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Empowering Peer Tutoring via AI- Driven Refinery Intervention Treatment in Education



Abstract: - Refinery intervention treatment via peer tutoring has gained recognition as an effective approach for enhancing student learning and academic achievement. This theoretical paper examines the manual processes involved in conducting peer tutoring sessions, identifies challenges in its implementation, and proposes an automation to streamline the process. This paper emphasizes the benefits of automating the peer tutoring process, including improved efficiency, and creating opportunities for personalized and adaptive learning experiences. Acknowledging the transformative potential of technology in education, the study advocated for the implementation of automated systems in peer tutoring. The system leverages machine learning, data analytics, and artificial intelligence to optimize tutor-student matching, generate personalized tutoring plans, and provide real-time progress tracking. By automating operational tasks, educators and peer leaders can focus on facilitating meaningful interactions and delivering targeted instructional support. While recognizing the potential challenges and ethical considerations associated with automation, this paper emphasizes the importance of striking a balance between technological advancements and human engagement. The transition from manual arrangements to automated systems in peer tutoring has the potential to revolutionize educational practices, ensuring that every student benefits from peer support and promoting a culture of collaborative learning. By embracing automation, this study can harness the power of technology to enhance the effectiveness and accessibility of peer tutoring, ultimately improving student outcomes and fostering a dynamic learning environment.

Keywords: Automation, Artificial intelligence, Peer tutoring, Refinery Intervention Treatment, Technology in Education

I. INTRODUCTION

In the realm of education, peer tutoring has emerged as a powerful strategy for enhancing student learning and academic achievement [1]. The concept revolves around the notion that students can effectively support and teach their peers and at the same time leverage their understanding of the subject matter. This peer tutoring approach fosters a sense of empowerment, engagement, and mutual growth among participants [2]. This theoretical paper delves into the potential of automation and artificial intelligence (AI) in transforming peer tutoring practices, specifically within the context of Refinery Intervention Treatment (RIT) in education. RIT aims to provide targeted support to students who require additional assistance in overcoming academic challenges [3]. By integrating automation into the peer tutoring process, the effectiveness and efficiency of RIT can be optimized providing students with personalized and adaptive learning experiences. It reflects the transformative nature of leveraging AI and automation to revolutionize the delivery of peer tutoring, particularly within RIT programs. By utilizing advancements in machine learning, data analytics, and AI technologies, automated systems can streamline tutor-student matching, generate personalized tutoring plans, and enable real-time tracking of student progress [4]. These systems can utilize state-of-the-art machine learning and natural language processing techniques to provide personalized feedback to students, including personalized hints, explanations, and mathematical hints. This integration not only reduces educators and peer leaders of administrative tasks but also allows them to devote more time and attention to facilitating meaningful interactions and delivering targeted instructional support.

A. Problem Statement

Peer tutoring has gained significant recognition as a valuable educational intervention that fosters collaborative learning and academic growth among students. The practice involves assigning peer members to peer leaders to provide personalized support and guidance in specific subjects or skills. Traditionally, the organization and management of peer tutoring sessions have relied on manual arrangements, necessitating considerable time and effort from educators and administrators. However, with the rapid advancements in technology and the potential for automation, there is a growing need to explore how automated systems can revolutionize the peer tutoring landscape. Manual arrangements encompass various tasks such as identifying suitable peer leaders, connecting

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them with peer members based on their academic needs, coordinating schedules, and monitoring the progress and effectiveness of peer tutoring sessions. These activities demand significant time and resources from educators, often resulting in delays, logistical difficulties, and inconsistencies in the delivery of peer tutoring support. Additionally, manual arrangements may be susceptible to human error and biases, potentially impacting the quality and equity of the tutoring experience. Considering these challenges, this study argues for the adoption of automated systems to streamline the process of peer tutoring. Automation has the potential to alleviate the administrative burden associated with manual arrangements, allowing educators and administrators to focus their efforts on facilitating meaningful interactions and tailoring instruction to meet individual student needs. By leveraging technology, automated systems can optimize the allocation process, generate personalized tutoring schedules, and provide real-time progress tracking, thereby enhancing the overall efficiency and effectiveness of peer tutoring sessions. The purpose of this theoretical paper is to delve into the manual arrangements involved in conducting peer tutoring sessions and shed light on the challenges inherent in the current approach. By doing so, this study aims to provide a comprehensive understanding of the limitations and complexities associated with manual arrangements, thus paving the way for the implementation of automated systems that can address these issues. Furthermore, automation can significantly expand the accessibility and scalability of peer tutoring support. Automated systems can bridge these gaps by connecting students with peer tutors who possess the necessary expertise, regardless of physical proximity. This broader reach ensures that more students can access the advantages of peer support, leading to improved academic outcomes and increased student engagement.

