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PAPER

Towards Effective Adaptive Revision: Comparative Analysis of Online Assessment Platforms through the Combined AHP-MCDM Approach

Kaoutar Smahi(✉), Ouidad Labouidya, Khalid El Khadiri

STIC Laboratory, Faculty of Science, Chouaib Doukkali University, EL Jadida, Morocco

smahi.k@ucd.ac.ma

ABSTRACT

This study presents a detailed comparative analysis of online evaluation platforms aimed at identifying the most suitable one for integrating an adaptive revision plugin. The study uses both the analytic hierarchy process (AHP) and multi-criteria decision making (MCDM) to give a structured and thorough evaluation of different learning management systems (LMSs). By scrutinizing the capabilities, interfaces, and underlying technologies of these systems, the analysis seeks to pinpoint the platform that offers optimal compatibility, flexibility, functionality, and user experience. The central objective of this study is to enhance the effectiveness of adaptive learning tools within educational technologies. This is achieved by evaluating different platforms to ascertain which one best supports the integration of adaptive revision functionalities. Our comprehensive analysis clearly identifies Moodle as the superior platform due to its robust adaptability and enhanced customization capabilities, which are essential for implementing effective adaptive learning tools. The results underscore Moodle's potential to significantly enhance the educational experience by supporting tailored learning paths and dynamic content adjustments. This study not only highlights Moodle's advantages but also sets the groundwork for future advancements in adaptive educational technologies.

KEYWORDS

comparative study, platforms, online assessment, revision plug-in

1 INTRODUCTION

The integration of educational technologies into distance learning has made education more accessible, interactive, and responsive to individual learner needs. Central to this transformation are distance assessment platforms, which enhance learning through innovative review and assessment mechanisms. This paper

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examines the potential for developing an adaptive revision plugin, addressing a gap in the current educational technology landscape [1].

We will establish the necessity of this plugin by surveying existing solutions and identifying deficiencies that our study aims to overcome. Our approach employs a novel methodological framework that integrates the analytic hierarchy process (AHP) and multi-criteria decision-making (MCDM) techniques, focusing on selecting and evaluating platforms capable of supporting such an advanced pedagogical tool. The theoretical foundations of our study are rooted in an extensive literature review, emphasizing the evolution of online learning platforms and their impact on higher education. This includes examining student perceptions, academic achievements, and strategic initiatives undertaken by universities to merge traditional and digital learning environments, enriching the context of our study and underscoring its relevance in the current educational paradigm [2] [3] [4].

We will discuss the challenges and opportunities presented by online learning, such as data security, technical support, and the need for assessment tools that can adapt to diverse educational requirements. This discussion aims to highlight the practical implications of our study and its potential contribution to enhancing online learning environments [5].

We will also delve into the significance of the systematic development and evaluation of progressive web applications for managing student internships, drawing on recent studies and developments in the field. These considerations ensure that our study is aligned with the latest academic discourse and addresses the most pressing issues in online education today.

This paper proposes not only to explore and compare these platforms but to pave the way for the subsequent development of an adaptive revision plugin architecture, thus marking a significant advancement in the field of adaptive learning. Through a comprehensive analysis of the technical features, user interfaces, and integration capabilities of various systems, we aim to provide a detailed understanding of best practices and select the most suitable platform—identified preliminarily as Moodle—for our development efforts.

In subsequent sections, we will present the theoretical underpinnings of e-assessment, conduct a thorough comparative study of available platforms using AHP and MCDM methodologies, and conclude with a discussion on current Moodle plugins for adaptive editing, underlying technologies, and future directions for designing a detailed plugin architecture tailored specifically for Moodle. The insights provided on adapting learning technologies to individual needs further substantiate our choice of methodologies and anticipated outcomes.

2 FOUNDATIONS OF E-EVALUATION

2.1 History and development of online assessment

Online learning assessment has evolved significantly since the 1990s, moving from simple quizzes and multiple-choice tests to interactive methods like discussion forums, collaborative projects, and digital portfolios [6]. The advent of Web 2.0 introduced networked learning, as explored by Siemens and Downes, which promoted more [7] Recently, artificial intelligence has been used to personalize assessments and provide real-time feedback, enhancing learning outcomes [8] and [9].

Emerging technologies such as augmented reality and gamification are also being integrated, promising further advancements in e-learning assessment [10].

