable solutions.

Problem Statement:

Traditional methods for managing Parent-Teacher Meetings (PTM) and student attendance are outdated and inefficient, leading to several challenges within the educational system. PTMs are often scheduled manually through phone calls, emails, or paper notices, which can result in miscommunication, low attendance, and lack of engagement between teachers and parents. This reliance on manual processes makes it difficult to track attendance patterns, identify trends in participation, and proactively address issues. Similarly, attendance tracking is commonly done using paper records or simple digital systems that fail to provide real-time data or insights. As a result, absenteeism may go unnoticed until it becomes a significant problem, preventing early intervention for students who may be struggling. Furthermore, these traditional methods do not integrate information such as student performance or socio-economic factors, which could provide a more comprehensive understanding of attendance patterns and potential issues. This gap in data-driven decision-making limits the ability of schools to effectively support students and engage parents. Machine learning (ML) offers a potential solution by automating attendance tracking, predicting absenteeism, and improving PTM participation through data analysis (Alburaiki et al., 2021). By utilizing ML, schools can enhance communication, identify potential issues earlier, and ultimately improve both student engagement and academic outcomes.

Objectives of the Study:

The primary aim of this study is to investigate the application of machine learning (ML) techniques in improving the management of Parent-Teacher Meetings (PTM) and student attendance. The objectives are outlined as follows:

- **To explore the potential of machine learning for automating and improving PTM scheduling and attendance tracking systems.**
- **To predict student attendance patterns using machine learning models and identify early warning signs of absenteeism.**
- **To enhance parent-teacher communication by analyzing factors that affect PTM participation and suggesting strategies to improve engagement.**
- **To evaluate the performance of different machine learning algorithms in predicting attendance and PTM participation.**
- **To provide actionable insights and recommendations for schools on implementing machine learning to optimize attendance management and PTM effectiveness.**

Research Questions:

The study aims to address several key questions related to the application of machine learning in improving Parent-Teacher Meeting (PTM) scheduling and attendance management. The following research questions guide this investigation:

1. How can machine learning be applied to improve the efficiency of Parent-Teacher Meeting (PTM) scheduling and attendance tracking?
2. What machine learning models are most effective in predicting student attendance patterns and identifying at-risk students?
3. Which factors most influence PTM participation and student absenteeism, and how can these be incorporated into machine learning models?
4. How do machine learning-based models compare to traditional methods in predicting PTM attendance and student absenteeism?
5. What recommendations can be made for schools to successfully implement machine learning models for enhancing PTM attendance and student engagement?

Motivation and Scope of the Study:

The motivation behind this study stems from the growing challenges that educational institutions face in managing Parent-Teacher Meetings (PTM) and tracking student attendance using traditional methods. These processes, which are often manual and time-consuming, result in inefficiencies that hinder communication between parents and teachers, ultimately affecting student outcomes. With the rise of digital tools and data analytics, there is a growing need to integrate machine learning (ML) into these educational processes. By leveraging machine learning, schools can automate PTM scheduling, predict attendance patterns, and identify potential

issues early on. This not only enhances the overall efficiency of the system but also improves engagement between parents and teachers, ensuring timely interventions when necessary. The ability to predict absenteeism and optimize PTM attendance holds the potential to address longstanding challenges in education, from improving parental involvement to reducing student disengagement.

The scope of this study is focused on exploring how machine learning techniques can be applied to automate and improve the management of PTM scheduling and attendance tracking in educational institutions. The study examines different machine learning models, including supervised learning algorithms, to predict and analyze student attendance and PTM participation patterns. It also explores the factors that influence these aspects, such as student performance, socio-economic background, and school-related events (Senthil et al., 2024). While the research is primarily based on data collected from schools, the findings and recommendations can be generalized and implemented in educational institutions globally, providing a framework for using machine learning to enhance communication, reduce absenteeism, and increase parental involvement in education.

Structure of the Paper:

This paper is structured to provide a thorough examination of how machine learning can enhance the scheduling and management of Parent-Teacher Meetings (PTM) and attendance tracking. The Introduction outlines the background, identifies the problem, and sets the objectives and scope of the study. Following that, the Literature Review explores previous research on traditional PTM and attendance systems, the role of machine learning in education, and the challenges faced in implementing ML in educational settings. In the Research Methodology section, the approach for data collection, preprocessing, machine learning models, and evaluation techniques used in the study is detailed. The Results and Discussion section presents the outcomes from the machine learning models and interprets their significance, followed by a comparison with traditional methods. Finally, the Conclusion summarizes the study's findings, offers practical recommendations for implementing machine learning in educational institutions, and suggests directions for future research to further improve PTM and attendance management using machine learning.

