# Psychometric Evidence of the Questionnaire to Evaluate the Didactic Sequence in Digital Environments in University Students

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**Abstract**

The recent changes, following the pandemic of COVID-19, have caused a significant transformation in the field of education, millions of students have migrated to digital environments and the use of digital practices. The research aimed to present the results of the process of creating and arranging the psychometric characteristics of an instrument for evaluating the development of online sessions in teaching and learning. For the validity and reliability stage, 379 students from fourteen universities in Peru were taken. The reliability of instruments using the split halves method with Pearson (0.954) and Cronbach's Alpha (0.947) ratified by the Guttman coefficient (0.932). For the exploratory factor analysisthe KMO (Kaiser-Meyer-Olkin) contrast and Bartlett's test, the rotation method for convergence with Varimax with Kaiser normalization were used. Two models were used to compare the best fit indicators as a final result. It is concluded the obtaining of an instrument with characteristics such as frequent or start-up activities, execution of synchronous sessions, follow-up of asynchronous activities and evaluation with evidences or products.

**Keywords:** online sessions, digital environments, assessment, online evidence

## 1. Introduction

Education, considered as a social and dynamic system, does not escape the significant changes caused by the growing use of information and communication technologies (ICT), today also known as Disruptive Technologies or Emerging Technologies (Flores, 2016). This implies the training of teachers for the progressive and personalized integration of ICTs, characterized by telematic networks, virtual teaching-learning environments, computer systems, new scenarios and hypermedia and multimedia educational resources, high interactivity and communication tools and resources that generate new paradigms of traditional education and favor inclusion, integration and contextualization processes (Garay-Argandoña et al., 2016).

The virtualization of substantive processes in universities entails the global transformation of the educational institution, where face-to-face and virtuality are combined, open learning and distance education are promoted as alternatives for the development of training processes characterized by a new conception of the parameters of space and time and virtual spaces (Lima Montenegro & Fernández Nodarse, 2017). On the other hand, distance training that had already been occurring for some decades, has been increased, in some cases, reaching one hundred percent, by the pandemic situation generated by the COVID - 19 pandemic. Since the state of alert was established in many countries, millions of students have been following the course from home. The pandemic has transformed many routines overnight and has put millions of students to study from their rooms. And in this scenario, the statement is resounding: "the online and multimedia world is becoming more and more established and students (of all levels) have shown us that they have an inexhaustible potential for adaptation".

According to the United Nations 2030 Agenda for Sustainable Development (Unesco, 2020), the commitment of Sustainable Development Goal 4 (SDG 4) is to ensure "inclusive, equitable and quality education" and promote "lifelong learning for all". In this context, Higher Education, in order to train students with the competencies, skills

and knowledge, coherently with the different pedagogical and labor efforts implemented in the countries, must use mechanisms that allow a better articulation of the training received with the productive sector.

Nowadays, universities are immersed in continuous processes of quality and improvement, making the presence of actions and strategies that promote a quality institution, prone to change and to the new approaches that arise, more and more necessary. Among these new organizational development strategies we can find mentoring, which, although it has hardly any tradition in Latin American universities, has been systematically developed in practically all universities in English-speaking countries. For García Nieto (2005, p. 15), these experiences demonstrate that mentoring and, specifically, mentoring processes among students at the university level constitute an innovative and effective tool in the face of the changes that are approaching us on a global scale. Mentoring can be understood, on the one hand, as "a process of learning assistance with different variants and models of development (natural, intentional, transit, etc.) and, on the other hand, it is often confused with terms related to learning assistance, such as tutoring or coaching (García Nieto, 2005, p.16).

The real educational disruption has occurred with the effects and consequences of the cause-effect brought about by the COVID-19 pandemic. With an impact on all strata of societies around the world, an amalgam of technologies have been designed, created, developed and implemented that have contributed to the disruption in people's lives. Work and education have been two of the environments most affected. COVID-19 may already be a milestone in the evolution of people, society and countries. The before and after will be very marked and it will take several years for people to return to their habits (Ocampo, 2020). Although all pedagogical processes are important, in this opportunity the study deals with the development of online classes since these actions were previously done in person.

## 2. Development of Classes

Although some university centers in the world have been implementing the hybrid blended or blended education model, the pandemic has boosted this model, both face-to-face and virtual and now hybrid, all of them use - or should use - different methodologies and pedagogies to achieve attendance to classes and their evaluation. But how do we motivate these modes of learning and evaluation? How do we achieve interest in virtual sessions in synchronous and asynchronous mode? How do we motivate students to obtain good learning results? If global education points towards a blended or hybrid teaching model, it must be understood what hybrid education or learning is all about. For experts in educational innovation, hybrid learning is defined as a disruptive, competency-based, learner-centered pedagogical approach that includes a combination of classroom training and *face-to-face* interaction in computer-mediated classes. In other words, the hybrid education model incorporates students, both face-to-face and remotely. Interaction is a fundamental process, and since it cannot be done in the classroom, it is substituted using technological tools. This is, in fact, a strategy used by many teachers as a preventive measure imposed by their universities by restricting access to classrooms to fifty percent of the student body. The classes taught by the teacher are both face-to-face (for face-to-face students) and virtual (for the other 50% connected to their computers) at the same time (Hernández Rangel et al., 2021).

