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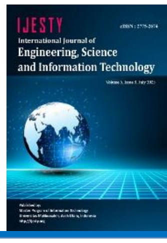

Advancing the Measurement of MOOCs Software Quality: Validation of Assessment Tools Using the I-CVI Expert Framework

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Abstract

The growing use of MOOCs in the post-pandemic era, particularly in developing countries, requires the availability of valid assessment tools to ensure software quality that meets users' needs. However, several tools are still being used without a proper content validation process, which risks producing biased and unrepresentative data. This study aims to evaluate the validity of the content of an assessment instrument designed to measure the dimension of software quality on the Massive Open Online Courses (MOOC) platform, particularly in the context of the increased adoption of online learning post-pandemic in developing countries. The instrument comprises 27 statement items representing ten quality software factors: functionality, usability, reliability, performance, security, maintainability, portability, compatibility, support, and integration. The validation was carried out by involving seven experts in information systems and digital learning. The method used is an item-level content validity index (I-CVI) based on a descriptive quantitative approach, with each item being assessed using a 5-point Likert scale. An item is declared valid if it obtains an I-CVI score of ≥ 0.79. The analysis showed that 21 items were valid; three needed to be revised at the I-CVI value between 0.70–0.78, and 3 invalid items at the I-CVI value < 0.70. The functionality, usability, support, and integration quality factors had the highest levels of validity, while the safety and support dimensions showed a higher degree of divergence in the expert assessment. These findings highlight the need for content validation to ensure MOOC indicators are accurate and relevant. The study showed the need for advanced validation tests involving real users and other validation methods, such as Aiken V or the fuzzy analysis hierarchy process (FAHP) to enhance the reliability and practical relevance of the tools developed.

Keywords: *Software Quality, Content Validity, I-CVI, Instrument Validation, MOOC.*

1. Introduction

Evaluation of software quality on Massive Open Online Courses (MOOCs) platforms is a key aspect of ensuring the sustainability and efficiency of large-scale e-learning. In the post-pandemic context, the increasing use of MOOCs in various developing countries demonstrates the need to ensure that the evaluation tools used are of high quality and reliability [1].
Unvalidated evaluation tools may create biased and misleading data and interfere with decision-making when developing MOOCs and their features. Therefore, the need for systematic content validation becomes inevitable. One of the most widely used approaches in educational research and software engineering is the I-CVI (item-level content validity index), a quantitative method to measure the degree to which a panel of experts judges a given item in a tool to be relevant [2] [3].
The I-CVI approach incorporates the principle of involving experts in the validation process so that results reflect the correspondence between the measured indicators and the reality of user or system needs [4]. This is particularly important for MOOCs, which have a complex and multidimensional nature, from technical performance and usability to security and inter-platform integration [5] [6].

In line with the systematic approach in the framework of digital learning, several studies highlighted the importance of a thorough evaluation of the instrument design [7]. Both are pedagogy, the software's functionality, and user support. The purpose of instrument validation is not only to ensure the semantic relevance of items but also to identify items that are irrelevant, ambiguous, or overlapping, which ultimately affect the validity of the design and the accuracy of the research results [8].

Due to the complexity of the MOOC ecosystem, content validation processes such as I-CVI may be combined with triangulation approaches such as FAHP [9], Fuzzy Analysis [10], and other exploratory statistical methods to support tool quality optimization [11]. This approach is increasingly important when tools assess MOOC platforms with a broad user base and adaptive AI features or personalized recommendations [12] [13].

This study aims to assess the quality of items in the assessment tool for Massive Open Online Courses (MOOCs) by applying the content validity index approach at the item level (I-CVI), involving seven experts in information systems and digital education technologies [14]. Through an assessment using a Likert scale of 1–5, items are considered relevant if they obtain a score of ≥ 3 and are categorized as valid if I-CVI ≥ 0.79 [7] [2]. This verification is essential to ensure that each item accurately reflects the quality aspects of the software, such as usability, functionality, security, integration, support, and functionality [6], [8], especially in light of the growing use of MOOCs in the aftermath of the COVID-19 pandemic [1][5]. By referring to recognized academic standards, the results of this research contribute to the development of evaluation instruments that are not only theoretically valid [15] but also useful for supporting decision-making in developing MOOC platforms that are adaptable and responsive to the needs of users [12][13].

