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Validation of questionnaires on the evaluation of the quality of LMS platforms in the university context using the modified DELPHI method

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Abstract

The purpose of this study was to develop and validate questionnaires aimed at students, faculty, and administrators to evaluate the quality of Learning Management System (LMS) platforms in university contexts. A methodological design based on the modified Delphi method was adopted, applied in two rounds of consultation with 12 experts in educational technology, pedagogy, instructional design, and digital platform management. The items were evaluated based on criteria of clarity and relevance using a Likert scale, and analyzed through descriptive statistics, Cohen's Kappa coefficient, and Cronbach's Alpha. The findings show high levels of agreement among experts (Cohen's Kappa > 0.75) and high internal reliability of the questionnaires ($\alpha > 0.94$), demonstrating the robustness of the instruments developed. The multidimensional validation (technical, pedagogical, usability, and administrative) made it possible to construct comprehensive and coherent tools aligned with the current needs of digital higher education. It is concluded that the validated questionnaires are suitable for evaluating the quality of LMS platforms from different institutional perspectives. As a practical implication, these questionnaires can be used by universities to diagnose strengths and weaknesses in their LMS platforms, facilitating continuous improvement processes and evidence-based decision-making.

Keywords: Evaluation questionnaires, Higher education, Instrument validation, LMS platforms, Quality assessment, Modified Delphi method.

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1. Introduction

The rapid evolution and growth of e-learning have driven the adoption of LMS platforms in higher education institutions (HEIs) worldwide [1-3]. The COVID-19 pandemic accelerated this trend, highlighting the need for robust digital tools to ensure educational continuity [4, 5]. However, the increasing complexity of these LMS platforms presents critical challenges, such as ensuring their technical, pedagogical, and administrative quality [6-8].

Despite its relevance, there is a scarcity of validated questionnaires that comprehensively evaluate the key dimensions of LMS platforms [9]. Most studies focus on specific aspects, such as usability or user satisfaction, which limits their applicability [10]. This study addresses this gap through the design and validation of multidimensional questionnaires using the modified Delphi method, recognized for its effectiveness in achieving structured consensus in digital educational contexts [11, 12].

2. The Modified Delphi Method

The modified Delphi method is a widely used research technique for obtaining expert consensus on a specific topic through iterative rounds of questions [13, 14]. This method has been adapted and modified for use in various areas, including education, technology, and the evaluation of complex systems [15]. In its modified form, it retains the key features of the original methodology, such as the collection of anonymous opinions and controlled iteration, but with adjustments that allow for greater efficiency, such as reducing the number of rounds or using more structured initial surveys, without compromising the rigor of the process [16]. This adaptation has proven particularly useful in research requiring rapid and structured consensus, such as the evaluation of educational technologies [17].

For this study, the modified Delphi method was selected for its ability to minimize biases and ensure validity through the participation of multidisciplinary experts [18]. Unlike other methods, such as traditional surveys or focus groups, the modified Delphi method allows for controlled iteration and continuous review of responses, which is especially useful in complex evaluation areas [19] such as the quality of LMS platforms [20].

Among its limitations are the potential dropout of participants and the need to balance the quantity and quality of judgments [16, 21, 22].

Therefore, this study, using the modified Delphi method, aims to develop and validate questionnaires to evaluate the quality of LMS platforms in the university context, considering key dimensions: technical, pedagogical, usability, and administrative. These questionnaires will not only enable higher education institutions to identify areas for improvement in their LMS platforms but will also contribute to the existing literature by providing validated and updated tools that address the current needs of online learning.

3. Method

3.1. Study Design

This study used an adapted version of the modified Delphi method to develop and validate questionnaires that evaluate the quality of LMS platforms in the university context. The study design was framed as methodological, descriptive, longitudinal, and prospective research [23]. The procedure followed aligns with several previous works to develop the final questionnaire Figure 1.

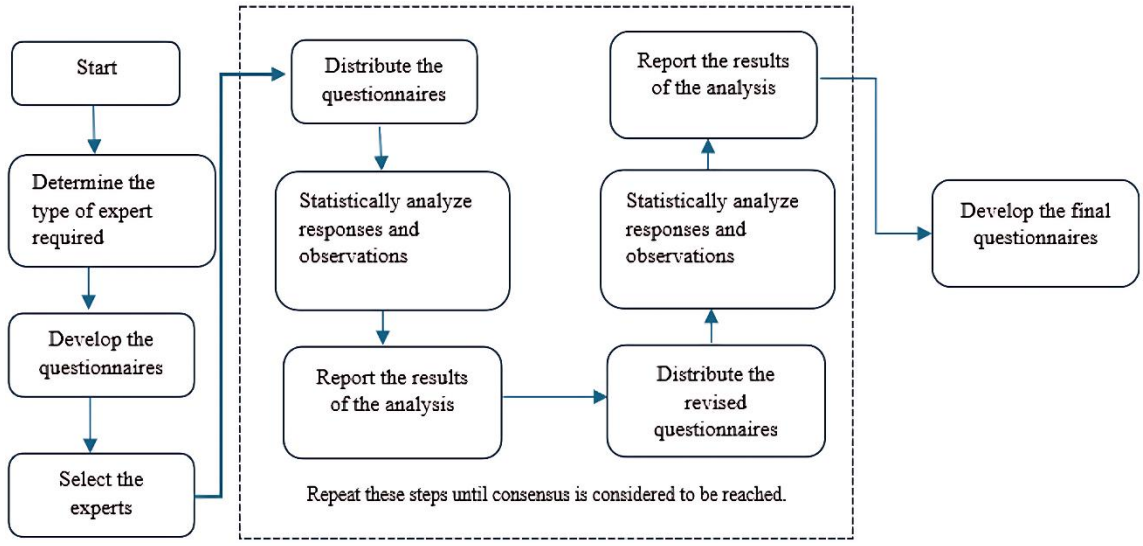

Figure 1.
General process of the Delphi method.
Source: Prepared by the authors based on: George and Trujillo [16], Linstone and Turoff [24], Landeta [25] and Aponte, et al. [26].

