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Transforming Virtual Education: The Importance of Learning Analytics in Moodle

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<p>Abstract. Today, online education has experienced significant growth, providing flexible and accessible learning opportunities. Learning management platforms, such as Moodle, play a key role in facilitating interaction between teachers and students in virtual learning environments. However, tracking and assessing the progress of online learning can be challenging. This is where learning analytics comes in, a discipline that uses data collected from the learning platform to gain valuable insights. In this article, we explore the importance of learning analytics in Moodle, how it works, and how it can improve the online learning experience.</p> <p>Keywords: Analytics, Learning, LMS, Moodle, Assessment.</p>	<p>Article Info Received Jul 7, 2024 Accepted Sep 26, 2024</p>
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1 Introduction

With the increasing adoption of online learning platforms, it is crucial to understand how students interact with content and how educators can make informed decisions to optimize the teaching-learning process. Moodle, an open-source learning management system, is widely used in educational institutions around the world. Learning analytics in Moodle involves the analysis of data generated by students and teachers during the online teaching process. This provides a detailed view of student performance, areas of difficulty, and effective teaching strategies.

Data analytics is based on the use of statistical, mathematical and computational tools and techniques to explore large volumes of information. As the amount of data generated increases exponentially, data analytics has become essential to extract value from this data and turn it into actionable insights.

Some fields, levels and terms where data analytics is strongly applied are (CIDEI 2023):

- Business Intelligence (BI)
- Business Analytics (BA)
- Data Science
- Advances in each of these levels in input and complexity, from a descriptive level, through explanation, diagnosis and prescription.

Some of the key concepts of data analytics are listed below:

- **Data collection:** involves the collection of relevant data from various sources, such as computer systems, sensors, mobile devices, social networks and more. This data can be structured (organized in tables) or unstructured (text, images, videos).
- **Data Processing and Cleaning:** Collected data often contains errors, duplicates and noise. The cleaning and pre-processing process is essential to ensure that the data is reliable and consistent prior to analysis.
- **Descriptive Analysis:** This stage involves the initial exploration of the data to understand its structure, distribution and characteristics. Graphs, statistical summaries and visualizations help to obtain an overview of the data.
- **Exploratory Analysis:** In this phase, deeper analysis is performed to uncover patterns, trends and relationships. This may include correlation analysis, clustering and principal component analysis.
- **Predictive Analytics:** Statistical models and machine learning algorithms are used to predict future results based on historical data. This can be useful in fields such as marketing, finance and medicine to predict behaviors or outcomes.
- **Prescriptive Analytics:** This type of analysis suggests actions and decisions to achieve certain objectives. It combines historical data with rules and algorithms to recommend the best action to take.

1.1 The importance of learning analytics in Moodle

Learning analytics in Moodle goes beyond simply tracking participation and grades. This Moodle option provides insight into the amount of time students spend on specific activities, participation patterns, assignment completion rates and more. This allows teachers, tutors or administrators to identify students who may be at risk of dropping out and provide personalized support. In addition, the data can reveal patterns of success and areas for improvement in digital course materials.

1.2 How Learning Analytics Works in Moodle

Learning analytics in Moodle is based on the real-time collection and analysis of data. The platform gathers information on student interactions, including completed activities, time spent on each task, participation in online discussions, course access, and grades. These data are processed and transformed into easy-to-understand reports and visualizations that allow teachers to assess both individual and group progress.

Analyzing these data not only helps identify students who may need additional support but also provides valuable insights into the effectiveness of the teaching materials and methods used. By understanding these patterns, educators can adjust their strategies to enhance learning and improve student performance. Furthermore, learning analytics in Moodle facilitates more personalized teaching, enabling teachers to tailor their approaches to the specific needs of each student.

2 Research Development

The development of the research involves an exploration of the methodologies, data collection techniques, and analysis methods employed in the study. This section describes the steps followed to collect and analyze the data, the reasoning behind the chosen methods, and the theoretical framework that guided the investigation. By documenting the research process, we aim to ensure transparency and reproducibility, while also highlighting the robustness and validity of our findings.

2.1 Problem Statement

The Moodle learning platform is an open system that allows precisely the management of learning, this platform has allowed a dynamic in education by giving the option to create online courses in a simple, friendly, aesthetic but at the same time complete, effective and adaptable for the student. However, the fact of transferring the contents to a platform does not guarantee that the learning process will be good to excellent. And it is precisely for this reason that data analytics takes great relevance, which we will call learning analytics since it is focused on the topic of education and refers to the fact of collecting, processing and analyzing data that are generated by the interaction of students with the courses in Moodle platform.