II. LITERATURE REVIEW

Peer tutoring can be conducted using both manual and automation methods. Manual peer tutoring involves students working together in pairs or small groups, with one student acting as the tutor and the other(s) as the tutee(s). The tutor provides guidance and support to the tutee(s) in their learning process. [5] Automation in peer tutoring refers to the use of technology or digital tools to facilitate the tutoring process. This can include the use of online platforms, virtual classrooms, or educational software to connect tutors and tutees remotely. Automation can provide additional resources and support for peer tutoring, such as immediate feedback, performance tracking, and interactive learning materials. [6] Both manual and automation methods are effective in improving student competence and understanding in various subjects, including math and machining practice [7]. Automation tools, such as Katalon Studio, have been developed to automate software testing processes, ensuring the quality and functionality of software systems [8]. Additionally, automation in computer tutoring systems can help mitigate user frustration and support student learning by adapting the interaction style based on the learner's needs and emotions [9].

Peer tutoring can be done manually or through automation. Manual peer tutoring involves students helping each other in their learning process. It can be effective in improving math fact fluency and computer application operating skills [17]. However, providing feedback and correcting mistakes can be challenging for teachers in manual peer tutoring [18]. Automation of peer tutoring can be achieved through machine-learning-based systems that recommend peer tutors and provide automated assessment and feedback. These systems use advanced technologies like computer vision to evaluate student assignments and improve learning performance. Adaptive collaborative learning support systems can also be used to provide targeted assistance in peer tutoring scenarios [18]. These systems analyze student collaboration and provide adaptive assistance to improve help-giving and learning [19]. The methodologies of artificial intelligence and cognitive psychology can be used to automatically generate tutorial interactions, eliminating the need for manual programming. Automating peer tutoring is effective in various educational contexts. In the field of mathematics, a peer-tutoring approach using a multicomponent motivational system significantly improved struggling students' math fact recall performance. In vocational high schools, a machine-learning-based peer tutor recommender system with automated assessment enhanced students' learning performance in computer application operating skills [20].

III. METHODOLOGY

Refinery intervention treatment through peer tutoring has emerged as a promising strategy for enhancing student learning and academic achievement. The potential of this approach lies in its ability to foster collaborative learning experiences, where students actively engage in the learning process and support each other's academic growth. As

educational institutions increasingly recognize the transformative impact of technology, there is a growing interest in automating the peer tutoring process to address challenges and improve its overall efficiency and effectiveness.

A. *Manual Processes in Peer Tutoring*

Traditional peer tutoring involves manual procedures for matching tutors with students, creating tutoring plans, and tracking progress. While this method has shown positive outcomes, it is resource-intensive and may not fully leverage the potential of educational technology to enhance personalized learning experiences. **Figure 1** depicts the flowchart of the manual process in peer tutoring.