The process consisted of two rounds of surveys, involving 12 experts selected through purposive sampling [23].

3.2. Development of the Initial Questionnaires

The construction of the items for the first-round questionnaires was based on the identification of dimensions and criteria derived from a systematic literature review on the evaluation of the quality of LMS platforms at the university level [27].

3.3. Selection of Experts (Modified Delphi Method)

Content validation aimed to ensure that the questionnaire items adequately covered the dimensions and criteria to be evaluated. For this purpose, expert judgment was used [28].

The selection of experts is a fundamental stage in the modified Delphi method; the quality of the results obtained depends on their expertise in the evaluation process [29]. Inclusion criteria included: willingness and interest in participating in the study, availability, level of experience related to the object of study, and degree of knowledge on the subject [30]. The selected specialists were responsible for anonymously reviewing the questionnaires in successive rounds and providing their assessment of the appropriateness of the proposed items in relation to the defined variables [30].

Experts were selected in key areas such as educational technology, pedagogy, instructional design, and LMS platform management, with more than 15 years of experience using LMS platforms from the University of Huelva (UHU), the University of Extremadura (UEx) in Spain, and the Technical State University of Quevedo (UTEQ) in Ecuador.

3.4. Delphi Rounds Process

The modified Delphi method process was conducted in two rounds of surveys, following recommendations from previous studies [16].

In the first round, the experts were presented with a preliminary version of the questionnaires developed ad hoc from the literature review, in their three versions: students, faculty, and administrators. These questionnaires included items grouped into four key dimensions: technical, pedagogical, usability, and administrative. The number of items per dimension was as follows: technical dimension (8), pedagogical dimension (12), usability dimension (7), and administrative dimension (5).

The questionnaires were sent and received by email with an attached file, including instructions for their validation. Additionally, informed consent was obtained from all participants. The questionnaires consisted of a 5-point Likert-type response scale (1 = Strongly disagree to 5 = Strongly agree), along with a column for collecting qualitative assessments, comments, and recommendations to improve the clarity and relevance of the items. Data collection lasted twelve weeks, with a response rate of 85%.

In the second round, the questionnaires were redistributed to the experts to request their reevaluation of the modified items. Consensus was achieved through structured discussions of discrepancies, with at least 80% of experts agreeing on the relevance and clarity of each item [31, 32].

3.5. Data Analysis

The data obtained in each round were analyzed using the statistical software SPSS (version 25) by calculating arithmetic means and standard deviations. Items with a mean score equal to or greater than 4 were considered valid, while those with lower means were reviewed or eliminated [23]. Additionally, Cohen's Kappa coefficient was used to quantify the agreement among experts' responses and to ensure the validity of the questionnaire. The experts' observations were analyzed qualitatively to identify discrepancies and establish preliminary consensus.

The evaluation of the agreement among experts' responses yielded the overall Cohen's Kappa coefficient values: 0.770 for the student questionnaire, 0.759 for the faculty questionnaire, and 0.809 for the administrator questionnaire Table 1. These Cohen's Kappa values, according to the proposed Kappa rating scale, are used to assess inter-rater reliability [33]. Table 1 indicate variability in expert judgments, determining a strength of agreement ranging from good to very good during the validation process of the questionnaires.

Table 1.
Overall values of Cohen's Kappa coefficient obtained for each questionnaire.

Questionnaire	Kappa Value	Strength of Agreement
Student Questionnaire	0.770	Good
Faculty Questionnaire	0.759	Good
Administrator Questionnaire	0.809	Very Good

On the other hand, the reliability of the questionnaires was assessed using Cronbach's Alpha coefficient for internal consistency, based on the average inter-item correlation, yielding values higher than 0.80 for each questionnaire, indicating a high level of internal consistency [34]. The overall Cronbach's Alpha coefficient values obtained from the expert validation of the questionnaires ranged from 0.946 to 0.986 Table 2.

According to Mateo, et al. [35] values within the range of 0.8 to 1.0 can be considered "very high," indicating high levels of reliability of the developed questionnaires.

Table 2.
Overall values of Cronbach's Alpha coefficient obtained for each questionnaire.

Questionnaire	Cronbach's Alpha	Level of Reliability
Student Questionnaire	0.946	Very High
Faculty Questionnaire	0.975	Very High
Administrator Questionnaire	0.986	Very High

3.6. Development of the Final Questionnaires

An extensive discussion was conducted among the research team to jointly evaluate the results obtained after the validation process of the questionnaires [36]. The results obtained after these processes led to the development of the final questionnaires. A copy of these can be reviewed at the following link: Questionnaires.

4. Results

4.1. First Round

In the first round of the modified Delphi method, a statistical analysis was conducted to determine the mean and standard deviation of each item, establishing a threshold of 4.0 out of 5.0 for their retention. The results (Figures 2, 3, and 4) showed a general positive trend, with most means ranging between 4 and 5. Items with means greater than 4 but lower than 5 required revision, while items with means below 4 were eliminated. Additionally, high dispersion was identified in some items, reflecting differences in experts' perceptions.