Validation of I-CVI-based tools is a necessary first step to ensure that each item in the MOOC quality assessment tool reflects the intended quality dimension and can be used for validating user data collection in the context of research or system development.

2. Literature Review

This literature review examines three key aspects underpinning the research: the concept of MOOCs, the software quality factors supporting the platform's performance, and the I-CVI (Content Validity Index) method for assessing the validity of the assessment tool's content. All three will become reference points for analyzing and developing the theoretical and practical instruments.

2.1. Massive Open Online Courses (MOOCs)

Continuous quality evaluation of Massive Open Online Courses (MOOCs) is essential to ensure the effectiveness, long-term usefulness, and relevance of online learning. The focus on this quality dimension is increasing as adaptive technologies are integrated and user engagement and personalization of big data-based learning are developed.

Shah et al. (2023) emphasize that the quality of pedagogy in MOOCs should be evaluated formatively to remain learner-centric, including alignment between content, interaction, and learning evaluation[16]. This aspect is the foundation for developing a sustainable evaluation framework [17].

Furthermore, Sebbeq and El Faddouli (2024) propose a micro-level framework for quality assurance in MOOCs, emphasizing the importance of quality measurement based on multidimensional indicators such as participation, interoperability of systems, and digital inclusion[18].

Regarding stakeholder commitment, Li et al. (2024) developed a predictive model for course recommendation based on an analysis of dropout rates and risk so that learning quality can be dynamically adapted to the profile and needs of the learner[19].

Another study by Wang et al. (2023) reinforces the urgency of systematic quality control as a key element in the success model of post-pandemic e-learning systems, highlighting the relationship between user experience and the sustainability of MOOC use [2].

The latest models also explore the integration of technical evaluation elements such as performance, data security, and cross-system integration, which are identified as key dimensions of the quality of MOOC software, such as usability, functionality, performance, security, support, and integration, as summarized in different literature.

Therefore, a sustainable quality assessment approach requires a synthesis of technical, pedagogical and user experience indicators and dynamic data-driven assessment frameworks to address the quality challenge in a complex and constantly evolving MOOC ecosystem.

2.2. Software Quality Factors

Software quality is a critical attribute that measures the degree to which the software product satisfies users' needs and functional and non-functional requirements. According to Galin (2018), standard models such as ISO 25010:2011 understand software quality through interdependent and structured factors. The model incorporates eight key factors: functional suitability, performance, compatibility, portability, reliability, security, durability, and portability [20]. Furthermore, according to Galin (2018), the six key quality attributes are usability, functionality, performance, safety, support, and integration.

Usability measures the extent to which a system is easy for users to understand, learn, and use efficiently [21]. In MOOCs, this aspect affects user engagement and learning success [2][20]. Functionality assesses the suitability of system features to user needs and their reliability in providing core services [22][20]. Performance includes responsiveness and resource efficiency, essential to maintain seamless access on large-scale platforms [23][20].

Meanwhile, security involves protecting user data and access control, which is becoming increasingly important in the digital age[20]. Support reflects the availability of technical support and documentation to support the user, whereas integration measures the ability of the system to work smoothly with other software [8][1][20].

Focusing on these six attributes is essential for developing and evaluating MOOCs to ensure a safe, efficient, and sustainable user experience.

2.3. Item Content Validity Index (I-CVI)

Sustainable quality evaluation is a critical process to ensure that the system, particularly in the context of digital learning, such as Massive Open Online Courses (MOOCs), can maintain its performance, relevance, and reliability over time. This assessment requires a systematic, valid, and reliable approach to assessing the quality of the system components, in particular software and pedagogical aspects [24].