2.2 Advantages and limitations of e-evaluation

The advantages of e-assessment are numerous. It offers unrivaled flexibility, enabling learners to take tests at their own pace and in a comfortable environment. What's more, it enables automatic correction, providing immediate feedback to students. However, it also has limitations, such as the lack of direct supervision, which can lead to cheating problems, and the dependence on a good internet connection and adequate equipment.

1. Advantages

   Flexibility and Accessibility: One of the most notable advantages of e-assessment is its ability to offer unprecedented flexibility. As Hillier and Fluck have demonstrated, this modality enables students to participate in assessments outside the traditional constraints of time and place, representing a major advance over conventional methods [11].

   Instant feedback and performance monitoring: E-assessment provides immediate, personalized feedback, enhancing the learning experience and promoting a student-centered approach [12].
2. Limitations

   Academic integrity: Despite these advantages, e-assessment faces significant challenges, particularly in terms of academic integrity. McCabe draws attention to the growing problems of cheating and plagiarism in e-learning environments, requiring rigorous measures to maintain high standards [13].

   Unequal access and technological skills: Not all students and teachers have equal access to technology or possess the necessary technological skills, which can impact the effectiveness of e-assessment [14].

   Although e-assessment makes substantial contributions in terms of flexibility and efficiency, it is also subject to significant limitations [15]. These aspects need to be carefully considered to ensure a fair and effective implementation of e-assessment in today's educational landscape.

2.3 Pedagogical and technical principles of e-evaluation

E-assessment is governed by principles ensuring fairness and accurate skill measurement without bias. Questions should assess memory, comprehension, and problem-solving abilities. Technically, e-assessment systems must be robust and secure, ensuring the confidentiality and integrity of results [16].

Understanding the systems used to create, manage, and deliver educational content and assessments is crucial. These include learning management systems (LMSs), content management systems (CMSs), and learning content management systems (LCMSs), each playing a unique role in shaping the e-learning experience [17] [18] [19]. Here's a comparative Table 1 illustrating the key differences between these three types of systems.

Table 1. Learning management systems

Criterion	LMS	CMS	LCMS
Primary Objective	Administration and dissemination of courses	Generation and administration of web content	Generation and administration of educational content
Principal Users	Teachers, trainers, students	Webmasters, content editors	Learning content developers, trainers
Core Functionalities	Course management, learner monitoring, assessments	Content management, Search Engine Optimization, content dissemination	Educational content creation, individualization, management of content repositories
Personalization	User-oriented (teachers, students)	Website-oriented	Learning content-oriented
Analysis and Reporting	Analysis of performance and learner progression	Web traffic analysis, visitor engagement	Analysis of usage and learning content efficacy
Integration	Integration with other educational systems and tools	Integration with plugins, SEO tools, social networks	Often integrated with LMS for content delivery
Examples	Moodle, Blackboard, Canvas	WordPress, Joomla, Drupal	Xyleme, Kenexa LCMS, Adobe Captivate Prime

3 COMPARATIVE STUDY OF E-ASSESSMENT PLATFORMS

3.1 Methods

To augment the robustness of our study on distance assessment platforms, we refined the criteria selection process by consulting a broad range of literature on online assessment and educational technologies. The relevance of each criterion was validated by a panel of education professionals and technology experts to ensure their applicability in higher education contexts. These criteria include compatibility, flexibility, functionality, and user experience, which are crucial for the integration of adaptive assessment tools.

We employed the AHP and MCDM methodologies for their robustness in integrating expert judgments and providing a quantitative assessment of platforms, chosen over alternatives such as TOPSIS, which is ideal for conflicting criteria [20] [21], and SWOT analysis, which offers insights into external factors [22]. The AHP was used to determine the relative importance of each criterion through a systematic process that included the construction of pairwise comparison matrices. Subsequently, the MCDM method utilized these weighted criteria to objectively evaluate and compare the performance of various e-assessment platforms, providing a systematic and quantifiable means of comparison [23]. The specific steps in these methodologies are:

- **AHP:** Construction of pairwise comparison matrices based on expert judgments to assess the relative importance of each criterion. Criteria weights are calculated using the eigenvector method [24].
- **MCDM:** Application of the weights derived from AHP to evaluate each platform against the established criteria. We utilized a scoring system to assess the features and capabilities of each platform, allowing for a quantifiable comparison.

Sensitivity analysis. The sensitivity analysis was expanded to assess the robustness of the study's results. We adjusted the criteria weights to examine how these changes affect the final ranking of the platforms, thereby providing an overview of the stability of our conclusions.