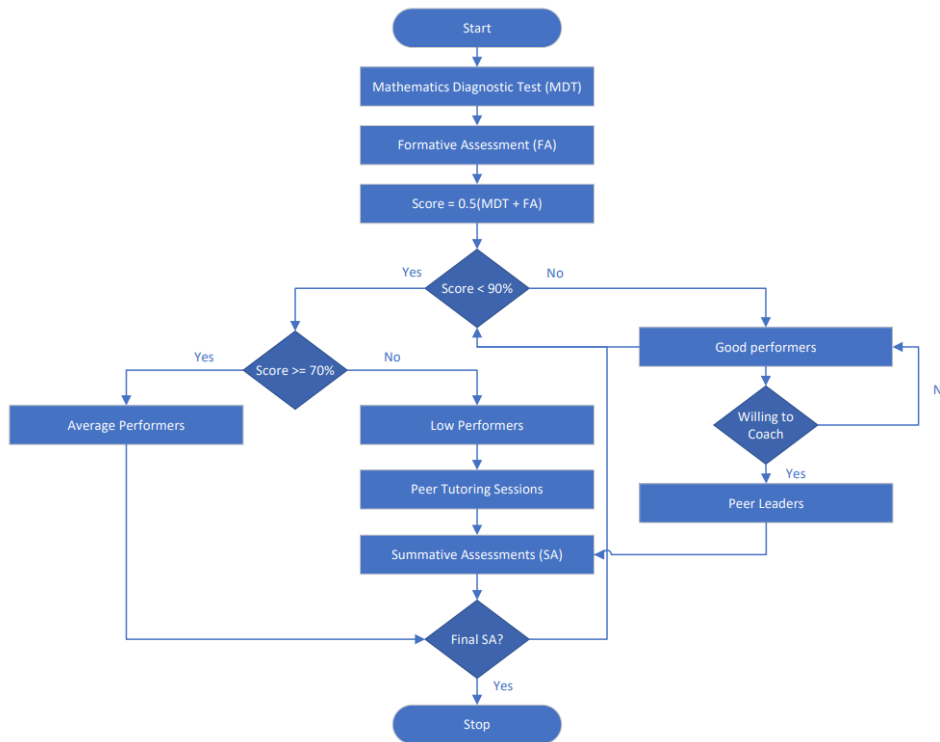


Figure 1

Conducting mathematics diagnostic test and formative assessments in a manual process

In a manual process, educators create diagnostic tests based on their expertise and knowledge of the subject matter. The test is designed to assess students' understanding of essential concepts and identify any knowledge gaps. The test is administered in a traditional classroom setting, with educators supervising the process to ensure fairness and integrity. After students complete the test, educators manually grade the responses and analyze the results. Educators review the test data to identify common misconceptions and areas of weakness among the students. Based on the test results, educators provide individualized feedback to students and design targeted interventions to address learning gaps. In a manual formative assessment process, educators create various assessment tasks, such as quizzes and class discussions to gauge students' ongoing progress. Educators administer these assessments throughout the learning process to monitor student understanding and adjust instruction as needed. Educators grade the formative assessments and provide timely feedback to students to guide their learning and improvement. Based on the results and feedback, educators modify their teaching strategies and materials to support student learning.

Identifying and selecting peer leaders in a manual process

In the manual process of identifying and selecting peer leaders, educators employ a criteria-based approach to identify students who exhibit exceptional academic performance and leadership qualities. Specifically, students who scored above 90% in both the diagnostic test and formative assessments are considered potential candidates for the role of peer leaders. After conducting the diagnostic test and formative assessments, educators collect and analyze the results to identify students who achieved outstanding scores, surpassing the 90% benchmark in both

evaluations. In addition to academic excellence, educators carefully observe potential candidates in various contexts, such as classroom activities, to assess their leadership qualities. Key traits, including effective communication skills, empathy, and a willingness to assist peers, are essential considerations in identifying suitable candidates for the peer leadership role. Once potential candidates are identified, educators may conduct individual or group discussions with the candidates to gauge their motivation, commitment, and vision for peer tutoring. This process provides an opportunity for candidates to share their ideas and passion for supporting their peers. After the selection process is complete, the chosen students are announced as peer leaders. They are then provided with comprehensive training and guidance on their roles and responsibilities, equipping them to effectively support their fellow students in peer tutoring sessions. Throughout their tenure as peer leaders, educators offer continuous support and mentorship to help them succeed in their leadership roles.

Identifying peer members in a manual process

After conducting the diagnostic test and formative assessment, educators collect the results and compile the data for each student. Educators conduct a thorough review of the data, evaluating individual students' performance against the established criteria. Educators carefully identify students who meet the specified conditions, specifically those who scored less than 60% in either the diagnostic test, formative assessment, or both, and designate them as peer members. Once the peer members are identified, educators communicate with the chosen students and inform them of their requirements to attend peer tutoring sessions. Educators also explain the benefits of peer tutoring and encourage the selected students to participate actively.

Attendance tracking in a manual process

In the manual process of attendance tracking for peer leaders and members, educators, and administrators rely on traditional methods that involve hands-on record-keeping and manual monitoring. During peer tutoring sessions, peer leaders and members physically sign in on paper attendance sheets. Educators collect and manage these sheets, noting the date and time of each session attended by the participants. After each tutoring session, educators manually enter the attendance data into spreadsheets or other tracking systems. They may also make notes about participants' engagement and any relevant observations during the session. Educators are responsible for organizing and storing the attendance records, ensuring they are easily accessible for review and reporting purposes. In case of any irregularities or absences, educators may follow up with peer leaders and members to address any issues and provide support if needed.