2.2 Justification

In today's educational context, it is essential for all educators, tutors, and administrative personnel in any educational institution to recognize and implement learning analytics in their assessments. This methodology not only enhances the accuracy and relevance of evaluations but also plays a crucial role in early identification of students facing academic challenges. By detecting

these challenges promptly, personalized interventions can be implemented to support their educational progress and ensure their ongoing success within the program.

The open-source learning management system Moodle, renowned for its flexibility and adaptability, has revolutionized online education by providing advanced tools for creating and managing virtual courses. Beyond serving as a content delivery tool, Moodle stands out for its capability to gather detailed data on student interaction with educational materials and course activities. This analytical approach enables educators and course designers not only to assess students' academic progress but also to identify learning patterns and areas for improvement. By strategically leveraging this data, informed decisions can be made to optimize the educational experience, fostering a more effective and personalized learning environment.

3 Literature review

In this section of the article, we will discuss concepts such as: data analytics, Moodle LMS, activities and resources within the platform, as well as what is data analytics already integrated in the platform.

Analytics is the process of discovering, interpreting, and communicating important patterns in data. Simply put, analytics allows us to see important statistics and data that we might otherwise miss. Business analytics is dedicated to using statistics derived from data to make more informed decisions that help organizations increase revenue, reduce costs, and improve other business issues (Oracle, 2023).

The main purpose of registries (data) is to provide useful information on prevalence, evolution, outcomes and needs. Registries must meet a number of characteristics, such as validity, accuracy, confidence and quality. A registry is considered valid if there is a 90% compliance rate. Missing data may be due either to problems of program interpretation (poorly defined concepts: need to standardize data classification) or to problems of the person entering the data (insufficient information) (Planas, M., Rodríguez, T., & Lecha, M., 2004).

According to Peña Matos, Maximino, & Dibut Toledo, Lázaro Salomón (2021), Moodle was created by Martin Dougiamas. He based its design on the ideas of constructivism in pedagogy, which affirms that knowledge is constructed in the mind of the student rather than transmitted unchanged from books or lectures, and on cooperative learning. In other words, Moodle is a web application of the Virtual Educational Environment type, a freely distributed course management system that helps educators create online learning communities.

In the Moodle platform environment, activities are the way students interact with a course. Examples of activities include quizzes, glossaries, forums and assignments. Resources are the elements used to expand the student's training through various study materials. They can be documents or presentations, or even an external web page, for example, a particular YouTube video (ISPRING, 2023).

Having understood the key concepts, let's define learning analytics: "Learning analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts, with the aim of understanding and optimizing learning and the environments in which it occurs" (Habeab, O.A., 2019).

In today's era, characterized by an abundance of data, educators, tutors, and administrators at educational institutions are constantly seeking innovative methods to enhance their eLearning courses and programs. The Moodle platform offers learning analytics tools that enable the optimization and enrichment of the educational experience, thereby achieving better outcomes for both students and institutions.

4 Methodology

To conduct this research, TecNM / Instituto Tecnológico de Pachuca was selected, focusing on the Bachelor's degrees in Administration and Computer Systems Engineering, both in distance and in-person modalities. This choice was made because many instructors use the platform to distribute study materials and facilitate various academic activities such as exams, assignments, and forums. During the semester from January to June 2024, an analysis was conducted involving different groups of 21 teachers who participate in both distance education and face-to-face modalities. To ensure a 95% confidence level and a margin of error less than 0%, a sample size of at least 21 teachers was required. These calculations were performed using an

online margin of error calculator from <https://es.surveymonkey.com/mp/margin-of-error-calculator/>, and the results are illustrated in **Figure 1**.

The image shows a web-based calculator titled "Calcula tu margen de error". It features three input fields: "Tamaño de la población" (Population size) with the value 21, "Nivel de confianza (%)" (Confidence level) with a dropdown menu set to 95, and "Tamaño de la muestra" (Sample size) with the value 21. Below these fields, a red error message states: "¡El cálculo no es válido! Revisa la información que ingresaste." (The calculation is not valid! Check the information you entered). Underneath the error message, the text "Margen de error" (Margin of error) is displayed above a large, light-colored "0", indicating that the calculation failed to produce a result.