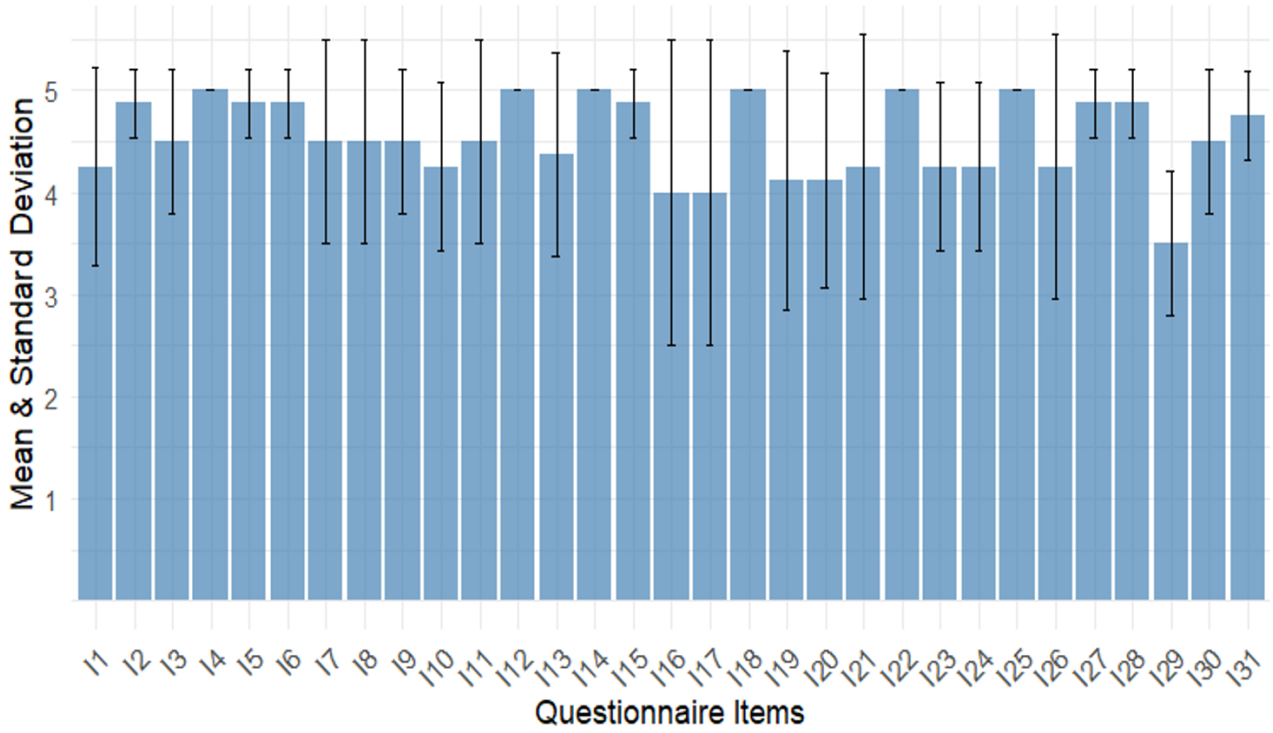

Figure 2.
Mean and standard deviation values of the student questionnaire items.

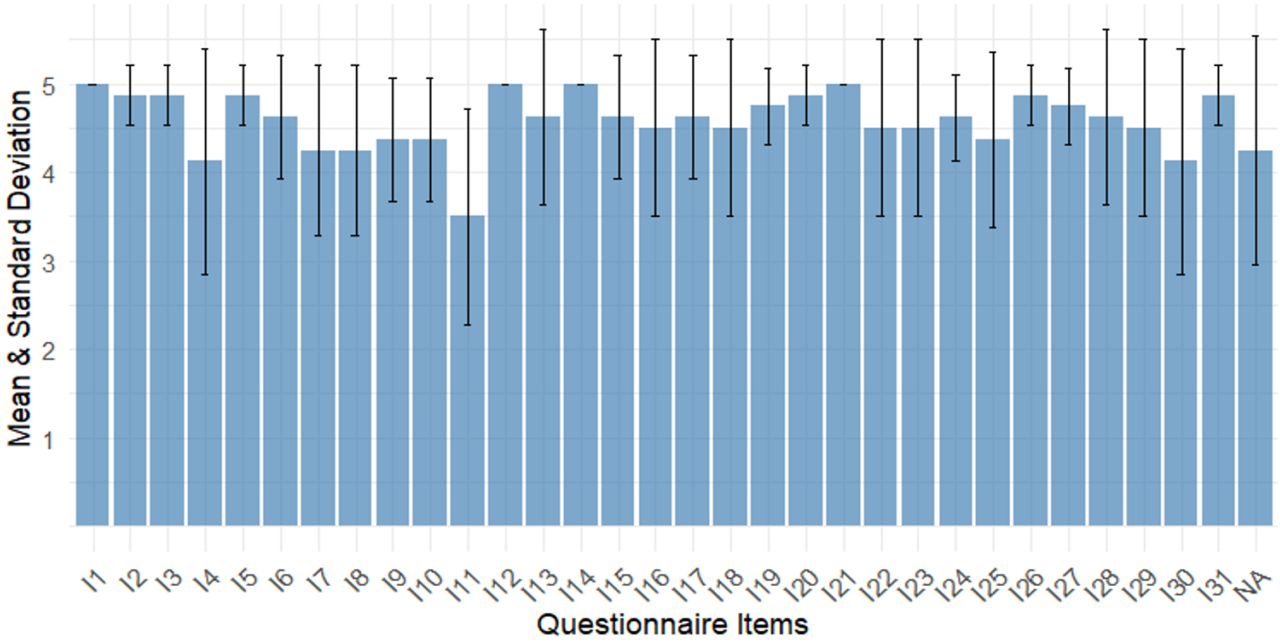

Figure 3.
Mean and standard deviation values of the teacher questionnaire items.