Addressing methodological limitations. This section discusses the limitations and potential biases of the AHP and MCDM methodologies, notably the subjective nature of expert judgments. By acknowledging these limitations, we provide a balanced and credible view of the methods employed and their implications for the study's findings [25] [26].

Data collection and analysis. The data collection and analysis procedures have been significantly detailed in this revision. We describe the selection of experts for the qualitative analysis, the methodologies used for constructing hierarchical numerical judgment scales, and the statistical methods employed to synthesize scores and develop a comprehensive performance profile for each evaluated platform. These enhancements ensure the clarity and replicability of our study process, thereby strengthening its contribution to the field of e-assessment in higher education.

3.2 Application of the combined AHP and MCDM method

1. Criteria definition and alternatives
   - Criteria selection: The evaluation of distance assessment platforms involves analyzing essential criteria to assess their adaptability and relevance in higher education. Key criteria include adaptability of assessment methods, personalization of learning paths, diversity of adaptive assessment methods, interoperability, analytics and reporting, scalability, accessibility, user experience, regular updates, technical support, and data security [27]. This multi-dimensional approach is designed to ensure that the resulting plug-in is closely aligned with the diverse and complex adaptive revision requirements of higher education.
   - Choice of Alternatives: The selection of seven platforms for distance assessment in higher education is based on several key criteria essential for institutions:
     - Blackboard Learn is known for its robust management of online courses and assessments, highlighted by Owston for its effectiveness in blended learning, which is relevant for large student groups [28].
     - Canvas is recognized for its user-friendly interface and integration capabilities. Hew and Siebrits emphasize its role in student engagement in MOOCs, which is crucial for rapid technological adaptation [29].
     - Moodle as an open-source platform, Moodle offers extensive customization to meet institutional needs. Studies show its effectiveness in improving student engagement and performance [30].
     - Sakai: Specifically developed for higher education, noted for its flexibility. Heyde and Siebrits highlight its importance in individualized pedagogical approaches [31].
     - Brightspace by D2L offers flexibility, advanced analytics tools, and accessibility across devices, making it inclusive and adaptable to diverse educational contexts [32].
     - TalentLMS: Though less study academically, industry reports like "Capterra" (2021) recognize its usefulness for small and medium-sized institutions [33].
     - Schoology: Popular for its collaborative focus and ease of integration. Studies in the "Journal of Study on Technology in Education" indicate its promotion of collaborative and interactive teaching methods [34].

   These platforms were chosen for their proven ability to meet the diverse online assessment needs of higher education institutions, ranging from flexibility and customization to robustness and rich functionality, while delivering a quality user experience. They are also backed by solid reputations and positive feedback from users in the education sector.

2. AHP for structuring and prioritizing criteria:
Criteria weights are very important for the decision and are determined by experts in the field. The most widely used method is the Saaty scale. It is used for comparison [35]. It contains nine points, as shown in the following Table 2:

Table 2. Criteria weights and their meanings

Weights	Meaning
1	Equal importance of both elements
3	Weak importance of one element over another
5	Strong or decisive importance of one element over another
7	Proven importance of one element over another
9	Absolute importance of one element over another
2, 4, 6, 8	Intermediate values between two neighboring assessments
Reciprocals	If element i is given one of the previous numbers Cij when compared to element j, then Cji will have the reciprocal value 1/Cij when comparing j to i (inverse of the number).

Source: (T. Saaty, 1984) [36].

Establishing peer-to-peer comparison matrices: directly comparing each criterion with the others, to give a clear perspective on the relative importance of each criterion (see Table 3).
Calculation of weights using the AHP method: calculate the weights of each criterion, normalize the matrices, and determine the corresponding eigenvector.

Table 3. Peer-to-peer comparison matrix

Criteria	Assessment Adaptation	Course Personalization	Richness of Evaluation Methods	Interoperability and Integration	Analytics and Reporting	Scalability and Performance	Accessibility and User Experience	Technical Support	Data Security	Weight Standards
Assessment Adaptation	1	1	4	4	8	4	6	3	5	0.261
Course Personalization	1	1	9	9	2	7	8	8	9	0.388
Richness of Evaluation Methods	0.25	0.11	1	5	4	1	4	6	1	0.110
Interoperability and Integration	0.25	0.11	0.2	1	4	4	4	8	1	0.081
Analytics and Reporting	0.125	0.5	0.25	0.25	1	3	8	3	1	0.045
Scalability and Performance	0.25	0.14	1	0.25	0.33	1	5	2	5	0.049
Accessibility and User Experience	0.17	0.13	0.25	0.25	0.13	0.2	1	3	1	0.012
Technical Support	0.33	0.13	0.17	0.13	0.33	0.5	0.33	1	5	0.021
Data security	0.2	0.11	1	1	1	0.2	1	0.2	1	0.032

3. Platform evaluation with MCDM
Alternatives scoring: For each criterion, we created a peer-to-peer comparison matrix for the alternatives, using Saaty's scale (see Table 4).