Polit, Beck, and Owen (2007) emphasized that content validity is the foundation for developing reliable evaluative instruments. One widely used quantitative method for assessing content validity is the Item-level Content Validity Index (I-CVI). This method relies on

expert judgment of each statement item in the instruments [25], which are then systematically converted and analyzed to determine the item's suitability with the measured construct [26].
The first phase of the evaluation using I-CVI consists of gathering evaluations from several experts, usually 3 to 10 people with appropriate expertise in the instrument. Each expert was asked to score each item using an ordinal Likert scale of 1–4 or 1–5, representing the relevance level to the measured construct [27].
Conversion to binary scale is done to calculate I-CVI; the score of each expert must be converted to binary scale. Scores that indicate importance, such as 3, 4, and 5 on the Likert scale, are given 1, while others, such as scores of 1 and 2, are given 0. This conversion aims to simplify calculations based on the proportion of agreement between experts on each item [26].

The formula and calculation of I-CVI for each item are calculated using the formula [26]:

$$I-CVI = \frac{\text{Number of experts rating the item as relevant (e.g., 3, 4, or 5)}}{\text{Total Number of Experts}} \quad (1)$$

For example, if 6 out of 7 experts rate an item as relevant, I-CVI = 6/7 = 0.857.

The interpretation of the I-CVI value is carried out using a certain threshold. Based on the recommendations of Polit et al. (2007), items with an I-CVI value of ≥ 0.79 are considered valid and can be used without revision. Items with a value between 0.70 and 0.78 need to be repaired, while items with an I-CVI of < 0.70 are generally eliminated or substantially revised.
Continuous evaluation using the I-CVI approach significantly ensures quality sustainability, particularly in online learning systems such as MOOCs [28]. Content validation through I-CVI helps filter out evaluative items that are inappropriate or less representative of the expected software quality factors. In a study by Mohamed and Salleh (2021), the expert-based validation process proved to be effective in ensuring the quality of the indicators used to measure the success of MOOCs [7]. In addition, Wang et al. (2023) underscore that the success of post-pandemic e-learning systems is highly dependent on the system's ability to evaluate and adapt to user needs on an ongoing basis[2].
The use of I-CVI, therefore, not only provides a standardized approach to quality assessment but forms an integral part of the development of digital learning systems geared towards quality sustainability and user-centered learning.

3. Materials and Method

3.1. Research Design

This study uses a descriptive quantitative approach that aims to evaluate the validity of the content of the software quality assessment instrument in the context of Massive Open Online Courses (MOOCs). Validation is carried out to guarantee that each item in the instrument truly represents the relevant quality aspects of the MOOC [29], which is in line with the principle of developing assessment tools in education technology and software engineering [2][7]. Figure 1 presents the software quality assessment research design in the context of Massive Open Online Courses (MOOCs).

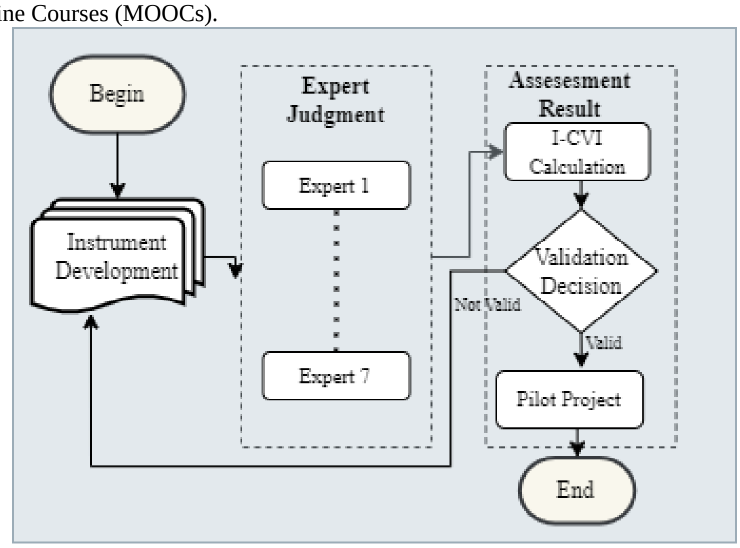

Fig 1. Research Design Software Quality Assessments about Massive Open Online Courses (MOOCs)