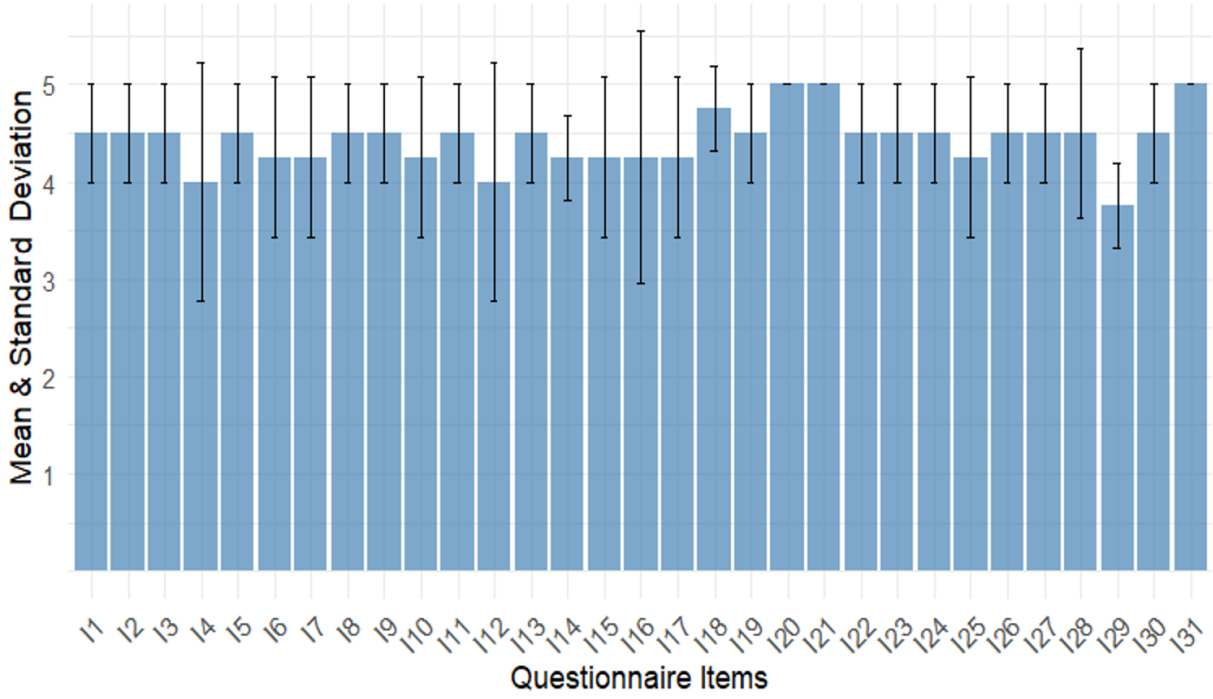

Figure 4.
Mean and standard deviation values of the items of the administrators' questionnaire.

4.2. Specific Analysis by Questionnaire

Students: The experts generally gave very positive ratings, although some items showed high dispersion in their responses. Only item I29 was eliminated, while those with scores of 5 were retained without modification. Items with a mean value between 4.99 and 4 (I1, I2, I3, I5, I6, I7, I8, I9, I10, I11, I13, I14, I15, I16, I17, I19, I20, I21, I23, I24, I26, I27, I28, I30, and I31) required modifications to improve their performance.

Faculty: The ratings for the faculty questionnaire showed a positive trend but with a lower average score and greater dispersion than those of the students, due to diverse experiences with LMS platforms. Item I11 was eliminated because of its mean of 3.50, while items I1, I12, I14, and I21, with means of 5, were retained without changes. A total of 27 items reached a mean value between 4.99 and 4 and required adjustments (I2, I3, I4, I5, I6, I7, I8, I9, I10, I13, I15, I16, I17, I18, I19, I20, I22, I23, I24, I25, I26, I27, I28, I29, I30, I31, and I32).

Administrators: Although the experts demonstrated relatively homogeneous experiences with LMS platforms, some items exhibited considerable deviations, reflecting differences in the perceived effectiveness of certain functionalities. In the administrators' questionnaire, only item I29 was eliminated, with a mean score of 3.75. Items with a mean value of 5 (I20,

I21, and I31) were retained without changes. Items with a mean value between 4.99 and 4 (I1, I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15, I16, I17, I18, I19, I22, I23, I24, I25, I26, I27, I28, and I30) were modified.

The questionnaires validated by experts in the first round received predominantly positive ratings (4 or 5), with consensus in the highest-rated areas among the different groups, although it is necessary to complement the quantitative results with qualitative data.

4.3. Second Round

After the first round, the evaluation of the degree of alignment with the dimensions was omitted due to its perceived importance, as indicated by the experts. In the second round, the items were reorganized by criteria, and the questionnaires were revised to reduce disagreement by incorporating qualitative suggestions to focus the items on the LMS platform itself, rather than on the design of courses or subjects [32]. The modified items are detailed in Tables 3, 4, and 5.

Table 3.
Modification and Updating of Student Questionnaire Items.