LITERATURE REVIEW

Overview of PTM (Parent-Teacher Meeting) and Attendance Systems:

Parent-Teacher Meetings (PTM) play a crucial role in fostering communication between parents and educators, ensuring that students' academic progress, behavior, and overall well-being are discussed and addressed. Traditionally, PTM scheduling and attendance tracking are managed manually, often through phone calls, emails, or printed notices sent to parents. This manual process, while functional, can lead to significant inefficiencies, such as miscommunication, low parent participation, and a lack of real-time tracking. Parents may miss out on valuable opportunities to engage with teachers due to inconvenient timing, scheduling conflicts, or lack of awareness about the meetings. Similarly, tracking attendance in PTMs is typically done through paper sign-in sheets or simple digital systems, which may not capture accurate data or offer insights into patterns of parent participation.

In addition to PTMs, attendance management is a critical component of the educational process. Traditionally, student attendance is recorded manually by teachers in physical registers or on digital platforms with limited features. This system, while serving its purpose, often lacks the ability to offer real-time analysis or detect emerging trends, such as frequent absenteeism, until it becomes a significant issue (Sharmila et al., 2023). Absenteeism can have a serious impact on students' academic performance and engagement, yet traditional attendance systems are reactive rather than proactive. The lack of integration between attendance records and other data, such as academic performance or socio-economic factors, means that schools often fail to identify at-risk students in time to intervene effectively.

With the increasing integration of technology, there is a growing need to move beyond traditional methods and leverage machine learning and data-driven solutions to automate PTM scheduling and improve attendance management. Machine learning has the potential to optimize these processes by providing real-time insights, predicting trends, and improving both parent-teacher communication and student engagement (Bittal et al., 2023). This shift can help schools foster a more collaborative and data-driven approach to student development, ultimately leading to better academic outcomes.

Key Factors Affecting PTM and Attendance:

Several factors, ranging from student demographics and academic performance to parental socio-economic status and PTM timing, significantly affect both PTM participation and student attendance. Understanding these influences is crucial for improving engagement and reducing absenteeism in educational settings.

- **Student Demographics and Behavioral Patterns**: A student's age, socio-economic background, and family dynamics can significantly impact their academic engagement and school attendance. Students from disadvantaged backgrounds or those exhibiting behavioral challenges are more

likely to miss school and have lower PTM participation, affecting overall academic progress.

- **Parent Engagement and Socio-economic Factors**: Parental involvement in PTMs is often shaped by their socio-economic status and work schedules. Parents with demanding jobs or financial struggles may find it difficult to attend PTMs, leading to decreased engagement in their child's education, which can negatively affect student performance and well-being.
- **Academic Performance and Attendance Trends**: Poor academic performance often correlates with higher absenteeism, as disengaged students may feel less motivated to attend school. In contrast, students who perform well academically tend to have better attendance records, and their parents are typically more involved in PTMs, ensuring a more collaborative relationship with teachers.
- **Time and Scheduling Factors**: The timing of PTMs can greatly influence parent attendance. Meetings scheduled during work hours or at inconvenient times are less likely to attract working parents, leading to lower participation. Offering flexible meeting times, including evenings or weekends, can help accommodate more parents and improve attendance.
- **Communication and Awareness**: Clear and consistent communication about the purpose and importance of PTMs can significantly boost parent participation. If parents are not properly informed or do not perceive the value of attending, they are less likely to participate, even if the meetings are scheduled at convenient times.

Machine Learning in Education:

Machine learning (ML) has become a transformative force in the education sector, offering significant improvements in how educational systems operate and how students engage with learning. At its core, ML allows for the analysis of large datasets to uncover patterns, predict outcomes, and provide valuable insights that would otherwise be difficult to identify. By leveraging these insights, educators and institutions can make data-driven decisions that enhance learning experiences and improve student outcomes. ML can automate administrative tasks, such as grading or attendance tracking, allowing teachers to spend more time focusing on instruction and student interaction.

