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Comparative Analysis of E-learning Platforms and Their Application in Higher Education

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Abstract: *The fast development of modern technologies in the field of education has become a challenge for academic institutions to choose the right Learning Management System (LMS) for their use. As part of the current research, an analysis of five selected platforms representing different implementation models: Moodle, Blackboard, Canvas, ATutor, and MS Teams, was performed. The platforms were assessed according to the following criteria: architectural, functional, user-centered, and implementation-based (open-source versus Software as a Service [SaaS] platforms). The analysis indicates that Moodle and ATutor offer considerable flexibility and show a strong documented emphasis on accessibility; however, self-hosted deployment requires substantial support from the institution's IT department. At the same time, commercial platforms such as Blackboard and Canvas provide stable, vendor-managed environments with lower maintenance requirements, but at higher recurring costs. Additionally, the research revealed that MS Teams is a proprietary SaaS platform with extensive integration and communication capabilities, but with fewer specialized pedagogical features than dedicated LMS solutions. In conclusion, it may be stated that there is no one-size-fits-all solution - the decision should be made depending on the trade-off between the institution's technical and financial capacities.*

Keywords: *e-learning; LMS; higher education; comparative analysis; platform evaluation*

1. INTRODUCTION

The digital transformation of education has changed how teaching is organized and delivered [1,2]. The spread of information and communication technologies (ICT) and the demand for flexible access to learning content drove the rapid adoption of e-learning and Learning Management Systems (LMS) in higher education [3]. An LMS is now a core infrastructure layer that organizes, distributes, and tracks teaching activities and supports both online and hybrid models [4]. The COVID-19 pandemic accelerated this shift, forcing many institutions to deploy digital learning environments in a short time and often without systematic preparation [5,6].

Under these conditions, choosing an LMS has become a strategic decision rather than a purely technical one. It involves pedagogical, organizational, security, and financial trade-offs [7,8]. A poor choice can reduce student engagement, raise operating costs, and complicate maintenance. The market offers many commercial and open-source solutions that differ in functionality, scalability, security, cost, and ease of use [9]. Decision-makers therefore need a transparent way to compare options against the needs of their institution [10].

Much of the existing literature approaches this problem with multi-criteria decision-making (MCDM) methods, often combined with aggregation techniques and expert panels [11,12,13]. These methods are rigorous and very reliable, but they require pairwise comparisons, weighting, consistency checks, and access to expert resources that are not always available to a teaching department or a small institution that simply needs to understand how candidate platforms differ.

This paper takes a complementary, lighter-weight position. It presents a structured comparative analysis of five selected platforms representing different implementation models - Moodle, Blackboard, Canvas, ATutor, and MS Teams - across four criteria categories: architectural, functional, user-centered, and implementation-based (open-source versus Software as a Service). The contribution of this paper lies in providing a transparent qualitative comparison rather than a numerical ranking of LMS platforms. Unlike previous MCDM-based studies, the analysis preserves the specific advantages, limitations, and trade-offs of each platform, includes MS Teams as a communication-oriented educational

environment, and provides practical guidance based on different institutional needs and capacities.

2. BACKGROUND AND RELATED WORK

E-learning is any form of education delivered with the assistance of ICT, including the distribution of materials, communication, testing, and progress monitoring [14]. It is related to, but not identical with, distance education, since the two differ in their degree of technological dependence and in the temporal dimension of communication [15]. The LMS is the central software framework that integrates these activities in a single digital environment [16]. Typical functionality covers course and content management, assignment distribution, assessment, activity tracking, discussion forums, video lectures, and integration with third-party tools [17]. Through these features, institutions gain flexibility, better organization, and higher student engagement [18].

Because the available solutions vary widely, the selection of an optimal platform is a recurring research problem. Early work applied AHP to structure e-learning platform evaluation into a consistent set of criteria [19]. Later studies combined subjective expert judgment with robust aggregation, for example the fuzzy AHP-TOPSIS approach [20], while more recent MCDM-based assessments continue to rank open-source systems, and Moodle in particular, highly because of their low cost and adaptability [21]. A recent study evaluated LMS platforms with a hybrid AHP-NWA model and again identified Moodle as the most sustainable choice, ahead of ATutor and Blackboard [22].