The development of online classes, which can be synchronous or asynchronous, requires an essential factor in the teaching-learning process that impacts the training of students and requires some control. That is why the development of online sessions must be evaluated and this will fulfill its role which is to evaluate the skills and abilities of university students (Piscitelli, 2015). The following are essential aspects that should be taken into account when executing the interaction with students.

### Dimension 1: Frequent activities, which involve

They are activities or situations that occur and are involved in all educational events in one or more circumstances such as attendance control using various applications or useful tools. For Raya Diez and Navaridas Nalda (2021) the problem of attendance is one of the oldest and most permanent in the educational world. While some theorists believe that attendance should be free, others point out that it is advisable to control it and even make it compulsory. In the middle of these poles, we find online education and distance learning. One way or another, in cases where students' attendance in class is controlled.

The experience of the virtual courses shows us that, "as the days go by, the discouragement, anxiety and stress that are perceived in the environment also make a dent when studying from home because these emotions lead to blocking and paralyze them. In this scenario, the lack of motivation is one of the main reasons why young people abandon their studies, this brings as a consequence that, the teachers, faced with the lack or little management of this extra effort, problems appear in the teaching-learning processes such as lack of motivation. Another important

element in the development of learning sessions is motivation, in these current times, the professional or academic success of any student will depend on their ability to acquire skills, collaborative teamwork, acquire emotional intelligence, the ability to manage complex problems, all this within an increasingly faster environment, constantly changing and progressively more demanding, that is, in a world shaped by a "hypercomplex society" (Dominici, 2017).

For Miras (2000), "prior knowledge" is a principle of constructivist pedagogy which, based on cognitive theories, states that the subject is capable of constructing his or her own knowledge. That is to say, the student upon entering the university has a series of knowledge that allows him/her to initiate a new learning process. However, with the application of this principle, the question that arises is: How is the previous knowledge of students juxtaposed in the teaching intervention? The answer is preceded by the analysis of students' prior knowledge - or even spontaneous ideas - and the teaching intervention that is generated from them. This framework places the teacher in a new role, that of facilitator.

**Dimension 2: Process of synchronous non-face-to-face sessions**

Many approaches to the educational model of Higher Education point out as a key didactic process the change of the center of attention from the teacher to the student, from teaching to learning, from teacher directivity to autonomy in student learning. Sánchez and Gairin (2008, p. 124), mention three global attitudes of the teacher towards teaching and learning linked to his or her practical performance in the classroom and to the processes of interdisciplinary inquiry: director, mentor and guide. However, it is not a question of opting for any of these three attitudes (or any other) as the only, definitive and universal solution to the problems of teaching and learning processes in the university. It is a myth that there is an ideal didactic method, perfect, perennial and applicable to any didactic situation. The elaboration of any didactic proposal that intends to have an impact on the transformation of reality in order to improve it requires an analysis of all the dimensions of the environment in which the teaching-learning process is going to take place. Decontextualization is one of the paths that leads to dogmatism, and dogmatism is one of the most dangerous deviations from rational and scientific thinking (Sánchez and Gairin, 2008).

The processes require actions that allow teacher and student interaction, for this purpose video conferencing platforms and other digital tools are used, we must first consider access and motivation in any educational act, motivation is not the solution to all learning problems at the university or any other educational level, but high motivation contributes greatly to the development of adequate and satisfactory learning processes (Chamorro & Sanchez, 2005). The tools used can be synchronous or asynchronous , which allow generating *feedback* with the teacher and interaction between students as if they were physically present. Therefore, in these technological spaces, all students, at some point, will be connected with audio and video, creating a scenario where online students will be watching the teacher and their classmates, using the combination of the classroom with virtual components, which allows to generate a learning experience superior to traditional training. Secondly, we must promote online socialization in this regard socializing and studying online go hand in hand, since it is easier to contact people with similar interests, objectives, goals and things in common, in addition to the fact of sharing a non-presential (virtual) training, in which geographical distance is not a negative factor. On the contrary, it becomes an identity that benefits the new community, since in online university environments, help and "tutoring" comes not only from the teacher, but also, and increasingly, from the virtual classmates themselves, who form their own group communities and are available at any time to help each other with homework, solve doubts, meet for teamwork and exchange information, as happens in a traditional and face-to-face model (Oyoyola Avalos et al., 2021).