Figure 1. describes a descriptive quantitative research approach focusing on the instrument's content validity through the Item-level Content Validity Index method (I-CVI). This process is systematically organized into several interrelated steps.
The first stage begins with the instrument preparation process, where the researcher proposes statement items representing the quality factor of the design or software to be measured. The tool is then sent to several expert judges with expertise in the relevant area to assess the relevance of each item on a Likert scale, usually 4 or 5 points.
Furthermore, the expert assessment results' data calculates each item's I-CVI value. I-CVI is calculated by dividing the number of experts who provide a relevant score (usually ≥ 3) by the total number of experts involved. An I-CVI value of ≥ 0.79 is considered valid, a value between 0.70 and 0.78 is considered to need revision, while a < value of 0.70 indicates an invalid item and is recommended for elimination [2][7].

Based on these results, researchers decide whether to retain, revise, or eliminate each item. This stage is followed by the finalization of the instrument, which has been improved and adjusted with expert input. These validated tools are then further tested by pilot studies with real users to gather further information on understanding, usability, and practicality in real-world implementation.

This approach emphasizes the importance of the involvement of experts and quantitative justification in the validation process. It aims to create a valid and representative content-based assessment tool for the measured construct, particularly in the context of complex and multidimensional online learning platforms such as MOOCs [6][8].

3.2. Instrument

The developed instrument consists of 27 statement items representing six key software quality factors: usability, functionality, performance, security, integration, and support, as recommended [6][29].

The content validation process involved seven experts with experience in information systems, digital education technologies, software engineering, and higher education. Each expert was asked to rate each item using a 5-point Likert scale, where a score of 1 indicates "irrelevant," and a score of 5 means "highly relevant." The scores considered relevant for the validity calculation were 3, 4, and 5, according to the approach used to validate previous online educational instruments [7][2].

Table 1. Expert Validation Table

No	Software Quality Factors	Code	Statement Items	Likert scale (1–5)
1.	Functionality	FC1	This MOOC platform provides all the necessary features to support end-to-end online learning goals.	…..
2.	Functionality	FC2	The functions in the MOOC system run without errors according to the purpose of their use.	…..
3.	Functionality	FC3	The features available are according to participants' learning needs and the material's context.	…..
4.	Usability	US1	MOOC platforms are easy for new users to learn without additional training.	…..
5.	Usability	US2	The MOOC's user interface is easy to use and supports efficient interaction.	…..
6.	Usability	US3	The MOOC platform is accessible to users with a wide range of special needs and devices.	…..
7.	Reliability	RE1	MOOC systems have high stability and rarely experience technical glitches.	…..
8.	Reliability	RE2	The platform can continue to function even if there is a minor error in the system.	…..
9.	Reliability	RE3	MOOC services are available consistently and reliably.	…..
10.	Performance Efficiency	PF1	The process of loading learning materials takes place quickly and without obstacles.	…..
11.	Performance Efficiency	PF2	The system uses resources (CPU, bandwidth) efficiently despite the large number of users.	…..
12.	Security	SC1	The personal data of MOOC users is kept confidential with high-security standards.	…..
13.	Security	SC2	The system ensures that user data is not altered or corrupted without authorization.	…..
14.	Security	SC3	The platform provides proof of transactions or user activity to ensure data validity.	…..
15.	Maintainability	MN1	The MOOC system is built with a modular structure that makes it easy to maintain.	…..
16.	Maintainability	MN2	Changes or updates to the MOOC can be made without interfering with other functions.	…..
17.	Maintainability	MN3	MOOC components are easy to test to ensure their quality and performance.	…..
18.	Portability	PO1	The platform can be used on various devices and operating systems without any issues.	…..
19.	Portability	PO2	The installation process or initial access to the platform is easy and does not require complicated technical configuration.	…..
20.	Compatibility	CM1	MOOC systems can run in tandem with other applications without conflicts.	…..
21.	Compatibility	CM2	MOOCs integrate with other systems, such as LMS or user authentication systems.	…..
22.	Support	SP1	When I encountered a technical issue, the MOOC support team responded quickly and provided a solution.	…..
23.	Support	SP2	The MOOC platform usage guide is obvious and easy to understand.	…..
24.	Support	SP3	I find having an active and responsive forum or	…..