Scheduling and logistics in manual process

In a manual process of scheduling and logistics for peer tutoring sessions, educators and administrators handle the coordination and communication through traditional methods. Educators manually identify available time slots for peer tutoring sessions and coordinate with peer leaders and members to find mutually convenient times. Once the schedule is finalized, educators inform peer leaders and members about the venue of the tutoring sessions through verbal communication, announcements, or written notices. In case of any schedule changes or venue adjustments, educators again communicate the updates manually to all relevant parties, which can be time-consuming and may lead to communication gaps. Educators are responsible for managing the logistics of the tutoring sessions, such as arranging the physical space, ensuring necessary learning materials are available, and addressing any issues that arise during the sessions.

Limitations and challenges in a manual process

Manual arrangements in peer tutoring have their limitations and challenges. Manual arrangements often involve a significant amount of time and effort, including data collection, record-keeping, and communication. This can divert educators' attention from other important tasks, affecting overall productivity. Manual processes may not be as efficient as automated ones, leading to potential delays, errors, and inconsistencies in tasks such as scheduling, data entry, and record maintenance. Manual decision-making can be influenced by personal biases or interpretations, potentially leading to variations in the quality of outcomes and selections. As the number of students and participants grows, manual arrangements can become increasingly challenging to manage effectively, particularly in larger educational institutions. Manual processes may not facilitate in-depth data analysis and insights due to the data collection and analysis, which could limit informed decision-making. Manual communication methods can lead to miscommunication or delays in conveying important information to students,

educators, and other stakeholders. Manual record-keeping may present challenges in ensuring the security and privacy of sensitive information, potentially leading to data breaches or unauthorized access. Manual processes may make it harder to track and monitor ongoing activities, such as attendance, progress, and intervention effectiveness. Manual arrangements may require more human and physical resources, leading to increased costs and administrative burdens. Manual processes may not be as accessible for students with disabilities or those who require accommodation, potentially excluding them from certain educational opportunities.

B. Automation process in peer tutoring

Automation can play a significant role in streamlining and enhancing various aspects of peer tutoring, making the entire process more efficient, effective, and personalized. **Figure 2** depicts the flowchart of the automation process in peer tutoring.

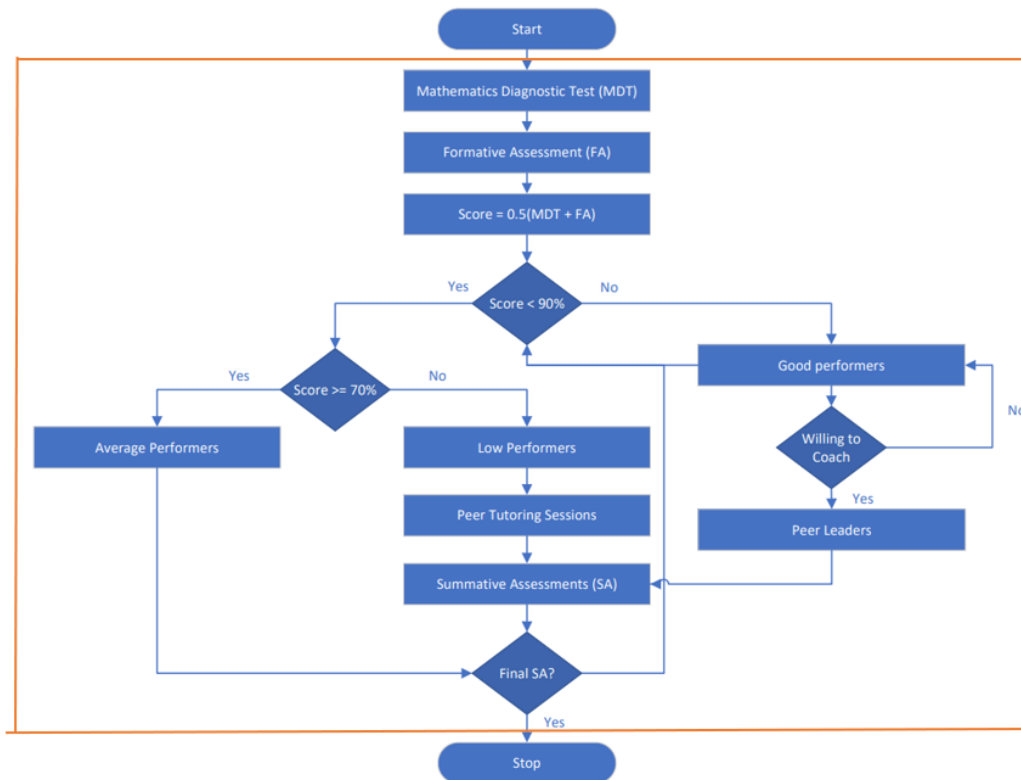


Figure 2

Conducting mathematics diagnostic test and formative assessments in the automation process