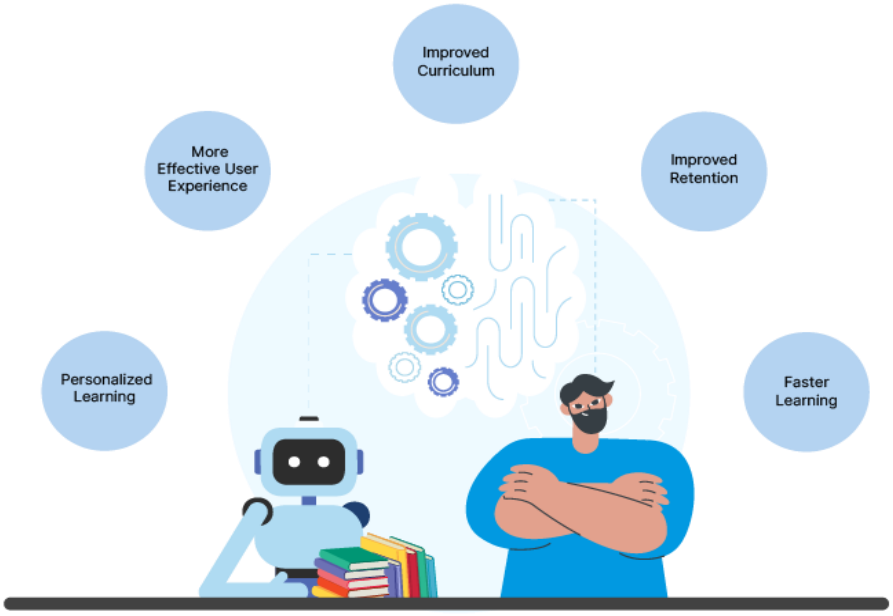

Figure 0.1: Machine Learning in Education

One of the primary benefits of ML in education is its ability to analyze student performance and provide personalized learning experiences. By tracking student progress over time, ML algorithms can identify strengths and weaknesses, allowing for tailored interventions that meet each student's unique needs (Mohammed et al., 2021). This customization helps to improve engagement, as students can work at their own pace and focus on areas where they need improvement. In turn, this can lead to better retention of knowledge and higher overall achievement.

Furthermore, ML allows for predictive analytics, helping educators anticipate potential challenges before they arise. By analyzing patterns in attendance, participation, and performance, ML models can predict which students may

need additional support or are at risk of falling behind. This early identification helps schools take proactive steps to provide timely assistance, improving retention rates and ensuring that students are receiving the support they need to succeed. With its capacity to drive insights and optimize educational practices, ML is poised to continue reshaping how education is delivered and experienced.

Machine Learning Models for Attendance Prediction:

Machine learning models have shown significant promise in improving attendance prediction by analyzing patterns in student data. These models can identify trends that might not be visible through traditional methods, such as predicting when students are likely to miss school or Parent-Teacher Meetings (PTM). By leveraging historical attendance data, academic performance, and other factors like socio-economic background, machine learning can forecast attendance with higher accuracy, allowing schools to proactively address potential absenteeism.

Supervised Learning Models are the most commonly used type of machine learning models for attendance prediction. These models rely on labeled datasets to train algorithms and make predictions based on historical data. For instance, classification algorithms like decision trees, support vector machines (SVM), and logistic regression are used to categorize students as likely to attend or likely to be absent. These models use input variables, such as previous attendance records, grades, student behavior, and socio-economic factors, to predict future attendance patterns. Once trained, these models can be tested on unseen data to evaluate their accuracy in predicting student attendance.

Unsupervised Learning Models also play a role in identifying hidden patterns in attendance data without predefined labels. Clustering techniques like k-means or hierarchical clustering can group students based on similar attendance behaviors, helping to identify subgroups that may be at higher risk of frequent absenteeism (Narkhede et al., 2023). Unsupervised models are particularly useful in identifying trends or anomalies that may not be immediately apparent, thus providing valuable insights into factors influencing attendance that might otherwise be overlooked.

Finally, **Hybrid Models,** which combine both supervised and unsupervised learning techniques, offer even greater predictive accuracy. By integrating multiple approaches, these models can provide more nuanced predictions, taking into account the complex, multifaceted nature of attendance behavior. For example, hybrid models can incorporate both past attendance records and behavioral patterns to create a more accurate and comprehensive prediction. These models can significantly enhance a school's ability to proactively manage attendance, reduce absenteeism, and improve overall student engagement.

Applications of Machine Learning in Attendance Prediction:

Machine learning (ML) is increasingly being used to predict and improve student attendance, helping schools manage absenteeism more effectively. By analyzing historical attendance data along with various factors such as academic performance, behavior, and socio-economic background, ML models can identify trends and patterns in student attendance. These models can predict which students are likely to be absent, providing an early warning system that allows educators to intervene before absenteeism becomes a larger issue. This proactive approach ensures that students receive the support they need to stay engaged and attend school regularly.