Criterion	Items	Original Items	Modified Items
Functionality		The LMS platform provides access to classes and educational materials without technical issues.	The LMS platform provides access to educational materials without technical issues such as forgotten passwords, unstable connections, browser incompatibility, etc.
		The LMS platform provides access to advanced features necessary for university teaching, such as class recording and participation analysis.	The LMS platform provides access to advanced features necessary for university teaching, such as session recording, tutorial videos, and participation analysis.
		The tools (uploading assignments, forums, quizzes) work properly during their use on the LMS platform.	The LMS platform enables the proper functioning of tasks, forums, quizzes, etc., during their use.
		LMS platform updates do not interrupt access to content and academic activities.	LMS platform updates do not interrupt access to content and academic activities.
Security and Privacy		The LMS platform adequately protects my personal and academic data (grades, activities, etc.).	The LMS platform records and verifies login data such as passwords, profile photos, and email addresses.
		When I log in to the LMS platform, I feel that my information is safe and protected.	The LMS platform includes resources to educate students about phishing, identity theft, and how to identify malicious emails.
Scalability		The LMS platform responds adequately even when many students use it simultaneously.	The design and development of the LMS platform respond adequately even when many students use it simultaneously.
		I have not experienced system crashes on the LMS platform during high-usage times, such as during exams or assignment submissions.	The design and development of the LMS platform can adapt to different course modalities: in-person, online, or hybrid.
Instructional Design		The organization of content on the LMS platform facilitates learning (clarity in modules, activity sequence).	The LMS platform facilitates the search for materials and resources in a logical and organized manner.
		The instructions for activities are clearly presented and easy to follow on the LMS platform.	The platform provides appropriate tools for developing collaborative activities among students.
		The course structure on the LMS platform is well organized.	The design of the LMS platform interface is intuitive and attractive.
Interactivity		The LMS platform facilitates interaction between students and instructors (discussion forums, messages).	The design and development of the LMS platform facilitate interaction between students and instructors (discussion forums, messages, instant messages).
		I can participate in collaborative activities, such as debates or group projects, within the LMS platform.	The LMS platform provides notifications, reminders, and alerts about assignments, exams, academic progress, and other related activities.
Assessment and Feedback		The assessment tools (exams, assignments) are easy to use and provide useful feedback on the LMS platform.	The assessment tools (exams, assignments) are easy to use and provide useful feedback on the LMS platform.

		I can view my grades and the progress of my activities clearly and up-to-date on the LMS platform.	I can view grades and progress of activities clearly and up-to-date on the LMS platform.
		I receive constructive feedback on my performance in assessments through the LMS platform.	The LMS platform's assessment tools include anti-plagiarism detection systems and AI recognition.
Content Formats Variety		The content available on the LMS platform is relevant to my studies.	The LMS platform allows educational content to be offered in various file formats, such as jpeg, gif, avi, mp3, pdf, etc.
		The LMS platform provides access to a variety of educational resources, such as videos, readings, presentations, and interactive activities.	The LMS platform provides access to a variety of tools and educational resources, such as videos, readings, presentations, and interactive activities (games).
Educational Content Quality		The resources (videos, readings, forums) provided on the LMS platform are useful and varied.	The tools and resources available on the LMS platform, such as videos, readings, and forums, are useful and effective in the teaching-learning process.
		The educational content on the LMS platform is relevant and of high quality for my learning.	The educational content on the LMS platform (videos, audios, images) is of high quality and enriches learning.
Ease of Use		The LMS platform is easy to use and navigate, both on computers and mobile devices.	The LMS platform is easy to use on all types of technological devices, such as mobile phones, tablets, computers, etc.
		The main functions (assignment submission, content access) are clearly visible and easy to find on the LMS platform.	The main functions (assignment submission, content access) are clearly visible and easy to locate on the LMS platform.
Accessibility		I can use the LMS platform without technical difficulties, even if I have some type of disability (visual, auditory, motor).	The LMS platform ensures inclusive access and use, respecting the functional diversity of all students.
		The LMS platform allows me to adjust settings such as text size or colors to improve my user experience.	The LMS platform allows users to adjust settings such as text size, colors, or contrast to enhance the user experience.
User Satisfaction		I am satisfied with the overall performance of the LMS platform for my studies.	I am satisfied with the overall performance of the LMS platform in carrying out my academic studies.
		The LMS platform allows me to complete my academic activities without constant frustration or problems.	The general features of the LMS platform are adequate and sufficient to achieve the proposed academic objectives.
Support and Maintenance		The LMS platform's technical support is available when I need it and resolves my issues quickly.	The LMS platform's technical support is available when needed and resolves issues quickly (login problems, content uploading, assignment submission errors, etc.).
		I can find tutorials, guides, and help resources within the LMS platform to solve common problems.	The LMS platform includes guides and help resources to solve common problems.
Cost-Efficiency		I consider that the LMS platform is an efficient tool in terms of time and effort for completing my academic activities.	The LMS platform is an efficient tool in terms of time and performance for completing academic activities.
		The LMS platform allows me to access information and resources that would be costly or difficult to obtain otherwise.	The design and development of the LMS platform provide access to information, resources, and tools that would otherwise be costly or difficult to obtain.

Table 4.
Modification and Updating of Faculty Questionnaire Items.

