

BUILT-IN LEARNING ANALYTICS CAPABILITIES IN MOODLE

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ABSTRACT

This article examines the possibilities of Learning Analytics within the Learning Management System (LMS) Moodle. With the increasing role of online distance education and technology in educational processes, Learning Analytics is becoming a key tool for enhancing the learning experience. Moodle, as a leading open-source platform, generates a substantial amount of data on learner activities, which can be analyzed to improve educational quality. Learning analytics involves the collection, measurement and evaluation of data regarding learners, with the aim of understanding their outcomes and optimizing the learning process. This allows for informed decisions regarding learning opportunities and teaching methods as well as the identification of students at risk of dropping out. There are four main types of learning data analysis: descriptive, diagnostic, predictive, and prescriptive. Moodle provides built-in learning analytics capabilities through its Moodle Analytics API, which utilizes models based on machine learning and “static” models. The main advantages of Moodle Analytics include predicting learner performance and data-driven decision-making, while some of the challenges are the complexity of setting up and configuring the API, as well as concerns related to data privacy.

KEYWORDS: e-learning, Learning Management System, Learning Analytics, Moodle Analytics API

INTRODUCTION

In recent years, the integration of technology into education has significantly impacted traditional teaching methods. With the advent of remote learning and online education during the COVID-19 pandemic, the needs of both educators and learners have changed. Learning Management Systems (LMSs) have become central to educational technology transformation, offering a large amount of data and opportunities for analysis to optimize the learning process.

Moodle LMS, one of the leading open-source platforms, is widely used around the world for its flexibility, scalability, and rich set of features designed to meet diverse educational needs. In Moodle, each participant's activity is recorded in log files that reflect various actions, such as account logins, file views, interactions with activities and resources. The learning data analysis process in Moodle LMS involves collecting, analyzing, and reporting learner data to improve and optimize the learning process and the environment in which it takes place. With Learning Analytics, instructors and administrators gain insights into learners' engagement, performance, and behavior.

The purpose of this report is to examine the learning data analysis capabilities of Moodle LMS, leveraging the built-in capabilities of the system via the Moodle Analytics API.

1. THE ROLE OF LEARNING DATA ANALYTICS

The process of systematically collecting and analyzing large datasets from online sources to improve educational processes is known as Learning Analytics (Mian et al., 2022). The entire data processing procedure includes collecting, measuring, analyzing, and reporting learner data to understand and optimize the learning process and environments in which it occurs. Data from various sources is used to gain insights into learners' behavior, performance, and engagement. According to Gaf-tandzhieva, Totkov, and Doneva (2020), Learning Analytics combines approaches, methods, and results from different fields, such as data mining, business intelligence, predictive modeling, and

pedagogy. A key feature of Learning Analytics is enabling learners to take an active role in their learning process, fostering the development of self-regulation skills (Hooshyar et al., 2023).

According to various authors, Learning Analytics can have a significant impact on educational practices by:

- **Evaluating and improving the quality of curricula and educational methods** (Mian et al., 2022). Data-driven approaches allow educational institutions to make informed decisions about curriculum development, resource allocation, and policy formulation, leading to more effective and efficient educational practices.
- **Identifying students at risk and taking timely actions** by customizing learning experiences to meet individual needs (Mian et al., 2022; Akçapınar et al., 2019). By analyzing data such as attendance, assignment completion, participation in discussions, and other student activities, educators can identify students facing challenges and provide targeted support to enhance their performance. Learning Analytics tools provide valuable insights for educators, helping them determine how learners interact with course materials and identify areas where they may struggle.
- **Facilitating data-driven decision-making** (Hantoobi et al., 2021). Through Learning Analytics, institutions can identify trends, patterns, and connections in the educational process that might otherwise go unnoticed. As a result, university or institutional leadership can make more informed, data-based decisions rather than relying on intuition or assumptions.

The primary goal of Learning Analytics is to make informed decisions regarding the educational process, the learner, the instructor, the curriculum or other related matters. Thus, Learning Analytics can be defined as the science of analyzing and evaluating data to reach specific conclusions (Hantoobi et al., 2021). The impact of Learning Analytics is not limited to one structural element in education. It benefits all participants across various educational structures – learners, instructors, institutions and the education field itself. For example, by identifying students at risk and providing timely interventions, not only do learners benefit, but also the quality of teaching improves, as does the institution's reputation.

2. TYPES OF LEARNING DATA ANALYTICS

Learning Analytics can be divided into four main categories: descriptive, diagnostic, predictive, and prescriptive analytics (Hantoobi et al., 2021) (see Fig. 1).