Fig. 1. Level of confidence and margin of error

Teachers are responsible for teaching a variety of subjects in the aforementioned fields, all of them using the Moodle platform both to publish study materials and to conduct student activities. Grades are determined based on the evidence submitted, assessing students' levels of competence according to the designed evaluation instruments. Each teacher handles an average of 30 students per subject.

This study focuses on analyzing 50 groups supervised by 21 teachers, applying data analytics techniques to identify students at academic risk. The goal is to provide insights that enable appropriate preventive and support measures to enhance student performance and retention

4.1 Data collection

The official Moodle platform of the Tecnológico Nacional de México / Instituto Tecnológico de Pachuca, through the plugins that have been installed specifically for data analysis, presents various options, as shown in **Figure 2**. These tools allow administrators and educators to collect and analyze data on student performance, thereby facilitating informed decision-making to enhance educational quality and the teaching-learning process.

Additionally, the integration of these data analytics plugins in Moodle not only enhances administrative efficiency but also promotes personalized learning by providing detailed insights into individual student progress. This allows for adjusting pedagogical strategies and offering personalized interventions that can effectively enhance academic success for each student.

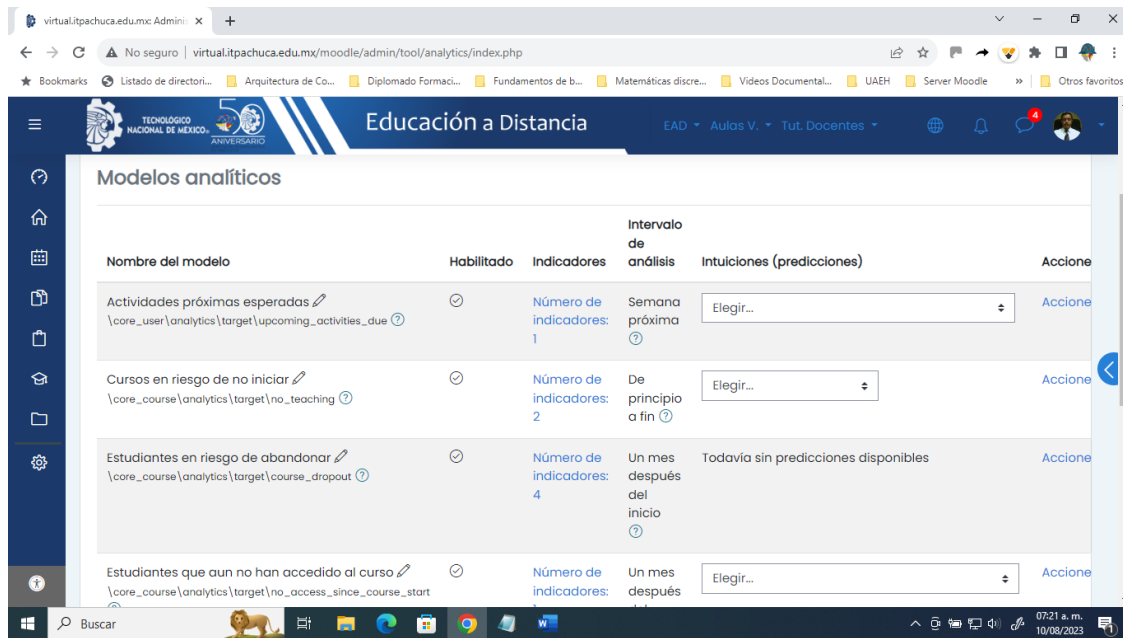


Fig. 2. Learning analytics options in Moodle

To begin the information gathering process, the option "Students who have not accessed the course recently" was selected. **Figure 3** illustrates the results of the learning analytics, using the General Accounting course as an example. This process is repeated for each analysis group, ensuring a thorough and systematic evaluation of student participation in the courses.

In addition to identifying students with low course access frequency, this analytical approach enables educational administrators and instructors to pinpoint potential engagement issues or content difficulties. The gathered information assists in designing specific interventions, such as activity reminders or content delivery adaptations, to encourage greater participation and enhance the students' learning experience.

It is important to note that this analysis process extends beyond access frequency, encompassing review of other key indicators like performance in assessments or interaction in discussion forums. This provides a comprehensive view of student performance and allows for proactive adjustment of pedagogical strategies to optimize educational outcomes.