Criterion	Items	Original items	Modified items
Functionality	I1	The LMS platform provides additional resources, such as tutorials and guides, that assist users in adapting to new features.	The LMS platform provides tools and educational resources (tutorials, guides) that help users adapt to new features.
	I2	The LMS platform enables efficient management of classes, including uploading resources, managing assessments, and posting announcements.	The LMS platform enables efficient management of sessions, including uploading resources, managing assessments, and posting announcements.
	I3	LMS platform updates do not interrupt access to academic content and activities.	The LMS platform provides access to advanced features necessary for university teaching, such as session recording, video tutorials, and participation analysis.
	I4	The LMS platform's tools function properly during teaching sessions.	LMS platform updates do not interrupt total or partial access to content nor interfere with the teaching-learning process.
Security and Privacy	I5	The LMS platform ensures the security of sensitive information and data of students and faculty.	Through its design and development, the LMS platform ensures the security of registered sensitive student and faculty data.
	I6	Clear policies exist regarding the privacy of academic data on the LMS platform.	The design and development of the LMS platform include resources to educate faculty about phishing, identity theft, and how to identify malicious emails.
Scalability	I7	The LMS platform responds properly even when many users use it simultaneously.	Thanks to its design and development, the LMS platform responds properly even when many students use it simultaneously.
	I8	I have not experienced performance problems on the LMS platform during peak usage times, such as exams or assignment submissions.	The design and development of the LMS platform can adapt to different modalities of courses: in-person, online, or hybrid.
Instructional Design	I9	The LMS platform facilitates the design and structuring of courses in an organized and coherent manner.	The design and development of the LMS platform consistently facilitate the structuring and organization of courses.
	I10	The LMS platform enables the planning of educational activities tailored to different learning styles.	The design and development of the LMS platform facilitate both the planning and implementation of educational activities.
	I11	The course structure on the LMS platform is well organized.	The course structure on the LMS platform is well organized.
Interactivity	I12	The LMS platform offers tools that promote active interaction between students and faculty (discussion forums, chats, surveys).	The LMS platform integrates tools and resources that promote active interaction between students and faculty (discussion forums, chats, surveys).
	I13	The LMS platform facilitates the implementation of collaborative activities among students, such as group work or virtual debates.	I believe that the pedagogical features and elements of the LMS platform facilitate the implementation of collaborative activities among students, such as group work or virtual debates.
Assessment and Feedback	I14	The assessment tools (exams, assignments) are easy to use on the LMS platform.	The assessment tools (exams, assignments, and rubrics) are easy to use on the LMS platform.
	I15	The LMS platform provides effective tools for creating and managing assessment activities (quizzes, exams, rubrics).	The LMS platform includes sufficient and effective tools and resources to create and manage assessment systems (real-time quizzes, rubrics, electronic portfolios, etc.).
	I16	The LMS platform enables detailed and timely feedback to students regarding their performance.	The integrated assessment tools in the LMS platform enable continuous, detailed, and valuable feedback to students regarding their academic progress and performance.
Variety of Content Formats	I17	The LMS platform allows for the integration of various teaching	The design and development of the LMS platform allow for the integration of multiple teaching and educational resources.

		resources, such as presentations, videos, simulations, and documents.	
	I18	The LMS platform facilitates the integration of external content that supports the teaching-learning process.	The design and development of the LMS platform facilitate the integration of external content (repositories, relevant publications, YouTube channels, conferences, etc.) that support the teaching and learning process.
Educational Content Quality	I19	The LMS platform helps improve the quality of the content I can provide to students, facilitating access to updated and high-quality materials.	The pedagogical features and elements of the LMS platform contribute to improving the quality of content offered to students in various formats, as well as access to updated and relevant materials.
	I20	The LMS platform allows me to update course content easily and quickly when needed.	The design and development of the LMS platform allows for easy and quick updates of course content when needed.
Ease of Use	I21	The LMS platform is easy to use, both for course creation and for managing educational activities.	The LMS platform is easy to use, both for course creation and for managing learning activities.
	I22	The essential functions of the LMS platform, which ensure its basic operation for managing learning, are easily accessible and do not require advanced technical training.	The main functions of the LMS platform (those ensuring its basic functioning to manage learning) do not require advanced technical training for their use.
	I23	The most important functions of the LMS platform, which enhance the educational experience, add value, and provide flexibility to the learning process, are easily accessible and do not require a high level of technical training to use.	The most important teaching and learning processes of the LMS platform (those enhancing the educational experience, adding value, and flexibility to the learning process) do not require a high level of technical training for their use.
Accessibility	I24	The LMS platform has features that make it accessible for students with disabilities (e.g., screen readers, captions, accessible navigation tools).	The LMS platform has features, elements, and components that make it accessible for students of all abilities (audio descriptions, screen readers, captions, accessible navigation tools).
	I25	The LMS platform enables the adaptation of content and educational activities for students with diverse needs.	The design and development of the LMS platform allow for the adaptation of features, components, and configurations according to the principles of Universal Design for Learning (UDL).
User Satisfaction	I26	Overall, I am satisfied with the ease of use of the LMS platform for teaching my classes.	Overall, I am satisfied with the ease of use of the LMS platform for teaching my sessions.
	I27	The LMS platform has enabled me to carry out my teaching activities efficiently, without major technical problems.	The design and development of the LMS platform enable teaching activities to be conducted efficiently, without technical issues.
Support and Maintenance	I28	The LMS platform's technical support responds promptly to help requests related to technical issues.	The LMS platform's technical support responds promptly to online help requests related to connection issues, browser incompatibility, content display errors, logs, etc.
	I29	The LMS platform is regularly maintained, and its updates do not interfere with teaching activities.	The maintenance of the LMS platform is carried out regularly, and its updates do not interfere with the teaching and learning process.
Cost-Efficiency	I30	I consider that the LMS platform is an efficient tool that allows me to optimize time in managing my courses.	I consider that the LMS platform is an efficient tool that allows for time optimization in course management.
	I31	The use of the LMS platform reduces administrative effort, such as automatic grading of assessments or organizing content.	The use of the LMS platform reduces the time dedicated to administrative tasks related to assessment systems thanks to automatic grading, generated reports, etc.