Figure 1. Levels of Learning Analytics
Source: Adapted from (Hantoobi et al., 2021)

- **Descriptive Analytics** – This involves summarizing and interpreting historical data to discover patterns, trends, and insights (Xin and Singh, 2021). Descriptive analytics answers the question, “What’s happening?” by clearly presenting past activities and events. In the context of Learning Analytics, it focuses on interpreting data related to learner activities, their performance, and interactions within the educational environment (Ramaswami et al., 2022). It serves as the initial step in the broader process of Learning Analytics by providing a clear and detailed understanding of past learning processes, which lays the foundation for more advanced forms of analysis. Typically, it is based on log file data from different LMSs.
- **Diagnostic Analytics** – This includes data analysis techniques to explore cause-and-effect relationships and identify factors contributing to specific outcomes (Xin and Singh, 2021). It answers the question, “Why is it happening?” by identifying and analyzing variables and conditions that influenced observed factors. In the context of Learning Analytics, diagnostic analytics helps educators and administrators uncover the root causes behind learner performance and engagement levels. It goes deeper into the “why” question – why certain outcomes occurred, why certain learners perform better or worse, and why specific educational interventions are effective or ineffective.
- **Predictive Analytics** – This involves using statistical techniques, machine learning algorithms, and data analysis to forecast future events (Xin and Singh, 2021). It answers the question, “What is likely to happen?” by identifying patterns and correlations in existing data. In Learning Analytics, predictive analytics uses past and current data from educational environments - such as student demographics, academic performance, and online interactions - to forecast learners' behaviors and outcomes. (Herodotou et al., 2021). It is a crucial component of Learning Analytics, focusing on predicting future outcomes based on historical data. It can be used to forecast various aspects of the learning process, such as learner performance, engagement, and retention. This approach allows instructors and administrators to identify potential challenges and take measures before they negatively impact learners.
- **Prescriptive Analytics** – This uses complex algorithms, simulations, and optimization models to suggest the best possible actions or decisions based on data analysis. It is “prescriptive” because it not only predicts future outcomes but also offers specific recommendations or actions to achieve optimal results. It answers the question, “What should we do?” by exploring different possible scenarios, constraints, and objectives. In Learning Analytics, prescriptive analytics aims to enhance educational outcomes by recommending actions, resource allocations, or learning strategies that are most likely to lead to success. This is the most advanced stage of data analysis in education, focusing on recommending specific actions or strategies to achieve desired educational outcomes (Xin and Singh, 2021). Prescriptive analytics is the next step toward increasing the maturity of Learning Analytics, leading to proactive decision-making to improve learner performance and providing data-based recommendations for learners at risk of dropping out or other suboptimal outcomes (Ramaswami et al., 2022).

3. LEARNING DATA ANALYTICS WITH MOODLE

The Moodle Learning Management System can be used across all levels and forms of education (including corporate training). Moodle is written in PHP and distributed as open-source software, used by over 325 million users worldwide (Buchner, 2022). As an LMS, Moodle provides core functionalities for successfully managing the learning process, including:

- **Course Management** – Tools for creating and managing courses, multimedia integration, and interactive activities.
- **User Management** – Capabilities for user enrollment, role, and group management, as well as tracking user activity.
- **Grading** – Tests, assignments, and tools for assessing learner performance.
- **Communication and Collaboration** – Forums, wikis, groups, and chat rooms.

Moodle offers built-in features for tracking various types of data. These include built-in functionalities for generating reports, statistics, and tracking user activity from Moodle logs, which store structured data from users' interactions with different activities and resources. According to Zhang et al. (2020), all stored data is useful and can be applied to data mining algorithms. Additionally, Moodle provides a learning analytics functionality called Moodle Analytics, which can be enabled and configured by administrators to analyze data from various interactions on the platform (see Fig. 2). In addition to Moodle's built-in capabilities, numerous plugins and integration options are available for external learning analytics tools. Moodle Analytics offers a predictive analytics system, using machine learning to generate forecasts (Fig. 2).