The pandemic also forced collaborative software suites to take on the teaching role. Comparative studies of Moodle and MS Teams describe Moodle as a complex but complete LMS and MS Teams as a simpler, communication-oriented tool that excels at real-time interaction and Office 365 integration but lacks structured pedagogical features [23]. Heuristic evaluations of MS Teams as a teaching platform report similar functional and pedagogical limitations [24]. Accessibility has likewise become a hard requirement rather than an optional quality, with platforms now reporting conformance against the Web Content Accessibility Guidelines (WCAG) 2.1 [25].

The gap this paper addresses is the lack of a broad, transparent, and reproducible qualitative comparison that places these five platforms side by side across architecture, functionality, user experience, and implementation model, without reducing the comparison to a single score.

3. METHODOLOGY

The study uses a structured qualitative comparative analysis. Unlike the MCDM approach, it does not assign weights or produce a single aggregate score. Instead, each platform is characterized against a fixed set of criteria, the results are summarized in category-based comparison tables, and then trade-offs between platforms are considered. This keeps the analysis transparent and reproducible and allows institutions to read the information they need directly, rather than through a weighting scheme.

Platform selection - The platforms were selected using a purposive, criterion-based approach rather than according to a ranking of market popularity. The aim was to include representatives of different licensing, deployment, and functional models: open-source and proprietary systems, self-hosted and cloud-based solutions, as well as dedicated LMS platforms and a communication-oriented platform used in education. Moodle and ATutor represent open-source, that can be self-hosted; Canvas and Blackboard represent commercial, predominantly cloud-delivered LMS solutions and MS Teams represents a communication-first SaaS environment increasingly used to support teaching and learning. ATutor was retained as a reference platform because of its accessibility-oriented design and its inclusion in earlier LMS evaluation studies. Although it is no longer actively maintained and should not be considered a primary option for new institutional implementations, its inclusion provides a historical open-source reference point for examining the development of accessibility, functionality, and maintenance requirements in e-learning platforms. Where relevant, the analysis refers to the platform versions and service editions considered during the study: Moodle 4.x, Blackboard Learn Ultra, Canvas LMS, ATutor 2.2.x, and Microsoft Teams for Education within Microsoft 365. Since Blackboard Learn Ultra, Canvas LMS, and Microsoft Teams are continuously updated cloud services, they are identified by their service editions rather than by a single fixed build number. The information was checked against official platform documentation and the available literature in early June 2026. Table 1 summarizes the platforms and their delivery model.

Criteria framework - The four criteria categories from the research aim were each reduced to four sub-dimensions, giving a compact but balanced grid:

- Architectural: hosting model, scalability, integration and interoperability (LTI/APIs) and extensibility (plugins/modularity).
- Functional: course and content management, assessment and gradebook, communication and collaboration (forums, chat, video), and analytics and reporting.

- User-centered: usability and interface, accessibility (WCAG 2.1), multilingual and localization support and mobile access.
- Implementation: licensing and cost model, deployment and maintenance effort, IT staffing requirements and vendor lock-in.

Evidence sources - Evidence was drawn from official platform documentation and vendor accessibility conformance statements, cross-referenced with peer-reviewed literature on LMS evaluation and platform comparison.

Assessment procedure - Each platform was examined according to the same predefined sub-dimensions. The entries in the comparison tables represent descriptive assessments rather than numerical scores. They were determined by comparing the capabilities reported in official platform documentation with findings from the reviewed literature. Terms such as "basic," "strong," "limited," and "high" indicate the relative scope and maturity of the documented features within the selected group of platforms. The final conclusions were derived by identifying recurring trade-offs across the four criteria categories, without calculating an aggregate score or producing a numerical ranking.