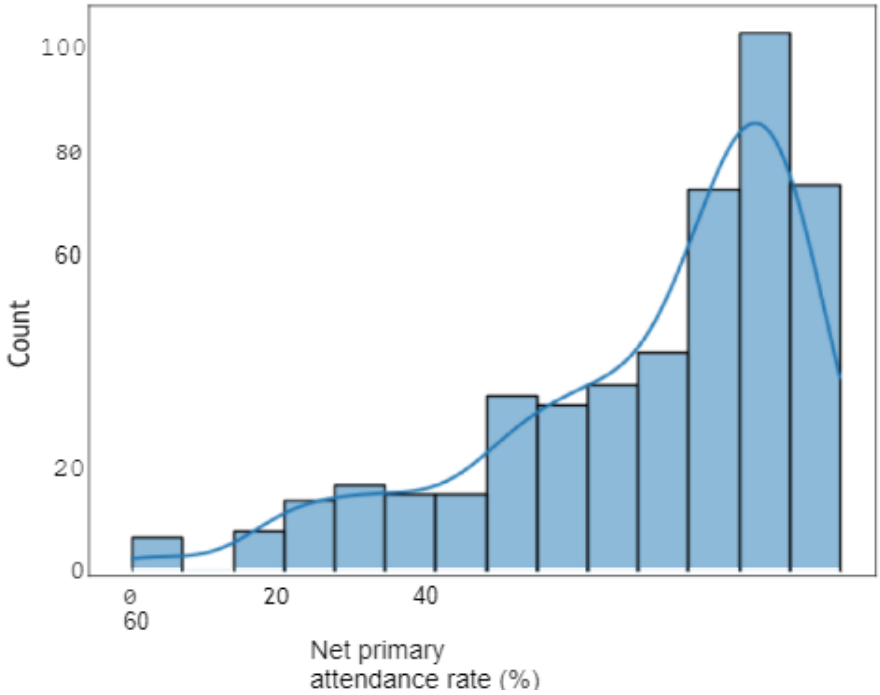

Figure 0.2: Machine Learning in Attendance Prediction

One of the most valuable applications of ML in attendance prediction is its ability to identify at-risk students. By analyzing past attendance data alongside academic performance indicators, ML models can forecast which students are at risk of frequent absenteeism. These predictions enable schools to take targeted action, such as sending reminders, offering additional resources, or providing counseling to help students address any underlying issues contributing to their absences (Al-Amoudi et al., 2021). By identifying these students early on, schools can prevent the negative consequences of chronic absenteeism, such as falling behind in coursework or disengaging from the educational process.

Additionally, ML can optimize the scheduling of Parent-Teacher Meetings (PTMs) to maximize attendance. By analyzing previous PTM participation data, ML models can predict when parents are most likely to attend based on factors like time of day, student performance, and family dynamics. This allows schools to schedule PTMs at times that are convenient for the majority of parents, thereby improving communication and increasing engagement between parents and teachers. In doing so, ML not only helps reduce absenteeism but also fosters stronger partnerships between families and schools, which is essential for student success.

Challenges in Implementing Machine Learning in Educational Systems:

Implementing machine learning (ML) in educational systems presents several challenges that need to be addressed for successful integration. One of the most significant challenges is **data quality and availability**. ML models rely heavily on large, accurate, and comprehensive datasets to make accurate predictions and insights. However, many educational institutions face difficulties in collecting high-quality data due to incomplete or inconsistent records, limited data access, or outdated information. Without reliable data, the performance of ML models may be compromised, leading to inaccurate predictions and potentially ineffective interventions for students.

Another challenge is **resistance to technology adoption** among educators and administrative staff. Many educators may not be familiar with machine learning or may feel hesitant to trust automated systems over traditional methods. This resistance can stem from concerns over job displacement, lack of understanding about how ML works, or fear that the technology might not work as expected (Al Hajji et al., 2022). For ML to be successfully integrated into educational practices, there needs to be adequate training, support, and clear communication about how these tools can enhance teaching and administrative processes rather than replace them.

Ethical and privacy concerns also play a crucial role in the successful implementation of ML in education. With the increasing use of student data to train algorithms, issues surrounding data privacy and security become central. Educational institutions must ensure that student data is protected, and compliance with privacy regulations such as GDPR (General Data Protection Regulation) is maintained. Furthermore, ML models must be designed to be free from biases, ensuring that predictions do not favor or disadvantage certain student groups based on gender, socio-

economic background, or other factors (Jin, 2023). Addressing these ethical concerns is vital to ensuring that ML implementations are fair, secure, and effective in the educational context.