Table 5.
Modification and Updating of Administrator Questionnaire Items.

Criterion	Items	Original items	Modified items
Functionality	I1	The LMS platform provides all the necessary tools for the proper development of teaching and administrative activities.	The LMS platform provides tools and educational resources (tutorials, guides) that help users adapt to new features.
	I2	LMS platform updates do not interfere with daily use or cause significant service interruptions.	The LMS platform allows efficient management of sessions, including uploading resources, managing assessments, and posting announcements.
	I3	The LMS platform possesses all the necessary technical functionalities for large-scale operation, including resource access, user management, and report generation.	The LMS platform provides access to advanced features necessary for university teaching, such as session recording, tutorial videos, and participation analysis.
	I4	LMS platform updates do not interrupt access to content and academic activities.	LMS platform updates do not interrupt access to content and academic activities.
Security and Privacy	I5	The LMS platform meets the necessary security standards to protect the academic and personal data of users, including faculty, students, and administrators.	Through its design and development, the LMS platform ensures the security of registered sensitive student and faculty data, in compliance with the Organic Law on Data Protection of Ecuador.
	I6	Clear policies exist on the handling and safeguarding of personal information on the LMS platform, including controlled access and data encryption.	The design and development of the LMS platform include resources to educate students about phishing, identity theft, and how to identify malicious emails.
Scalability	I7	The LMS platform can handle a high number of users simultaneously without affecting its performance or stability.	The design, development, and hardware of the LMS platform respond adequately even when many students and professors use it simultaneously.
	I8	The LMS platform responds properly during periods of high demand, such as during exams or mass assignment submissions.	The design and development of the LMS platform can adapt to different course modalities: in-person, online, or hybrid.
Instructional Design	I9	The course structure on the LMS platform is well organized.	The design and development of the LMS platform consistently facilitate the structuring and organization of courses.
	I10	The LMS platform enables faculty to structure and organize their courses and teaching content effectively, thereby facilitating the teaching-learning process.	The design and development of the LMS platform facilitate both the planning and implementation of educational activities.
	I11	The LMS platform offers tools that facilitate the creation of modules and learning sequences clearly and efficiently.	The LMS platform includes tools and external applications that facilitate the creation of modules and learning sequences clearly and efficiently.
Interactivity	I12	The LMS platform offers features to promote interaction between students and faculty, such as discussion forums, chats, and virtual debates.	The LMS platform integrates tools and resources that promote active interaction between students and faculty (discussion forums, chats, surveys).
	I13	The LMS platform offers options to integrate collaborative activities among students, such as group work or shared projects.	I believe that the pedagogical features and elements of the LMS platform facilitate the implementation of collaborative activities among students, such as group work or virtual debates.
Assessment and Feedback	I14	The LMS platform effectively manages student assessments (quizzes, exams, evaluation rubrics).	The assessment tools (exams, assignments, and rubrics) are easy to use on the LMS platform.
	I15	The LMS platform provides effective tools for creating and managing assessment activities, including partial evaluations, exams, and rubrics.	The LMS platform includes sufficient and effective tools and resources to create and manage assessment systems (real-time quizzes, rubrics, electronic portfolios, etc.).
	I16	The LMS platform facilitates student feedback through grading tools and comments on assessment activities.	The LMS platform's assessment tools include anti-plagiarism detection systems and AI recognition.

Variety of Content Formats	I17	The LMS platform allows the integration of a wide variety of content formats, including videos, presentations, documents, and interactive multimedia resources.	The design and development of the LMS platform facilitate the integration of multiple resources, not only didactic but also educational.
	I18	It is easy to upload, manage, and share various teaching resources on the LMS platform for use in classes.	The design and development of the LMS platform facilitate the integration of external content (repositories, relevant publications, YouTube channels, conferences, etc.) that support the teaching-learning process.
Educational Content Quality	I19	The LMS platform ensures easy access to high-quality educational content and promotes its use by faculty.	The pedagogical features and elements of the LMS platform contribute to improving the quality of content offered in various formats, as well as access to updated and relevant materials.
	I20	The LMS platform allows for continuous updates of content and teaching resources to ensure their relevance and quality.	The design and development of the LMS platform allow for easy and quick updates of course content when necessary.
Ease of Use	I21	The LMS platform's user interface is intuitive and user-friendly.	The LMS platform's user interface is intuitive and user-friendly.
	I22	The LMS platform is intuitive and easy to use, both for technical staff and for faculty and students.	The LMS platform is intuitive and easy to use, both for technical staff and for students and faculty.
	I23	The LMS platform adapts well to different screen sizes (computers, tablets, smartphones).	The LMS platform is easy to use on all types of technological devices, such as smartphones, tablets, computers, etc.
Accessibility	I24	The LMS platform complies with accessibility standards, enabling its use by individuals with functional diversity (visual, auditory, motor).	The LMS platform has features, elements, and components that make it accessible for students of all abilities (audio descriptions, screen readers, captions, accessible navigation tools).
	I25	The LMS platform offers customization options to enhance accessibility, including text adjustment, contrast, and compatibility with assistive devices.	The design and development of the LMS platform allow for the adaptation of features, components, and configurations according to the principles of Universal Design for Learning (UDL).
User Satisfaction	I26	Overall, users (faculty, students, and administrators) are satisfied with the user-friendliness of the LMS platform in their respective roles.	Overall, users (students, faculty, and administrators) are satisfied with the user-friendliness of the LMS platform in their respective roles.
	I27	The LMS platform offers a positive and efficient user experience, enhancing both educational and administrative interactions.	The LMS platform offers a positive and efficient user experience, enhancing both educational and administrative interactions.
Support and Maintenance	I28	The LMS platform's technical support is efficient, responding quickly to problems and providing timely solutions.	The LMS platform's technical support responds promptly to online help requests related to connection issues, browser incompatibility, content display errors, logs, and other related concerns.
	I29	The LMS platform is regularly maintained, and its updates ensure the stability and availability of its functionalities.	The maintenance of the LMS platform is carried out periodically, and its updates do not interfere with the teaching-learning process.
Cost-Efficiency	I30	The costs associated with the maintenance and operation of the LMS platform are reasonable in relation to the benefits it offers to the institution.	The costs associated with the maintenance and operation of the LMS platform are efficient relative to the benefits it offers to the institution.
	I31	The LMS platform optimizes the time and resources invested in its management, allowing administrators and technical staff to work efficiently.	The LMS platform optimizes the time and resources invested in its management, allowing administrators and technical staff to work efficiently.