Accessibility-related findings were based on official accessibility documentation, vendor conformance statements, and the reviewed literature. No independent accessibility audit, assistive-technology testing, or user-based evaluation was conducted as part of this study.

Table 1. *Analyzed platforms and delivery model*

Platform	Type	Delivery model	Core technology
Moodle	Open-source	Self-hosted or provider-hosted	PHP/ MySQL-MariaDB
ATutor	Open-source	Self-hosted	PHP / MySQL
Canvas	Commercial open-core (AGPLv3)	Primarily SaaS (AWS); self-host possible	Ruby on Rails/ PostgreSQL
Blackboard	Commercial, proprietary	SaaS	Vendor-managed cloud
MS Teams	Commercial, proprietary	SaaS (Microsoft 365)	Vendor-managed cloud

4. COMPARATIVE ANALYSIS

4.1. Architectural Criteria

The five platforms occupy different points on the hosting spectrum. Moodle and ATutor can be self-hosted as PHP-based applications, while Moodle is also available through external hosting providers. In self-hosted deployments, institutions retain greater control over data, but scalability depends on local infrastructure and technical management. Canvas is a multi-tenant Ruby on Rails application built as a native cloud service on Amazon Web Services and designed to scale horizontally to very large user numbers, while its source code is also available under the AGPLv3 license for self-hosting [26]. Blackboard Learn Ultra and MS Teams are vendor-managed cloud services that scale on the provider's hyperscale infrastructure. Integration and extensibility separate the group further. Moodle exposes web service APIs, LTI, and a community catalogue of thousands of plugins. Canvas offers an open REST API, LTI, and a large partner ecosystem [26]. Blackboard supports LTI and REST APIs through proprietary extensions. MS Teams is a proprietary SaaS platform with an extensible integration model supported through the Microsoft Graph API, tabs, bots, and education connectors, although its extensions primarily target communication and collaboration rather than the pedagogical functions of a dedicated LMS [23]. ATutor supports basic IMS/LTI interoperability but has a small and largely inactive module ecosystem.

Table 2. *Architectural comparison*

Sub-dimension	Moodle	ATutor	Canvas	Blackboard	MS Teams
Hosting model	Self/provider-hosted	Self-hosted	SaaS (AWS); self-host possible	SaaS	SaaS (Microsoft 365)
Scalability	Infrastructure-dependent	Limited, small-scale	Horizontally scalable, cloud-native	Enterprise cloud	Hyperscale
Integration (LTI/APIs)	Web services API, LTI	Basic IMS/LTI	Open REST API, LTI, 500+ partners	LTI, REST APIs	Graph API, education connectors
Extensibility	Thousands of plugins	Small module set	Source open, LTI apps	Proprietary extensions	Apps/bots/tabs (non-pedagogical)

4.2. Functional Criteria

For core teaching functions the dedicated LMS products are clearly ahead of the communication suite. Moodle, Canvas, and Blackboard all provide structured course and content management, full assessment engines, and gradebooks. Moodle's quiz engine and Canvas's SpeedGrader are mature examples, and Blackboard offers comprehensive assessment with integrated reporting. ATutor covers the basics: content packaging, tests, and a simple gradebook, but its feature depth and interface are dated. MS Teams has no formal course model: teaching is organized around

channels and files, and assessment is limited to the Assignments feature in the education tier, which does not match a full LMS gradebook [23,24]. The pattern reverses for communication and collaboration, where MS Teams is the strongest of the five thanks to native chat, meetings, and video, while the LMS products rely on forums, messaging, and bundled or integrated conferencing tools. Analytics also differ: Moodle exposes detailed logs that require statistical expertise to exploit, Canvas and Blackboard offer built-in dashboards, and MS Teams provides simple engagement indicators that are quick to read but predefined [24].