RESEARCH METHODOLOGY

Research Design:

This study adopts a **quantitative research design** to investigate the use of machine learning models for predicting student attendance and Parent-Teacher Meeting (PTM) participation, with a focus on key factors such as academic performance, socio-economic background, and historical attendance patterns. The approach is ideal for analyzing large datasets and applying machine learning techniques to identify trends and predict future outcomes based on these factors, enabling schools to make data-driven decisions in managing attendance and PTM schedules.

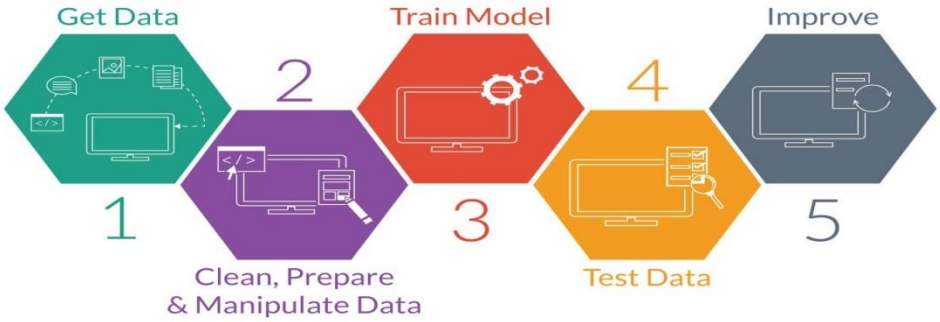

Figure 0.1: Research Design

The research begins with **data collection,** where relevant data, such as student attendance, academic performance, socio-economic factors, and past PTM participation, is gathered. Afterward, **data preprocessing** is performed to clean the dataset, ensuring it is accurate and ready for analysis. **Feature selection** is then carried out to identify the most significant variables influencing attendance and PTM participation. Following this, machine learning models are applied to predict attendance and PTM participation based on the selected features, with performance assessments conducted to ensure reliable predictions. The overall goal is to offer valuable insights to educational institutions for optimizing attendance management and PTM scheduling.

Data Collection:

Data collection is crucial for this study as it forms the foundation for analyzing and predicting student attendance and Parent-Teacher Meeting (PTM) participation. The primary dataset is sourced from publicly available datasets on Kaggle, which include comprehensive records on student attendance, academic performance, and socio-economic factors. The attendance data provides a detailed overview of student presence or absence, enabling the identification of trends in attendance behavior. Academic performance data, such as grades, test scores, and overall student achievement, is also included to examine how academic success or challenges influence attendance and PTM participation.

In addition to academic and attendance data, the Kaggle dataset includes socio-economic factors such as family income, parental education, and other relevant demographic information. These variables are important for understanding how external factors influence both student behavior and parental involvement. The dataset also contains historical PTM participation records, offering valuable insights into parental engagement. By analyzing this data, the study applies machine learning models to predict student attendance and PTM participation while considering the influence of various factors. All data collection methods adhere to ethical standards, ensuring privacy and security throughout the study.

Data Preprocessing:

Data preprocessing is a crucial step in ensuring the accuracy and effectiveness of machine learning models. For this study, the raw data collected from the Kaggle datasets undergoes a series of preprocessing steps to ensure it is clean, structured, and suitable for analysis. The first step in data preprocessing involves **handling missing values**. Missing data can occur due to incomplete records or gaps in student participation and performance data. Techniques such as mean imputation, median imputation, or, in some cases, removal of missing data will be applied based on the type and quantity of missing information.