Automated systems can generate diagnostic tests based on predefined criteria and learning objectives, ensuring standardized and consistent assessments. Students can take the diagnostic test online, which allows for flexibility in scheduling and reduces administrative burden. The system automatically grades the test responses, providing instant feedback to students and educators. Automation enables the quick analysis of test data, generating reports that highlight patterns and areas of improvement for each student. The system can offer personalized feedback to students, suggesting specific learning resources or activities based on their performance. Automated platforms offer various digital assessment tools, such as interactive quizzes facilitating ongoing assessment. Automated systems provide immediate feedback to students, enabling them to track their progress and adjust their learning strategies.

Identifying and selecting peer leaders in the automation process

In an automated process, technology and data analytics play a crucial role in identifying and selecting peer leaders. Automated systems collect and analyze data on students' diagnostic test results, formative assessment results, and academic performance. Machine learning algorithms can identify potential peer leader candidates based on predefined criteria, such as leadership qualities and academic performance. Automated systems generate reports and rankings of potential peer leader candidates based on data analysis. Educators and administrators can review

these insights, enabling more informed and data-driven decision-making when selecting peer leaders. Automated platforms distribute email notifications to students, asking them to self-nominate as peer leader candidates and willing to support their peers.

Identifying and selecting peer members in the automation process

In an automated process, technology and data analytics play a crucial role in identifying peer members based on the given criteria. Automated systems collect and analyze the results of the diagnostic test and formative assessment for each student. Using predefined criteria, the system identifies students who scored less than the threshold that can be set in either test or both. The system automatically selects students who meet the specified conditions as peer members based on the data analysis. It generates a list of selected students who are required to attend peer tutoring sessions. The automated system can send personalized notifications or emails to the selected students, informing them of their selection as peer members and the requirement to attend peer tutoring sessions. The system also provides details about the schedule and location of the sessions.

Attendance tracking in a manual process

In an automated process, technology streamlines attendance tracking for peer leaders and members, reducing administrative burden, and providing real-time data. Automated platforms offer digital attendance tracking systems that allow peer leaders and members to sign in electronically using unique identifiers or scanning QR codes. This data is instantly recorded in the system. Attendance data is automatically collected and stored in a centralized database in real-time, eliminating the need for manual data entry and ensuring accuracy and efficiency. Automated systems can send automatic notifications to peer leaders and members to remind them of upcoming tutoring sessions and encourage regular attendance. The system can generate comprehensive attendance reports, providing educators and administrators with insights into attendance trends and patterns. This data can inform decision-making and intervention strategies. Automated attendance tracking systems can be integrated with communication tools, allowing educators to send messages or alerts to peer leaders and members directly through the platform.

Scheduling and logistics in manual process

In an automated process, technology streamlines scheduling and logistics for peer tutoring sessions, making the process more efficient and accessible. Automated platforms can offer scheduling tools that allow educators, peer leaders, and members to view available time slots and select their preferred tutoring sessions. The system can use algorithms to optimize scheduling based on participant availability. Educators can update the venue of tutoring sessions directly in the automated system. Participants can access this information in real time through the platform, eliminating the need for manual communication. Automated systems can send automatic notifications to peer leaders and members about upcoming tutoring sessions, including the scheduled time and venue. These reminders ensure participants stay informed and prepared. Automation allows for centralized management of logistics. Educators can use the platform to ensure that the necessary learning materials are available for each session and address any logistics-related issues efficiently. Automated platforms offer real-time communication features, allowing peer leaders, members, and educators to exchange messages and updates regarding scheduling and logistics within the system.