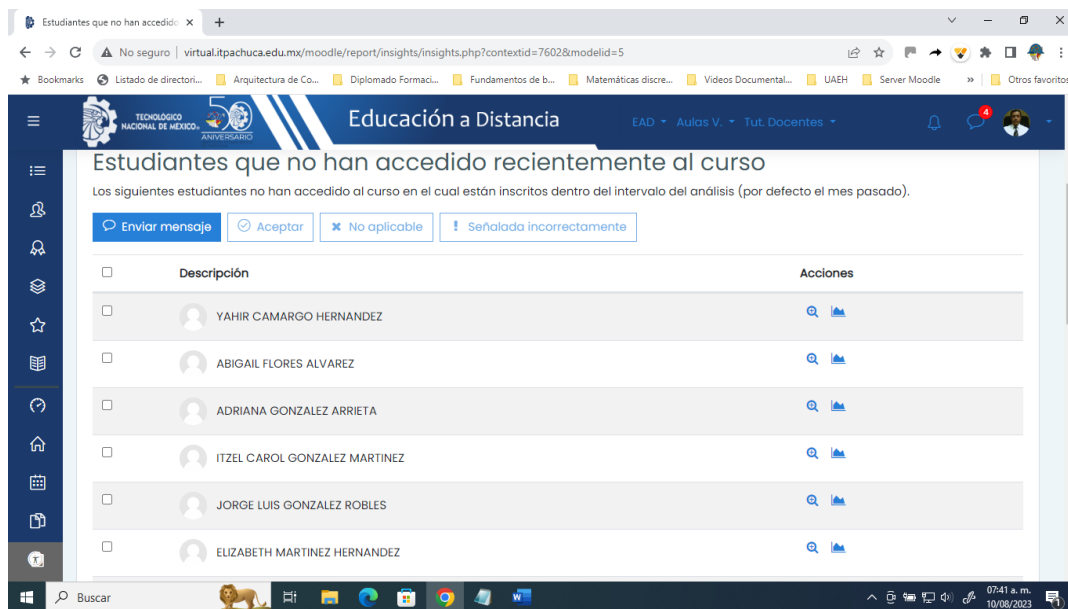


Fig. 3. Sample of students who have not accessed the course recently

After conducting the aforementioned learning analytics across the 50 groups, a total of 83 students were identified as at-risk due to irregular course attendance during the first month of the semester.

This finding underscores the importance of closely monitoring student attendance from the semester's outset to identify potential issues early and provide appropriate support. The learning analytics employed utilize attendance records to identify patterns and trends that may indicate academic or personal difficulties among students.

Students at risk may face various challenges impacting their regular attendance, such as transportation issues, family responsibilities, or health difficulties. It is crucial to proactively address these barriers to improve retention rates and student success.

Moreover, implementing personalized early intervention strategies can make a significant difference in academic performance and student satisfaction. These interventions may include additional tutoring, academic counseling sessions, or emotional support to help students overcome their challenges.

Learning analytics also enable educational institutions to adjust policies and procedures to enhance the student experience. By gaining a better understanding of factors contributing to absenteeism, administrators and educators can design more effective preventive measures and allocate appropriate support resources.

Promoting a culture of support and engagement among students is essential, fostering open and accessible communication with academic advisors and administrative staff. This can facilitate early detection of issues and implementation of solutions before academic problems escalate.

Furthermore, leveraging advanced technology in learning analytics can provide deeper insights by analyzing historical patterns of attendance and academic performance. This can help predict future challenges and enhance intervention strategies.

Collaboration among faculties and departments within the institution also plays a crucial role in comprehensive support for at-risk students. By working together, education professionals can develop holistic approaches that address academic, social, and emotional needs comprehensively.

Lastly, ongoing evaluation of implemented interventions allows educational institutions to adjust and improve their student support strategies, ensuring an inclusive and high-quality learning environment for all students.

5 Data analysis

The information extracted from the Moodle learning analysis was initially subjected to a data cleaning process, where duplicate students were removed, resulting in a final group of 71 students. This cleansing allowed for a more precise and representative dataset for further analysis of academic performance and course participation.

Subsequently, a detailed analysis of the cleaned data was conducted to identify significant patterns in student behavior within the virtual learning environment. This analysis included exploring variables such as course access frequency, time spent on each activity, and performance in assessments. These insights provided a deeper understanding of how students interact with Moodle's content and tools, offering opportunities to enhance both the learning experience and academic outcomes.

In the Moodle platform, each teacher responsible for the subjects individually reviewed the Preliminary Report of the students, which provides a detailed analysis of the student's behavior regarding the completion and submission of scheduled activities. This report is crucial for assessing student progress and participation in the course.