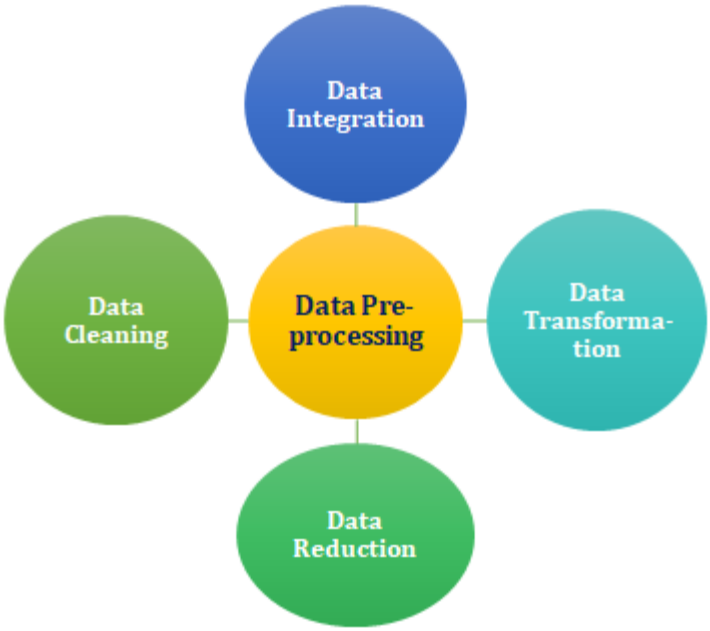

Figure 0.2: Data Preprocessing

Next, **data normalization** and **scaling** are applied to ensure that features with varying scales (e.g., attendance percentages vs. socio-economic data) do not disproportionately influence the machine learning models. This step helps maintain consistency across features, allowing the models to interpret the data correctly. In addition, **categorical data encoding** is performed to convert non-numeric features, such as parental education level or PTM attendance, into numeric representations. Methods such as one-hot encoding or label encoding are used to ensure the model can process categorical variables effectively.

Finally, **outlier detection** and **removal** are performed to identify and address any extreme values that could skew the results. Outliers that are not representative of typical attendance or performance patterns are removed to ensure the dataset accurately reflects the general student population. After these preprocessing steps, the data is ready for feature selection and subsequent machine learning model training. Proper data preprocessing ensures that the models trained on the dataset are both accurate and reliable in predicting student attendance and PTM participation.

Data Splitting:

Data splitting is an essential step to ensure that machine learning models are trained, tested, and validated effectively. For this study, the dataset will be divided into three sets: a **training set**, a **validation set**, and a **test set**. The **70/30 split** will be used, where 70% of the data is allocated for training, 15% for validation, and the remaining 15% for testing.

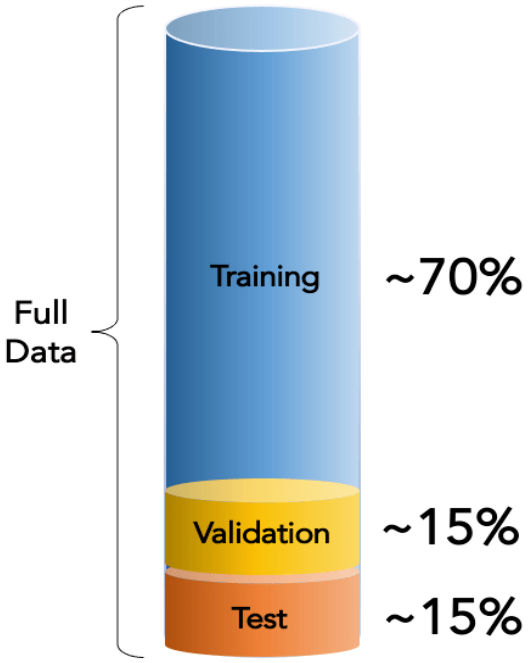

Figure 0.3: Data Splitting

The **training set** (70%) will be used to train the machine learning models. This data is used by the algorithm to learn patterns and relationships between the features and the target variable, such as student attendance or PTM participation. The **validation set** (15%) will be used during the training process to tune the model's hyperparameters and prevent overfitting. This set allows for fine-tuning, ensuring the model generalizes well to unseen data before final testing. The **test set** (15%) is kept entirely separate from the training and validation process and is used solely to evaluate the model's performance after training. This ensures that the performance metrics are unbiased and reflect how the model would perform on new, unseen data. By using this three-set approach, the study ensures robust evaluation of the machine learning models, minimizes overfitting, and provides an accurate assessment of how well the models predict attendance and PTM participation.

Machine Learning Models Used:

This study employs machine learning models to predict student attendance and Parent-Teacher Meeting (PTM) participation based on key factors such as academic performance, socio-economic background, and historical attendance data. The models are selected to identify patterns and relationships in the data that help predict future attendance trends and PTM engagement.

The focus is on **supervised learning techniques**, where models are trained using labeled data. These models include **classification algorithms** to predict categorical outcomes, such as whether a student is likely to attend or miss school or PTM. Additionally, **regression models** are used to predict continuous variables, such as the number of absences or the likelihood of PTM participation, based on various input features. Models are trained using the **training set** and fine-tuned with the **validation set** to optimize performance.