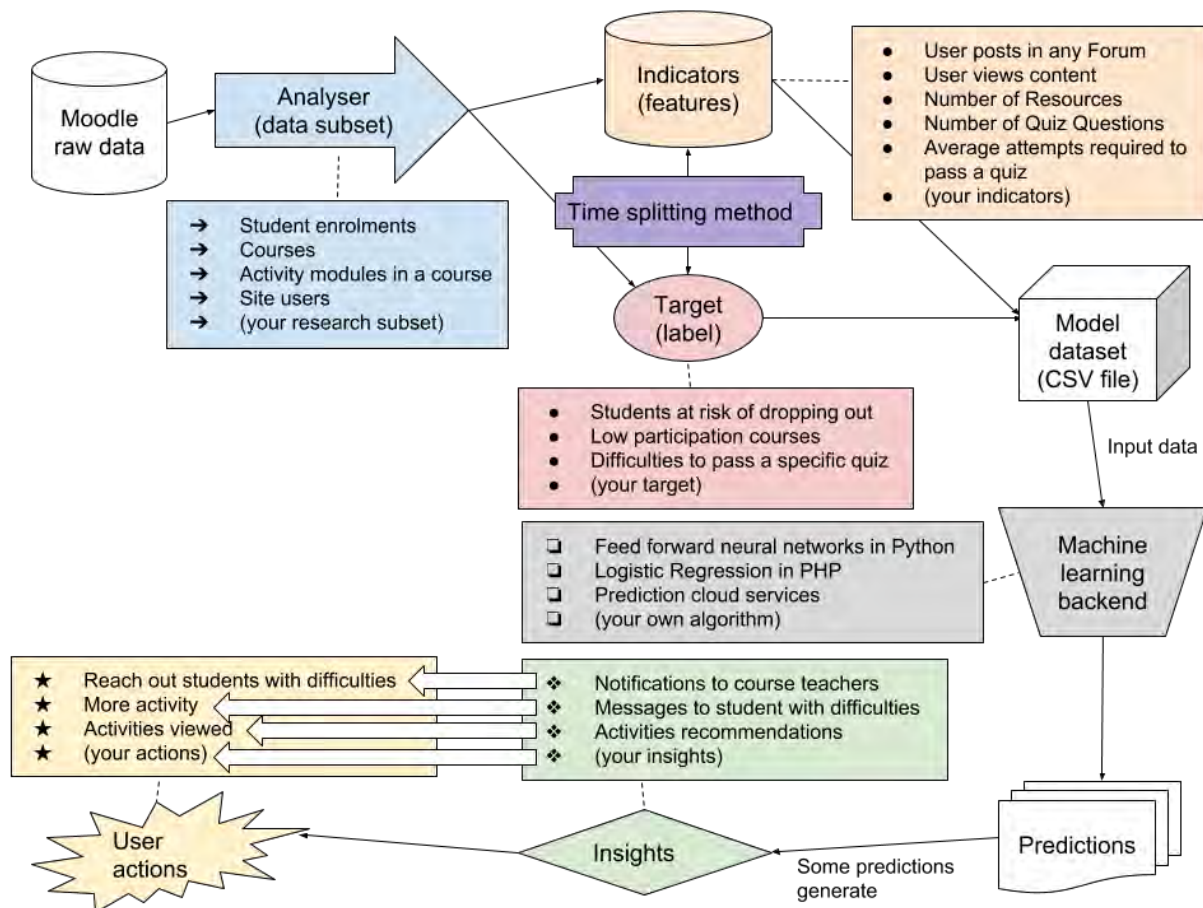


Figure 2. Data Flow in Moodle Analytics API

Source: Created by (Nicols, 2024)

Moodle Analytics includes the following five models by default:

1. Courses at risk of not starting
2. Learners at risk of dropping out
3. Learners who have not visited the course recently
4. Learners who have not yet accessed the course

5. Upcoming activities

There are two types of models – machine learning models, including predictive models, and “static” models for identifying critical situations based on past events. Each model has several main fields – indicators (about 60), analysis time frame, and insights (Buchner, 2022). Some of the indicators are shown in Fig. 3.



Figure 3. Sample Indicators Studied in Moodle

The use of Moodle Analytics helps users enhance learning outcomes and recommend improvements for learners based on data from past activities. Optimization of the educational process with Moodle Analytics is achieved by measuring, collecting, and analyzing various data, such as cognitive and social interaction statistics (for example, what content a learner viewed, sent, or edited, in which events they participated in, etc.) (Suad et al., 2023). Forecasting and analysis can be selectively applied to specific courses, categories, or instructors rather than the entire platform. According to Suad et al. (2023), modeling and forecasting learner performance in an e-learning environment has become a crucial task for modern education.

Advantages and Challenges of Using Moodle Analytics API

The advantages and challenges of using the Moodle Analytics API can be examined as follows, based on information from the module documentation (Nicols, 2024):

Advantages:

- **Predicting learner performance** – Moodle Analytics API allows the creation of predictive models that can identify learners and courses at risk (in various platform directories), enabling early intervention.
- **Data-driven decision-making** – Provides useful information that can help make timely decisions and improve student outcomes.
- **Customization** – Site administrators can define their own indicators and goals, adapting analytics to specific needs.
- **Automation** – Automates data collection and analysis processes, saving time and reducing manual effort.

Challenges:

- **Complexity** – Setting up and configuring the API can be complex and require technical expertise.
- **Data privacy** – Handling sensitive learner data requires strict compliance with data protection regulations, which can be challenging.

- **Resource-intensive** – Running predictive models and analyses may require additional resources, which can impact system performance.
- **Limited built-in models** – The core Moodle system includes only a few built-in models, which may not cover all use cases.

CONCLUSION

In conclusion, Learning Analytics in Moodle LMS, specifically through the Moodle Analytics API, offers significant potential to improve the educational process by providing valuable insights into learner behavior, engagement, and performance. This report reviewed various types of learning data analysis, including descriptive, diagnostic, predictive, and prescriptive analytics. Each type plays a role in understanding learner behavior and optimizing outcomes throughout the learning process. By leveraging data from learner interactions, educators can personalize the learning experience, identify students at risk, and make data-driven decisions to enhance the overall educational process. Despite the challenges associated with technical implementation and data privacy, the advantages of using Learning Analytics are significant, leading to a more informed and effective educational experience.

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