No	Software Quality Factors	Code	Statement Items	Likert scale (1–5)
			community of MOOC users is helpful.	
25.	Integration	IT1	The MOOCs I take can be connected to my campus learning system.	…..
26.	Integration	IT2	I could access the MOOC through various devices without any display or function issues.	…..
27.	Integration	IT3	My grades and learning progress at MOOCs can be reported or synchronized to the official academic system.	…..

Seven experts were involved in the validation process, selected based on their academic background and professional experience in information systems and digital learning technologies. The involvement of seven experts was considered sufficient to carry out a precise and reliable analysis of the I-CVI, as suggested by Wang and Yang (2023)[30].

Each expert was asked to assess the relevance of each item in the tool based on a five-point Likert scale, ranging from 1, indicating no item at all, to 5, indicating an essential item. The evaluation shall be considered relevant if it scores 3, 4, or 5. This system refers to the content validation approach used in previous educational and digital tools [7].

The validity of the content is calculated using the I-CVI (item-level content validity index), which is the division of the number of experts providing the relevant assessment of the item by the total number of experts (n = 7). Interpretation of I-CVI is based on the following criteria: value > 0.79 is considered valid, value > 0.70-0.78 should be revised value> 0.70 is not valid [30]. This method has been chosen for its simplicity and the ability to identify items relevant to the content based on expert consensus. This interpretation refers to the validation practice of the instrument, which is widely used in MOOC and e-learning tools [1], [5].

This approach has been chosen because I-CVI is a simple but effective way to identify items relevant to the content based on expert consensus. Moreover, the use of seven experts was considered sufficient to achieve high reliability in the validation of content as proposed by Wang & Yang (2023) [30] in the assessment of the quality of MOOCs based on the classification of big data [2].

4. Results and Discussion

Results of a survey of instrument validation using the I-CVI (Item Level Content Validity Index) approach showed that of the 27 statement items developed for the assessment of MOOC software, up to 12 had an I-CVI value of >0.79 and were classified as valid. Three items had an I-CVI between 0.70 and 0.78 and had to be corrected, while three others had an I-CVI < 0.70 and were classified as not eligible. Table 2 shows the results of the I-CVI assessment by seven experts.

Table 1. I-CVI Assessment Results by 7 experts

No	Software Quality Factors	Code	I-CVI	Interpretation
1.	Functionality	FC1	0.29	Not Valid
2.	Functionality	FC2	1.00	Valid
3.	Functionality	FC3	1.00	Valid
4.	Usability	US1	0.71	Revision
5.	Usability	US2	1.00	Valid
6.	Usability	US3	1.00	Valid
7.	Reliability	RE1	1.00	Valid
8.	Reliability	RE2	0.86	Valid
9.	Reliability	RE3	0.86	Valid
10.	Performance Efficiency	PF1	0.86	Valid
11.	Performance Efficiency	PF2	0.86	Valid
12.	Security	SC1	0.29	Not Valid
13.	Security	SC2	0.29	Not Valid
14.	Security	SC3	0.86	Valid
15.	Maintainability	MN1	0.86	Valid
16.	Maintainability	MN2	0.86	Valid
17.	Maintainability	MN3	0.86	Valid
18.	Portability	PO1	0.86	Valid
19.	Portability	PO2	0.86	Valid
20.	Compatibility	CM1	0.86	Valid
21.	Compatibility	CM2	0.86	Valid
22.	Support	SP1	0.71	Revision
23.	Support	SP2	1.00	Valid
24.	Support	SP3	1.00	Valid
25.	Integration	IT1	0.71	Revision
26.	Integration	IT2	1.00	Valid
27.	Integration	IT3	1.00	Valid