Overcoming limitations with automation process

Using automation processes can effectively overcome the limitations of manual arrangements in various educational tasks, including peer tutoring. Automation significantly reduces the time required for various tasks, such as data collection, scheduling, and record-keeping. By automating these processes, educators, and administrators can allocate their time more efficiently to focus on providing personalized support to students and improving instructional practices. Automation streamlines tasks and minimizes the likelihood of errors, leading to enhanced overall efficiency in educational processes. Automated systems can handle tasks consistently and promptly, ensuring smoother operations and reducing the risk of delays or inconsistencies. Automation removes the potential for bias and subjectivity in decision-making processes. Algorithms and data-driven approaches ensure objective criteria are used in selecting peer leaders, identifying peer members, conducting assessments, and providing personalized support. Automated systems can easily handle large amounts of data and accommodate a growing number of students and participants. This scalability ensures that educational processes remain effective and efficient, even as the student population expands. Automation enables sophisticated data analysis and reporting,

providing educators with deeper insights into student performance, engagement, and progress. Educators can use this information to make informed decisions, identify trends, and tailor interventions to meet individual students' needs effectively. Automated communication tools facilitate seamless and real-time communication between educators, peer leaders, and peer members. This reduces communication gaps, ensures timely updates, and promotes a collaborative learning environment. Automated systems can employ robust security measures to protect sensitive student data, ensuring compliance with data protection regulations and safeguarding privacy. Automation allows for accurate and continuous tracking of various aspects, such as attendance, progress, and intervention effectiveness. This enables educators to identify and address issues promptly, providing timely support to students. While automation may require an initial investment in technology, it can lead to long-term cost savings by streamlining administrative processes and optimizing resource allocation. Automated systems can be designed with accessibility features, ensuring that all students, including those with disabilities or diverse learning needs, can fully participate in educational activities.

IV. RESULTS

Leveraging technology for enhanced educational support revolutionizes the traditional approaches to teaching and learning.

A. *Manual vs automation process of diagnostic test and formative assessments*

Table 1 shows the comparison of manual and automated processes that have their merits in conducting diagnostic tests and formative assessments. An integration of automation can optimize the learning experience by combining the strengths of both approaches.

Table 1

Aspect	Manual Process	Automated Process
Customization	Educators can tailor assessments and interventions based on expertise.	Standardization may limit customization but allows for consistency.
Efficiency	Requires more time and effort to administer assessments manually.	Offers efficiency, streamlining assessment processes, and saving time.
Scalability	Limited scalability due to human resource constraints.	Scalable, accommodating many students efficiently.
Data-Driven Insights	Limited data insights due to manual record-keeping.	Provides data-driven insights, aiding in personalized learning paths.
Speed and Accuracy	May vary in terms of speed and accuracy depending on human factors.	Offers consistent speed and accuracy in assessment procedures.
Human Involvement	Highly reliant on educator involvement for assessment design and administration.	Balances technology with human expertise, fostering a holistic approach.

B. *Manual vs automation process of identifying and selecting peer leaders*

Table 2 shows the comparison of manual and automated processes of identifying and selecting peer leaders. The integration of automation can result in a more effective selection process.

Table 2

Aspect	Manual Process	Automation Process
Identification Process	Personal observations, interviews, and discussions.	Utilizes technology and data analytics for insights.
Decision-Making Process	Involves subjective judgments and human biases.	Provides streamlined and data-driven decision-making.
Time and Efficiency	time-consuming and reliant on human availability.	Offers efficiency, potentially reducing selection time.
Subjectivity	Subject to personal biases and varying opinions.	Aims for objectivity, reducing bias in selection.

Scalability	May have limitations when dealing with a large candidate pool.	Scales easily accommodate a larger candidate pool.
Data Utilization	Limited use of data for decision-making.	Leverages data analytics to make informed selections.

C. *Manual vs automation process of identifying and selecting peer members*

Table 3 shows the comparison of manual and automated processes for identifying peer members. The integration of automation can save more time in the selection process.

Table 3

Aspect	Manual Process	Automation Process
Identification Criteria	Relies on low performance in diagnostic tests and formative assessments.	Also relies on the same low-performance criteria for identification.
Educator Involvement	Heavily reliant on educators for hands-on involvement and data review.	Minimizes the need for educator intervention, automating data analysis.
Data Handling	Requires educators to manually review and interpret data for selection.	Automates data analysis, ensuring consistent identification.
Selection Process	Subject to variations based on individual educator judgments.	Standardizes selection criteria, reducing potential biases.
Time Efficiency	time-consuming, depending on the number of educators involved.	Offers timesaving benefits and streamlines the identification process.
Accuracy	Subject to human errors in data interpretation and selection.	Enhances accuracy through automated data analysis and selection.