5. Discussion

The validation of questionnaires for assessing the quality of LMS platforms constitutes a relevant methodological challenge in the context of the digital transformation of higher education. This study, through the application of the modified Delphi method, has demonstrated the utility of this approach in reaching expert consensus on the design and review of questionnaires, as also highlighted by Altınpulluk, et al. [11] in their application of the modified Delphi method to open and distance learning systems.

The implementation of two rounds using the modified Delphi method made it possible to quantitatively evaluate the agreement among experts through Cohen's Kappa coefficient. The values obtained showed substantial agreement among judges [37] reinforcing the reliability of expert judgment and justifying the decisions made regarding the modification or exclusion of certain items. Recent studies, such as those by Boulkedid, et al. [38] and Holey, et al. [39] have emphasized the importance of using Cohen's Kappa coefficient to objectively support the results of a Delphi process.

Additionally, from a statistical perspective, the high reliability coefficients (Cronbach's Alpha > 0.94) and inter-rater agreement (Cohen's Kappa > 0.75) achieved in this study confirm the consistency of the items, in line with the methodological standards proposed by Almanasreh, et al. [40] who indicate that content validity is strengthened when quantitative evaluation is combined with the judgment of qualified experts.

The results obtained reinforce the evidence that technical, pedagogical, usability, and administrative criteria are key dimensions for a comprehensive evaluation of LMS platforms, consistent with the findings of Al-Fraihat, et al. [6] who emphasizes that an effective evaluation of these environments should consider multiple perspectives to ensure their success. The multidimensional structure of the validated questionnaires thus aligns with the recommendations of previous research on the evaluation of digital educational quality, being especially relevant in post-pandemic contexts such as the current one [9].

Furthermore, the process of adapting and modifying items after the first round, supported by the qualitative analysis of the observations, reflects an iterative and dialogical methodology that allows for refining the questionnaires and adjusting them to the institutional reality. In this regard, the relevance of the modified Delphi method as a flexible tool for research in educational technology is reaffirmed [17] especially in contexts that require a balance between standardization and adaptability.

Likewise, as noted by Rasheed, et al. [10] the perception of the end user students and faculty is essential for validating both empirical and content validity.

Finally, the experience with experts from different universities and countries not only guaranteed the heterogeneity of perspectives but also highlighted the need to develop questionnaires that are sensitive to local contexts without losing their global applicability, a line consistent with the proposal for standardizing quality criteria in digital learning environments in low- and middle-income countries [12].

6. Conclusion

The application of the modified Delphi method enabled the development of a systematic, rigorous, and consensus-based process to validate questionnaires designed to assess the quality of LMS platforms in university contexts. The inclusion of multidisciplinary experts, controlled iteration, and robust statistical analysis ensured the content validity of the items, reflected in the high inter-rater agreement coefficients (Cohen's Kappa) and the high levels of internal consistency (Cronbach's Alpha > 0.94). This confirms the methodological relevance of the approach adopted to construct reliable questionnaires in complex educational environments.

Although the modified Delphi method ensured consensus, the sample was limited to institutions in Spain and Ecuador, which could affect its generalizability.

The results obtained empirically validate the need to incorporate technical, pedagogical, usability, and administrative dimensions to carry out a comprehensive evaluation of LMS platforms. The high acceptance of items in these categories by experts demonstrates that these dimensions align with the current needs and expectations of university stakeholders in digital learning environments. The validated questionnaires enable higher education institutions to make informed decisions for the continuous improvement of LMS platforms, thereby promoting higher educational quality and a more satisfactory user experience.

6.1. Practical Implications

The proposed questionnaires are adaptable to different institutional contexts, allowing the evaluation of advanced functions in universities with robust technological infrastructure as well as basic dimensions in countries with limited resources. Additionally, their periodic application will facilitate the comparison of results between institutions, promoting global quality standards without losing sight of local needs. Thus, their use can support internal audits, accreditation processes, and evidence-based pedagogical redesigns, fostering improvements in digital learning management. This research offers a standardized quantitative tool that, unlike generic satisfaction surveys, allows for the identification of specific areas for improvement, such as data security or pedagogical interactivity.

6.2. Future Work

For future research, it may be interesting to replicate the study in other degree programs at different universities, in various educational contexts, considering cultural and technological factors. Longitudinal studies are recommended to analyze the evolution of perceived quality and its relationship with indicators such as academic performance and student satisfaction.

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