Table 3. *Functional comparison*

Sub-dimension	Moodle	ATutor	Canvas	Blackboard	MS Teams
Course/ content management	Rich, flexible	Basic, dated	Modern, streamlined	Comprehensive	Channel/file-based, no course model
Assessment and gradebook	Advanced quiz + gradebook	Basic tests + gradebook	Strong (SpeedGrader)	Robust	Assignments only (EDU tier)
Communication/ collaboration	Forums, messaging, conferencing	Forums, chat (basic)	Discussions, conferences	Discussions, Collaborate	Extensive chat and video communication capabilities
Analytics and reporting	Detailed logs (needs expertise)	Minimal	Built-in dashboards	Analytics + Ally reports	Basic engagement insights

4.3. User-Centered Criteria

User experience is where the open-source and commercial features are most visible. Based on the reviewed documentation and literature, Canvas is frequently described as one of the more intuitive dedicated LMS platforms. It is built on modern web standards and has been independently evaluated by WebAIM as substantially conformant with WCAG 2.1 Level AA [26]. Moodle reports WCAG 2.1 AA conformance for its core components from release 4.2 and extends accessibility through tools such as the Brickfield Toolkit, although full compliance depends on theme and plugin choices, and its broad feature set may result in a steeper learning curve [27]. ATutor's distinguishing trait is its accessibility-first heritage. It was originally designed around accessibility and adaptive-technology standards. Blackboard documentation reports support for core accessibility requirements and adds Anthology Ally for automated content remediation and alternative formats such as audio and Braille [28]. MS Teams inherits Microsoft's general accessibility features and broad localization, and its chat-style interface is familiar and easy to learn, but it is not structured around educational accessibility needs [24]. All five offer multilingual interfaces and mobile access, with Moodle, Canvas, and MS Teams providing the strongest mobile applications, including offline support in Moodle.

Table 4. *User-centered comparison*

Sub-dimension	Moodle	ATutor	Canvas	Blackboard	MS Teams
Usability and interface	Powerful, steeper learning curve	Dated	Clean, intuitive	Clean, structured	Familiar, simple
Accessibility (WCAG 2.1)	Core AA + Brickfield	Accessibility-first heritage	WebAIM-verified AA	Core + Ally remediation	General MS accessibility
Multilingual/localization	100+ languages, RTL	Multilingual	Many languages	75+ via Ally/translation	Broad MS localization
Mobile access	Official app + offline	Responsive, limited	Strong mobile apps	Mobile app	Strong mobile support

4.4. Implementation Criteria (Open-Source vs SaaS)

The implementation model captures the central trade-off of the study. Moodle and ATutor carry no licensing fee, but their total cost shifts to the institution as hosting, administration, updates, and backups, which requires a capable IT team and accepts more operational responsibility in exchange for control and low vendor lock-in through open standards and data export. Canvas code is open-source, yet most institutions consume it as an enterprise SaaS subscription with custom, generally high pricing, gaining hands-free updates and minimal maintenance while retaining a partial exit path because the code is open [26]. Blackboard is a fully proprietary SaaS offering with strong stability and low maintenance burden but the highest licensing cost and the strongest lock-in. MS Teams is typically already available through an institution's Microsoft 365 subscription, so its marginal cost is low and it is vendor-managed, but adopting it as a teaching platform deepens dependence on the Microsoft ecosystem and still leaves the pedagogical gaps noted above.

Table 5. *Implementation comparison*

Sub-dimension	Moodle	ATutor	Canvas	Blackboard	MS Teams
Licensing/cost	Free; hosting/admin costs	Free	Open code; high SaaS pricing	High commercial license	Bundled with Microsoft 365
Deployment/maintenance	Self-managed	Self-managed, aging	Hands-free SaaS (or complex self-host)	Vendor-managed	Vendor-managed
IT staffing	Dedicated team needed	IT team needed	Minimal (SaaS)	Minimal	Minimal
Vendor lock-in	Low	Low	Moderate (open code mitigates)	High	High (Microsoft ecosystem)