D. *Manual vs automation process of attendance tracking*

Table 4 shows the comparison of manual and automated processes of attendance tracking. An integration of automation attendance tracking offers real-time data collection, automatic notifications, and data analysis, reducing manual tasks and providing educators with valuable insights for a more organized and efficient peer tutoring program.

Table 4

Aspect	Manual Process	Automation Process
Real-Time Data Collection	Requires manual record-keeping and updates.	Provides real-time data collection and updates.
Notifications	Manual notifications may be delayed or overlooked.	Offers automatic notifications for timely reminders.
Manual Tasks	Involves manual tasks like record maintenance.	Reduces manual tasks, saving time and effort.
Access to Records	Access to attendance records may be delayed or restricted.	Offers instant and convenient access to records.
Educator Effectiveness	Educators may have limited tools for data-driven decision-making.	Empower educators with data for informed decisions.

E. *Manual vs automation process of scheduling and logistics*

Table 5 shows the comparison of manual and automated processes of scheduling and logistics. An integration of automation in scheduling and logistics for peer tutoring sessions offers real-time updates and reduces manual efforts.

Table 5

Aspect	Manual Process	Automation Process
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Scheduling	Manual scheduling with potential conflicts and delays.	Automated scheduling with reduced conflicts and real-time updates.
Venue Updates	Relies on manual notifications for venue changes.	Offers real-time venue updates and notifications.
Communication	Manual communication may lead to missed updates or delays.	Facilitates effective and timely communication.
Efficiency	May experience inefficiencies and delays in session organization.	Enhances overall efficiency in managing peer tutoring sessions.
Educator Focus	Educators spend time on logistics rather than instructional support.	Allows educators to focus on meaningful interactions and targeted support.

While manual arrangements have been used effectively in various educational settings, it is essential to recognize their limitations and challenges. Embracing automation and technology can address many of these issues, providing more efficient, accurate, and scalable solutions. Striking a balance between manual and automated processes can lead to a more effective and inclusive educational environment, ensuring that students receive the support and resources they need to succeed academically and beyond. Embracing automation processes in education can overcome the limitations of manual arrangements by promoting time efficiency, objectivity, scalability, comprehensive data analysis, seamless communication, data security, enhanced tracking, and cost-effectiveness. Automation improves the overall educational experience, empowering educators to provide personalized support and create a more inclusive and dynamic learning environment for all students.

V. CONCLUSION

This paper has shed light on the imperative transition from manual arrangements to automated systems in peer tutoring sessions. By acknowledging the challenges inherent in the current approach and emphasizing the potential benefits of automation, this paper advocates for the integration of technology to optimize peer tutoring practices. The subsequent sections have delved into the specific challenges faced during manual arrangements, discussed the advantages and considerations of automation, and outlined potential avenues for future research and development in this evolving field. Automation processes in education bring multifaceted advantages that positively impact all stakeholders. For educators, automation streamlines administrative tasks, freeing up valuable time to focus on personalized instruction and fostering meaningful interactions with students [10]. Students, in turn, benefit from adaptive learning experiences, timely support, and increased accessibility cultivating a more engaging and effective learning journey [11] [12]. Educational organizations gain scalability, cost-effectiveness, and data-driven decision-making capabilities, leading to continuous improvement and strategic planning. Embracing automation in education has the potential to revolutionize the educational landscape, creating a dynamic and inclusive learning environment that maximizes student potential and propels educational institutions toward greater success [10]. As technology continues to evolve, harnessing automation becomes vital in nurturing a future-ready generation and advancing the frontiers of learning. In conclusion, this paper lays the foundation for further research and development in automating peer tutoring sessions. By exploring the challenges of manual arrangements and highlighting the advantages of automation, it provides a roadmap for educators and researchers to embrace technological solutions that enhance the effectiveness and accessibility of peer tutoring, ultimately contributing to improved educational outcomes for all students. The integration of automation in peer tutoring represents a pivotal step towards an innovative and learner-centric education ecosystem, where technology serves as an enabler of personalized support and collaborative learning experiences. As the field of education continues to evolve, embracing automation becomes essential to meet the demands of an ever-changing educational landscape and prepare students for success in the digital age.

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