Table 4. Comparison matrix for the "Assessment Adaptation" criterion

Assessment Adaptation	Moodle	Sakai	Canvas	Blackboard Learn	Brightspace by D2L	TalentLMS	Schoology
Moodle	1	6	6	6	8	7	8
Sakai	0.166	1	3	1	3	1	2
Canvas	0.166	0.333	1	1	2	3	1
Blackboard Learn	0.166	1	1	1	2	3	2
Brightspace by D2L	0.125	0.333	0.5	0.5	1	1	2
TalentLMS	0.142	1	0.333	0.333	1	1	2
Schoology	0.125	0.5	1	0.5	0.5	0.5	1

Checking the consistency of the judgments: For each matrix, we need to check the consistency by calculating the consistency ratio (CR). A crucial step in the AHP methodology is to assess the consistency of the judgments made during the construction of the pairwise comparison matrices [37]. To do this, we calculate the consistency index (CI) and the CR for each criterion evaluated. The CI provides a measure of the deviation of judgments from consistency, while the CR compares this deviation to an acceptable level of random consistency.

The CR was calculated as follows [38]:

- Calculate the maximum eigenvalue (λmax) of each matrix.

$$\lambda\text{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(Aw)i}{wi}$$

  – $(Aw)i$: represents the sum of the i-th row of the matrix A multiplied by the eigenvector w, and (wi) is the i-th component of the eigenvector.
- The standard formula for calculating the CI of each matrix is as follows: CI = (λmax–1)/(n–1) where n is the matrix size.
- The randomized index (RI), or random coherence index is obtained from a Table 5 provided by Saaty [39], a 9 × 9 matrix RI is usually 1.45.

Table 5. Random coherence index (RI)

Matrix Size	1	2	3	4	5	6	7	8	9	10
Random coherence index	0	0	0.58	0.09	1.12	1.24	1.32	1.41	1.45	1.49

The CR was obtained by dividing the CI by the random index (RI), CR = CI/RI, which is a reference value based on the size of the matrix. This Table 6 provides an overall perspective on the consistency of evaluations according to each criterion.

Table 6. Consistency ratios

Criteria	λ_{max}	Consistency Index (CI)	Consistency Ratio (CR)
Assessment adaptation	7.5	0.083	0.063
Course personalization	7.41	0.069	0.053
Richness of evaluation methods	7.75	0.125	0.094

(Continued)

Table 6. Consistency ratios *(Continued)*

Criteria	λ_{max}	Consistency Index (CI)	Consistency Ratio (CR)
Interoperability and integration	7.72	0.121	0.091
Analytics and reporting	7.78	0.131	0.099
Scalability and performance	7.52	0.087	0.066
Accessibility and user experience	7.56	0.093	0.070
Technical support	7.77	0.129	0.097
Data security	7.60	0.101	0.076

A CR of less than 0.10 suggests possible consistency in the assessments. This consistency in the final matrices increases the reliability of our evaluation and effectively supports decision-making based on this method. Then we calculate the weight of each alternative for each criterion using the eigenvector of the comparison matrix (see Table 7).

Table 7. Comparison matrix for the "Adaptation of evaluation with calculated weight" criterion

	Moodle	Sakai	Canvas	Blackboard Learn	Brightspace by D2L	TalentLMS	Schoology	Weight
Moodle	1	6	6	6	8	7	8	0.502
Sakai	0.166	1	3	1	3	1	2	0.123
Canvas	0.166	0.333	1	1	2	3	1	0.091
Blackboard Learn	0.166	1	1	1	2	3	2	0.109
Bright space by D2L	0.125	0.333	0.5	0.5	1	1	2	0.057
Talent LMS	0.142	1	0.333	0.333	1	1	2	0.064
Schoology	0.125	0.5	1	0.5	0.5	0.5	1	0.051

4 RESULTS

4.1 Score aggregation and ranking

We multiplies the alternative weights (obtained in each comparison matrix) by the criteria weights (obtained via AHP) to obtain an overall score for each alternative. Then we calculate the overall score for each alternative by combining the weighted scores [40]. Then, we rank the alternatives based on these aggregate scores to identify the best option (see Table 8).