5. DISCUSSION

Read across the four categories, the comparison does not produce a single best platform but a consistent set of trade-offs. The open-source systems, Moodle and ATutor, offer considerable flexibility and show a strong documented emphasis on accessibility. Moodle provides accessibility support through its conformant core and related tools, while ATutor reflects an earlier accessibility-oriented LMS design. That flexibility is paid for in operational effort: self-hosting moves responsibility for deployment, scaling, updates, security, and backups onto the institution's IT department, which is feasible only where that capacity exists. This point is reinforced by recent work on latency-aware autoscaling for LMS platforms, which shows that maintaining reliable system performance under changing user loads requires continuous monitoring and adaptive infrastructure management [29]. Commercial cloud systems represent the opposite implementation model. Both Blackboard and Canvas provide stability and minimal maintenance, since the service provider controls the underlying architecture; however, institutions incur higher recurring subscription costs, and, in Blackboard's case, there is vendor lock-in. Canvas represents an interesting compromise between both camps, as it is delivered through SaaS while still remaining open source.

MS Teams is a different kind of option. It offers excellent communication and real-time collaboration and is usually already paid for inside a Microsoft 365 subscription, but it does not provide the same depth of course management, assessment, and gradebook functionality as dedicated LMS platforms and therefore remains more limited as a standalone pedagogical environment [23,24]. It works best as a synchronous communication layer alongside a real LMS rather than as a standalone teaching platform.

These observations confirm that there is no one-size-fits-all solution. The right choice depends on the trade-off between an institution's technical capacity and its financial capacity. An institution with a strong IT team and a tight budget is well served by an open-source system; an institution that can fund a subscription but wants minimal maintenance is better matched to a commercial cloud platform; and accessibility or communication priorities tilt the decision further. Institutions planning a new implementation should consider Moodle or another actively maintained open-source LMS and evaluate it according to their specific functional, technical, and accessibility requirements. Table 6 translates these trade-offs into guidance by institutional profile.

Table 6. *Decision guidance by institutional profile*

Institutional profile	Primary constraint	Suggested fit	Rationale
Budget-constrained, capable IT team	Low budget, has technical capacity	Moodle	No licensing cost, flexible, and supported by an active ecosystem; maintenance is managed internally
Funded, limited IT capacity	Wants stability, minimal maintenance	Canvas or Blackboard	Vendor-managed SaaS, stable, low operational effort
Accessibility/inclusion priority	Compliance and inclusive design	Moodle or Canvas	Strong documented accessibility support and available accessibility tools
Communication-first / hybrid	Real-time interaction	MS Teams + an LMS	Strong real-time collaboration capabilities, but should be paired with an LMS for structured course management

6. CONCLUSION

This paper compared five selected e-learning platforms - Moodle, Blackboard, Canvas, ATutor, and MS Teams - across architectural, functional, user-centered, and implementation criteria, using a transparent qualitative framework. The analysis shows a coherent picture. Open-source systems such as Moodle and ATutor offer considerable flexibility and a strong documented emphasis on accessibility but place the maintenance burden on the institution's IT department. Commercial cloud systems (Blackboard and Canvas) provide stability and low maintenance at a higher financial cost. MS Teams brings excellent communication capabilities

but more limited pedagogical structure than dedicated LMS platforms. The central conclusion is that no single platform is optimal for every institution, and that the decision should follow the trade-off between an institution's technical and financial capacities.

There are some constraints to the research. It is desk-based, relying on official documentation and literature so the findings reflect documented capabilities rather than measured performance. It is also a static picture of evolving platforms, and the qualitative approach specifically avoids the numerical ranking that would be produced through a quantitative model. A specific limitation of the selected platform set is the inclusion of ATutor, which is no longer actively maintained. Future research should therefore replace or supplement it with actively maintained platforms such as Sakai, Open edX, or Google Classroom, validate the qualitative findings against empirical data such as response times, uptime, and user-satisfaction surveys, and repeat the comparison periodically so that it remains current. The framework itself is reusable: institutions can apply the same four categories to their own shortlist and reach a context-appropriate decision without specialized decision-analysis expertise if this is easier for them and more in line with the needs of the institution.

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