Machine learning models such as **decision trees, random forests**, and **logistic regression** are applied in this study. **Decision trees** provide interpretable decision-making rules, while **random forests** combine multiple decision trees to improve predictive accuracy. **Logistic regression** is effective for predicting binary outcomes, such as whether a student will attend PTM or not. These models handle various types of data and make predictions based on a combination of factors, enabling the study to draw meaningful insights about student attendance and parent-teacher engagement.

Evaluation and Prediction:

The evaluation of the machine learning models plays a critical role in determining the effectiveness of the predictions for student attendance and Parent-Teacher Meeting (PTM) participation. Once the models are trained and fine-tuned using the training and validation sets, they undergo evaluation using the **test set** to assess their generalization ability.

The evaluation process helps to ensure that the models do not overfit the training data and can accurately predict unseen data, which reflects real-world scenarios.

The models' performance is assessed based on their ability to make accurate predictions for student attendance and PTM participation. Various metrics, such as accuracy, precision, recall, and F1-score, are used to measure the performance of classification models, which predict outcomes like attendance or non-attendance. For regression models, metrics such as mean absolute error (MAE) or root mean squared error (RMSE) are employed to evaluate the precision of predictions for continuous variables like the number of absences or expected PTM participation rates. In addition to the quantitative evaluation metrics, predictions are made for new or unseen data to assess how well the models can generalize beyond the existing dataset. This predictive ability allows schools and educators to proactively identify students at risk of absenteeism or low PTM participation, providing the foundation for more personalized interventions. By leveraging these predictions, the study aims to offer actionable insights that educational institutions can use to optimize their attendance and PTM management processes.

RESULTS AND DISCUSSIONS

Dataset Description:

The dataset used in this study is sourced from publicly available Kaggle datasets, providing a comprehensive collection of student attendance, academic performance, socio-economic factors, and Parent-Teacher Meeting (PTM) participation data. This dataset is crucial for analyzing patterns and relationships that can help predict future attendance trends and PTM engagement.

The dataset includes multiple features related to **student attendance**, such as the frequency of absences, the reasons for absences, and overall attendance rates. It also contains **academic performance** data, including grades, test scores, and other metrics that reflect a student's academic success or challenges. Additionally, the dataset incorporates **socio-economic factors**, such as family income, parental education, and employment status, as these are known to impact student behavior, attendance, and involvement in PTMs.

Furthermore, the dataset includes **historical PTM participation data**, showing whether parents attended meetings and the frequency of their involvement. This data provides valuable insights into the level of parental engagement, which is an important factor in both student attendance and academic performance. The combination of these diverse features enables the application of machine learning models to predict student attendance and PTM participation, offering a more comprehensive approach to understanding and addressing absenteeism and parental involvement in education.

Model Training and Evaluation:

In this section, the machine learning models used for predicting student attendance and Parent-Teacher Meeting (PTM) participation undergo training and evaluation. The training process involves utilizing the **training set**, which comprises 70% of the collected data. The models are trained on this subset to learn patterns and relationships between various features, such as student attendance, academic performance, socio-economic factors, and historical PTM participation. The **validation set** (15% of the data) is used to fine-tune the models by adjusting hyperparameters and ensuring that they are not overfitting to the training data.

During the **training phase**, the models learn to map the input features to the target variable, such as predicting whether a student will attend school or a PTM. For instance, supervised learning models like decision trees or logistic regression are trained to classify students as likely to attend or miss school/meetings based on their historical attendance and other influencing factors. The models are then evaluated on the **test set** (15% of the data) to assess their predictive performance.

The evaluation focuses on how well the models generalize to unseen data, measuring the accuracy of predictions related to student attendance and PTM participation. The performance of each model is assessed based on its ability to predict attendance patterns accurately and identify students who may require additional support. This process helps ensure that the models are reliable and can provide actionable insights for educational institutions to improve attendance management and PTM engagement.

Performance Comparison of Models:

The performance of the machine learning models used for predicting student attendance and Parent-Teacher Meeting (PTM) participation is compared based on their ability to make accurate predictions on the test set. Each model is evaluated on its effectiveness in predicting attendance trends and PTM engagement using input features such as academic performance, socio-economic factors, and historical attendance data.

The comparison focuses on various metrics to determine the accuracy and reliability of the models. For **classification models**, the evaluation emphasizes

the accuracy of predicting binary outcomes, such as whether a student will attend or miss school or PTM. For **regression models**, the comparison is based on how well the model predicts continuous variables, like the number of absences or the likelihood of PTM participation. The models are also assessed for their ability to generalize to new data, ensuring that they do not overfit to the training data.