Table 2 shows the results of the content validation assessment (I-CVI) of 27 software quality assessment tools on the MOOC platform by seven experts. Each item is grouped into ten quality dimensions: functionality, usability, reliability, performance, security, maintainability, portability, compatibility, support, and integration. The calculation results showed that 21 items had an I-CVI value greater than 0.79 and were declared valid; three items had values between 0.70 and 0.78 and were therefore considered ineligible. The usability and integration quality factors showed high consistency, with two of the three items being declared fully valid, while the security quality factor had two invalid items. These results confirm the importance of a critical evaluation of instrument constructions, especially regarding the quality factor, which shows the diversity of assessments between experts. In Figure 2. Is the I-CVI Score Distribution for Each MOOC Quality Instrument Item.

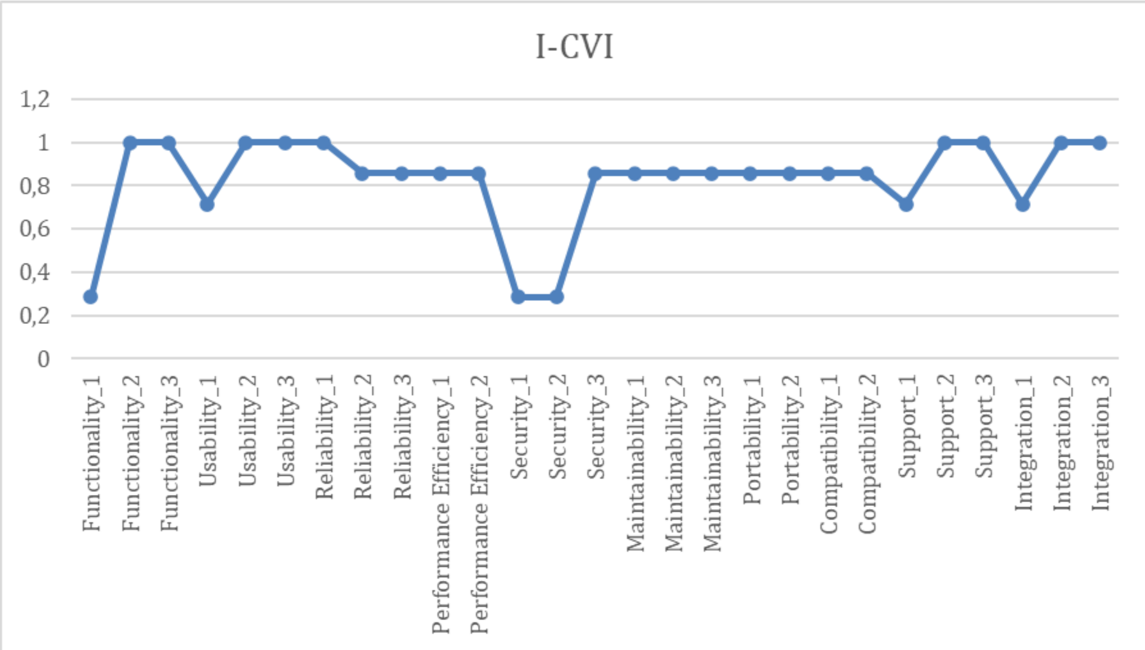

Fig 2. I-CVI Score Distribution for Each MOOC Quality Instrument Item

From Figure 2, interpretation value I-CVI with a value of ≥ 0.79 is categorized as valid and suitable for use without revision; items between 0.70 - 0.78 need revision to clarify the meaning or correct the redaction. Meanwhile, items below 0.70 are considered invalid and should be eliminated or reordered. This approach has been widely used in the validation of instrument content in the fields of education and technology, as recommended by Polit et al. (2007) and Beck & Gable (2001) [31]. Moreover, it is revealed that software functionality, usability, support, and integration factors occupy the highest proportion in the valid category. This reflects the perception of experts that the aspects of ease of use, compatibility of functions, and integration between systems are the main elements that have been well-reflected in the instrument statement items. These findings are in line with research by Wang et al. (2023), which states that functional and integration aspects are crucial components in the success of post-pandemic online learning systems [2].