Figure 4 shows an illustrative example of the Preliminary Report, serving as a fundamental tool to identify strengths and areas for improvement in each student's learning journey. It enables educators to tailor instructional approaches and support strategies based on individual student needs, fostering a more personalized and effective learning environment. This process also facilitates ongoing communication between teachers and students, promoting a collaborative approach to academic success.

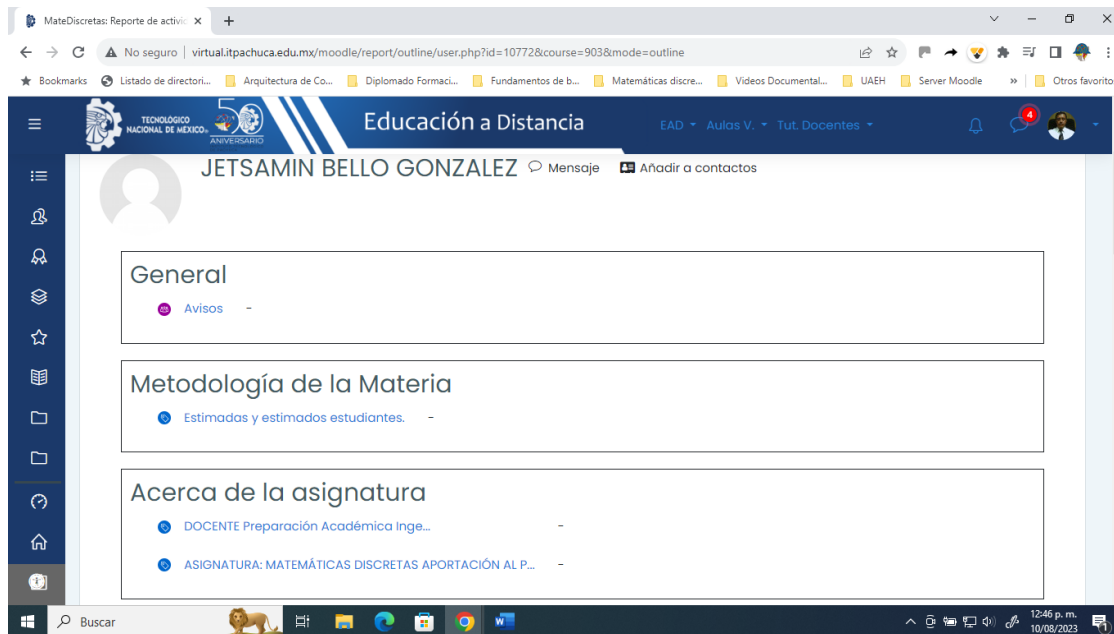


Fig. 4. Shows an example of a Preliminary Report.

After obtaining and refining the information, the next stage of the learning analytics analysis process begins.

5.1 Prediction and Feedback

The Moodle platform records every interaction students have with course content and activities, enabling tracking of time spent on each resource, frequency of access, and overall progress. Leveraging this functionality, each instructor reviewed and analyzed preliminary reports to assess students' academic performance. Subsequently, students were notified via email about their course status and the risk of failing if they did not meet scheduled activities on time.

Additionally, each instructor allocated one hour per week to support students at risk of dropout or academic disengagement. This proactive measure ensured that 65 out of 71 students attended their courses and achieved regular status within a month.

This personalized intervention not only enhanced student retention but also strengthened the teacher-student relationship, fostering a supportive environment and mutual commitment to academic success.

6 Enhancing the Educational Experience

Implementing these data-driven strategies allows educators to better understand the individual needs of students and proactively respond to their challenges. For example, they can identify behavioral patterns indicating specific difficulties and offer additional resources or tutoring sessions to address these areas. This personalized support not only improves academic performance but also increases students' motivation and engagement with the course.

Furthermore, the use of learning analytics fosters a culture of continuous improvement among educators. With precise and up-to-date data on student progress, teachers can reflect on the effectiveness of their teaching methods and make informed adjustments. This approach not only benefits current students but also contributes to the development of more robust and adaptable pedagogical practices for future courses, ensuring a high-quality educational experience.

The fact that the Moodle platform offers various options for learning analytics is of vital importance for tracking current online education. This allows teachers and students to make well-founded decisions. By understanding how students interact with course content and how they progress, it is possible to design more effective, suitable, and adapted teaching strategies to different learning styles. In an era where technology and education are closely connected, learning analytics in a system like

Moodle stands out as an important and indispensable tool for achieving a more effective, engaging, dynamic, and enriching online education.