The performance of models like decision trees, random forests, and logistic regression is compared to identify which model provides the most reliable predictions. Factors like accuracy, interpretability, and robustness to overfitting are considered. The comparison aims to determine the most effective model for predicting student attendance and PTM participation, offering actionable insights for improving school attendance and parent-teacher engagement strategies.

CONCLUSION

Theoretical Contributions:

This study makes several important theoretical contributions to the field of educational data science, particularly in the application of machine learning to student attendance and Parent-Teacher Meeting (PTM) participation. One significant contribution is the demonstration of how machine learning can be used to analyze and predict patterns in student attendance and parental involvement, areas that have traditionally been managed manually or with limited data analysis. By leveraging machine learning models, the study provides new insights into the relationships between student demographics, academic performance, socio-economic factors, and engagement in PTMs.

Another theoretical contribution is the development of a framework for predicting student attendance and PTM participation using a combination of supervised and unsupervised learning models. This study highlights how multiple machine learning techniques can be integrated to improve predictive accuracy, providing a foundation for future research on the effectiveness of various algorithms in educational settings. Additionally, the study contributes to understanding the role of socio-economic factors and parental involvement in educational outcomes, suggesting that these factors can be incorporated into predictive models to enhance student engagement and performance.

Overall, this research expands the theoretical understanding of how data-driven approaches can optimize educational processes, offering a new perspective on the application of machine learning in addressing challenges related to student attendance and parental engagement. The findings also lay the groundwork for future studies exploring machine learning's potential in other areas of educational management and policy-making.

Practical Contributions:

This study provides several practical contributions to the field of education, particularly in the areas of student attendance management and Parent-Teacher Meeting (PTM) scheduling. By applying machine learning models to predict attendance patterns and PTM participation, the research offers actionable insights for educational institutions to improve their operational efficiency. One key practical contribution is the ability to identify at-risk students early based on historical data, academic performance, and socio-economic factors. This predictive capability enables schools to take proactive measures, such as sending reminders, offering additional support, or engaging parents, to prevent absenteeism and encourage greater involvement in PTMs.

The study also contributes to the development of data-driven strategies for optimizing PTM scheduling. By analyzing historical participation data, schools can schedule PTMs at times when parents are most likely to attend, thus improving engagement and fostering stronger parent-teacher relationships. This not only enhances communication between schools and families but also supports better academic outcomes for students by ensuring that parents are informed and actively involved in their child's education.

Additionally, the use of machine learning models offers a more scalable and efficient approach to attendance tracking and PTM participation analysis, compared to traditional manual methods. Educational institutions can leverage these insights to automate and streamline attendance management processes, saving time and resources while improving overall student and parent engagement. Ultimately, this research provides schools with practical tools and strategies to enhance their administrative functions and improve student success.

Conclusion:

In conclusion, this study demonstrates the potential of machine learning to enhance student attendance management and Parent-Teacher Meeting (PTM) participation. By analyzing data such as academic performance, socio-economic factors, and historical attendance records, machine learning models were able to accurately predict attendance patterns and parental involvement. These predictions offer educational institutions valuable insights, allowing them to take proactive steps to address absenteeism and engage parents more effectively. Through this approach, schools can improve communication, foster stronger relationships between educators and families, and create a more supportive environment for students.

The research highlights the importance of data-driven decision-making in educational settings. By utilizing predictive models, schools can optimize PTM scheduling, increase parental engagement, and provide timely interventions to students at risk of absenteeism. These findings contribute both theoretically and practically, offering schools actionable tools to improve operational efficiency and student success. The study also opens avenues for future research, suggesting that machine learning could be further applied to other aspects of educational management, leading to even greater improvements in the educational experience.

Future Work:

Future work in this area can focus on expanding the scope of machine learning applications within educational systems by incorporating additional features into the models, such as psychological factors, student behavior, and engagement with online learning platforms. These additional variables could offer a more holistic understanding of student performance and engagement, leading to more accurate predictions for attendance and PTM participation. Additionally, exploring advanced machine learning algorithms, such as deep learning and reinforcement learning, could enhance prediction accuracy and help develop adaptive learning systems capable of responding to real-time student data, enabling dynamic intervention strategies.

Moreover, extending this research to include a more diverse range of educational institutions, including different school systems and universities, would allow for testing the generalizability of the models across various contexts. The scalability of the models should also be explored, evaluating how well they perform with large datasets and whether they can be implemented effectively in smaller or resource-limited schools. Finally, future work should address the ethical considerations of machine learning in education, ensuring fairness, transparency, and protection of student data, to maintain trust and safeguard the welfare of all stakeholders involved.

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