On the other hand, some items in the quality of safety and support factors show a variety of expert scores. This variation indicates that editorial or conceptual improvements are needed in the statement items to make them more representative of the context of data security implementation and user support on MOOCs. According to El Mourabit et al. (2023), the security dimension often faces technical implementation problems and conceptual differences among experts [1]. In the meantime, the damages award against Fernandes et al. (2023) underlines that features of user support that are not designed interactively are perceived as less relevant by end users [5].

Therefore, the results of this analysis are an essential basis for the tool's revision process to ensure that the tool developed is valid in terms of content and reflects the practical needs and complexity of the MOOC features.

The validity of the content of MOOC assessment tools has important implications for the development of quality measurement tools for online learning [32]. Based on the analysis results, most of the items achieved an I-CVI value greater than 0,79, indicating that they met the criteria of relevance as assessed by the experts. This shows that the composition of the item statement was adapted to the expectations, perceptions, and needs of MOOC users when assessing the quality of software [6]. Meanwhile, items classified as invalid (I-CVI < 0.70) need further attention. Revisions of these items may be made by redactions, contextual adjustments, or redrafting based on expert input. [8][2]. This validation activity is important to ensure that every indicator in the instrument can accurately and representatively reflect the measured dimensions [33]. In the context of MOOC implementation in developing countries where access and quality remain key issues, the availability of valid evaluation tools will greatly benefit quality assurance and data-driven policymaking [1][7].

These results provide a solid basis for reviewing and refining the tools for evaluating MOOCs. Successful validation of the content will ensure that this tool is not only conceptually valid but also relevant for use in the context of large-scale online learning implementations, notably in the post-Covet-19 phase, which has seen a significant increase in the use of MOOCs [1].

Validated tools will support data-driven decision-making when developing and evaluating MOOC platforms and allow for more adaptive and responsive systems to user needs [12][13].

5. Conclusion

The study concluded that most items in the MOOC assessment tool demonstrated a sufficient level of content validity based on the I-CVI approach. The results of the I-CVI calculation from a total of 27 items analyzed, as many as 21 items reached an I-CVI value of ≥ 0.79. They were declared valid; three items were in the range of 0.70–0.78 and required revision, while the other three obtained I-CVI < 0.70 and were categorized as invalid. These findings show that most instrument indicators could reflect relevant and scientifically responsible quality aspects of MOOCs [8], [6]. Furthermore, These results will contribute to developing tools that are more adaptive and relevant to the needs of MOOC users, particularly in the era of online learning, which is still growing [2] [7]. A content-valid instrument is an

essential prerequisite in ensuring the effectiveness of the digital-based learning evaluation process [3]. As a suggestion, it is recommended that the validation process should not stop at the stage of expert evaluation but continue with empirical validation tests involving MOOCs' real users. In addition, the combination of the I-CVI approach with other methods, such as Aiken's V or Fuzzy Analytic Hierarchy Process (FAHP), can strengthen the accuracy and reliability of validation results [9][34]. This recommendation is essential to ensure that the tool developed is valid in theory, applicable, and relevant in practice [5][2].
In the follow-up, empirical validation testing is recommended on actual MOOC users to confirm the tool's validity in real-world use. In addition, combining the I-CVI approach with other methods, such as Aiken's V or Fuzzy AHP, can improve the accuracy and generalization power of the validation results [9][35]. Revisions to invalid items should be based on linguistic and contextual analysis that considers the user's characteristics and the MOOC's digital environment [7][2].

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