Additionally, learning analytics enable the rapid identification of areas where students may be struggling, facilitating early and personalized intervention. This proactive responsiveness not only improves academic outcomes but also increases student satisfaction and engagement with their studies. By continuously integrating data and analysis, educators can constantly adjust and enhance teaching and learning processes, ensuring high-quality education that adapts to the changing needs of students.

7 Results

The research on learning analytics in Moodle focused on the practical implementation of analytic tools to optimize educational management. By activating specialized plugins, initially 83 at-risk students were identified due to their low course access frequency, with the sample refined to 71 for detailed analysis.

Preliminary reports provided crucial insights to educators regarding student behavior, enabling personalized feedback and individualized support sessions. This strategy resulted in 65 students achieving regularization within a month, highlighting Moodle's effectiveness in enhancing student retention through learning analytics.

Furthermore, the research emphasized the importance of adapting pedagogical strategies based on collected data, benefiting not only at-risk students but also strengthening the design and management of online courses. Moodle's capability to collect and analyze real-time data not only offers a detailed view of individual student progress but also empowers educators to make informed decisions to personalize the learning experience.

This holistic approach not only improves educational efficiency but also assists students in reaching their full academic potential in a dynamic, active learning-centered digital environment.

The research also highlighted how learning analytics in Moodle can be crucial for educational institutions aiming to enhance learning quality in virtual environments. By focusing on early detection of at-risk students and providing personalized interventions, Moodle not only optimizes educational management but also strengthens the student-teacher relationship. This proactive approach not only reduces dropout rates but also promotes more inclusive and adaptive learning, catering to individual student needs.

8 Conclusions

Learning analytics in Moodle is crucial for enhancing the online educational experience, as it allows educators to obtain detailed information about student performance and their interaction patterns with courses, helping to identify areas for improvement and effective teaching strategies. One of the main advantages is the ability to identify students at risk of dropping out, detecting those who do not regularly access courses and who need intervention.

Educators can design personalized action plans, such as tutoring and individualized follow-up, proving effective in reducing dropout rates. Additionally, it provides valuable data on the effectiveness of materials and teaching methods, allowing for continuous adjustments and improvements in courses. By analyzing student interactions and progress, educators can create a more dynamic and engaging learning environment, facilitating more effective and personalized learning.

Accurate data collection and processing ensure that analyses are robust and reliable, making learning analytics an indispensable tool in contemporary online education. In summary, the ability to identify problems in a timely manner and apply effective solutions translates into a richer and more productive educational experience, benefiting both students and educators. Data analytics in Moodle not only optimizes teaching but also fosters educational innovation by continually adapting pedagogical methods to emerging needs.

This creates a virtuous cycle where education becomes more personalized and effective, thereby improving academic outcomes and overall student satisfaction. In an increasingly digital world, the integration of learning analytics becomes a fundamental pillar for institutions seeking to offer quality education.

Moreover, it supports long-term educational strategies by providing a data-driven foundation for decision-making. The continuous feedback loop created by learning analytics ensures that educational practices evolve to meet the highest standards. This advancement underscores the transformative potential of technology in education.

References

CIDEI. (2023). Data analytics: What it is, scope, and why it is so important for companies? <https://cidei.net/que-es-analitica-de-datos/>

Habeb, O. A. (2019). The importance of learning analytics in learning and development. <https://elearningindustry.com/learning-analytics-benefits-ld>

ISPRING. (2023). The 15-minute guide for teachers on how to use Moodle. Retrieved August 09, 2023, from <https://www.ispring.es/blog/como-usar-moodle>

ORACLE. (2023). What is analytics? <https://www.oracle.com/mx/business-analytics/what-is-analytics/>

Moodle. (2021). Moodle learning analytics. https://docs.moodle.org/310/en/Learning_Analytics

Planas, M., Rodríguez, T., & Lecha, M. (2004). The importance of data. *Nutrición Hospitalaria*, 19(1), 11-13. http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112004000100003&lng=es&tlng=es

Peña Matos, M., & Dibut Toledo, L. S. (2021). Some considerations on the development of the Moodle platform. *Conrado*, 17(83), 64-69. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1990-86442021000600064&lng=es&tlng=es

Siemens, G. (2013). Learning analytics: The emergence of a discipline. *American Behavioral Scientist*, 57(10), 1380-1400.