Table 8. Aggregate scores and platform rankings

Alternative	Aggregate Score	Ranking
Moodle	0.0268	1
Sakai	0.0077	2
Canvas	0.0056	3
Blackboard Learn	0.0049	4
Brightspace by D2L	0.0046	5
TalentLMS	0.0039	6
Schoology	0.0036	7

Pair-wise comparison matrices, developed for each criterion, enabled a subjective, qualitative analysis based on expert judgment, followed by a quantitative analysis of alternatives based on hierarchical numerical judgment scales. This resulted in a synthesis of the scores, leading to the development of an overall performance profile for each platform evaluated. This rigorous analytical process produced a clear hierarchy of available options, establishing Moodle as the solution most in line with our predefined criteria by virtue of its predominant aggregate score.

4.2 Sensitivity analysis

A sensitivity analysis is essential to see how variations in criterion weights can affect the final ranking, and to highlight the robustness of our results' rankings (see Table 9) [41].

In our scenario, we adjusted the weights of "Customization of courses" (+10%) and "Adaptation of assessment" (–10%), then recalculated the overall scores for the top five platforms.

Table 9. Platform ranking after adjusting the weights of two key criteria

Platform	Adjusted Global Score
Moodle	0.510699
Sakai	0.117785
Canvas	0.101177
Blackboard Learn	0.092368
Brightspace by D2L	0.065804
TalentLMS	0.063623
Schoology	0.048543

Sensitivity analysis reveals that Moodle retains its dominant position even after adjustments to criteria weights. This suggests that Moodle is robust to moderate variations in the weighting of evaluation criteria.

4.3 Selection and validation

Moodle stands out as the most advantageous platform in this specific context due to its highest overall score of 0.0268, which reflects a strong fit with the chosen criteria. Its position at the top of the list can be attributed to its outstanding performance in several key criteria, reflecting its versatility and overall suitability for the defined needs.

5 CONCLUSION AND PERSPECTIVES

This study successfully utilized the AHP and MCDM to thoroughly evaluate online assessment platforms, specifically their capacity to support adaptive revision functionalities. Among the platforms analyzed, Moodle emerged as the most suitable due to its superior adaptability, customization capabilities, and comprehensive functionality. These features render Moodle an ideal environment for fostering enhanced educational experiences through support for tailored learning paths and dynamic content adjustments.

The major strength of this study lies in the rigorous application of AHP and MCDM methodologies, providing a detailed, quantifiable, and systematic evaluation of the platforms. This approach, grounded in expert judgments and objective data, ensures both the reliability and replicability of the findings. Nonetheless, the study is subject to limitations, particularly the inherent subjectivity of expert judgments and the potential for rapid evolution in digital learning technologies, which could affect the long-term relevance of the findings.

Building on the results of this study, the next logical step would be to develop a detailed architecture for an adaptive revision plugin specifically tailored for the Moodle platform. This proposed architecture should integrate seamlessly with Moodle's existing functionalities and be designed to accommodate a variety of teaching methods, emphasizing user experience and personalization. Further study should also explore the implementation of this plugin within Moodle to assess its effectiveness in real-world educational settings. Additionally, future investigations could extend to other educational technologies, particularly those incorporating advanced analytics and artificial intelligence, to widen the scope of adaptive learning tools available. It would also be beneficial to expand the expert panel and include diverse educational contexts to enhance the robustness and applicability of the study findings across different learning environments.

The effectiveness of the combined AHP and MCDM approach in this study underscores its utility in addressing complex decision-making processes within educational technology study. This methodology has facilitated a detailed and structured evaluation, proving its merit in academic and practical applications.

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7 AUTHORS

Kaoutar Smahi is state engineer and a PhD student at the Department of Physics and Engineering, at Chouaib Doukkali University in Morrocco. Her areas of interest include e-learning, docimology, and e-assessment techniques (E-mail: smahi.k@ucd.ac.ma).

Ouidad Labouidya is state engineer and has a PhD in information and communication technologies (ICT), She is a teacher-researcher at Chouaib Doukkali University in Morocco. Her research interests include the integration of ICT in university pedagogy, docimology and evaluation in education, and adaptive e-learning to enhance higher education teaching (E-mail: labouidya.o@ucd.ac.ma).

Khalid El Khadiri is currently a full professor at the Faculty of Sciences, El Jadida, Network and Telecommunications Team, ChouaIb Doukkali University, Eljadida, Morocco (E-mail: elkhadiri25@gmail.com).