As a third aspect, the exchange of information is a fundamental characteristic of teaching-learning, both in its face-to-face and online form. However, it acquires greater fluidity when it is carried out online. Professionals, teachers and researchers, as well as groups of students who have academic activities in a virtual environment under virtual community models, need to have a network for information exchange and an optimized communication flow. The fourth aspect is the construction of knowledge in the virtual modality, in the first place, it will be more dynamic and satisfactory as long as they are used correctly and in a collaborative way between teachers and students (Buitrago-Bohórquez & Sánchez, 2021).

The fifth is the development of autonomy as a fundamental characteristic in virtual teaching-learning. It is more about the student's ability to take charge of his or her own learning. As opposed to being dependent on the teacher, the learner assumes responsibility for his or her own learning path. In short, learner autonomy means giving the learner the opportunity to take charge of his or her own development. The new pedagogies encourage these current values and take advantage of innovation to stimulate and motivate students. But what is the process of problem-solving that enables students to acquire new knowledge? For some experts, the forms of knowledge acquisition by the subject are diverse,

but one of the most common and connatural is through problem solving, an important tool to face uncertainty in the search for solutions to problems (Díaz & Hernández, 2002).

**Dimension 3: Process of asynchronous non-face-to-face sessions**

The learning for virtual learning environments (EVA) is necessary to think about the development of the diversity of the student body, including its logistical possibilities. In this sense, it is convenient to follow guidelines that facilitate access to all students to our training experiences, developing a true inclusive digital teaching and not a simple transfer of content used in the classroom, which is what, unfortunately, most teachers at all levels have done when faced with a lack of digital culture content. The various e-learning platforms (LMS) have incorporated a wide range of technological tools and resources, which are increasingly used in the development of asynchronous virtual classes. It is important to note that the materials on the platform, such as the use of external videos, it is important to ensure that they have subtitles and especially to verify the validity of the URL of the video, to provide the recording with adequate lighting, to facilitate the presentation to students with didactic and multimedia devices, use of tutorials for the realization of digital documents and assignments, articles, books and chapters in PDF, especially if they are documents that have intellectual property rights, links to web resources and larger teaching documents that can be stored in the Google Drive system, the use of other resources and tools for virtual teaching-learning . Another element considered as an asynchronous activity is the tasks on the platform. Designing the tasks of a course or any learning experience in virtual environments requires reflection work that, in some cases, involves questioning the teachers' own beliefs (how they have been doing it) about the teaching and learning processes. The process of designing a course or a subject, at first, is not an easy task since, depending on different experiential or research approaches, different models have been developed to systematize this practice (Pimentel et al., 2023).

One of the asynchronous activities are the questionnaires considered as effective tools that have the virtual platforms (LMS), since it allows to generate a series of tests, exams, tests, etc. totally online. Although it is one of the most complex tools offered by the virtual learning space, it will be very useful when evaluating students both virtually and face-to-face. The quiz is an activity whose grade is automatically calculated. It serves the student as a self-evaluation and the teacher can use it to test the students on certain contents or as a continuous evaluation of the subject. They can be created with different types of questions, random questionnaires can be generated from batteries of questions, allows users to have multiple attempts and consult all stored results, another activity is the academic forum on the online platform, is one of the technological tools used in non-classroom education are virtual forums, the same that have become in many cases one of the favorite activities of teachers and students as their greatest virtue is the interaction through the so-called virtual classrooms or campus. The forum offers us the advantage that, being asynchronous, the student can better reflect on his answer, look for authors or references that support his position in case he does not have an extensive knowledge of the subject and pay more attention to the positions of his classmates, who are not always in favor of the subject initiated, in order to generate a more argumentative and pragmatic dialogue

**Dimension 4: Closing the session with evidence and products**

Closing activities aim to consolidate skills and competencies through academic products or evidence. According to Da Silva and Lima (2011), comprehension occurs so smoothly that we are not aware of the performance of our own schemas. In comprehension, the ability to elaborate a schema that accounts for the relationships between the different elements is critical. Using the schema highlights the fact that more than one interpretation of a text or topic is possible. The second strategy is cases as evidence in this context, "evidence" refers to something empirical and not theoretical (Molina and Sequeira, 2004). Thus, the case study method is a strategy that brings several advantages in terms of interactivity, as well as the creation of attractive content. Moreover, the case method promotes the development of complex thinking skills, as it presents complex data and information that requires serious and deep reflection on the topic of ethics and related concepts.

The third strategy is the reports as evidence oriented in the evaluation carried out by expert working groups and offers a complete and contrasted overview of the object of study and facilitates the dissemination of the evidence to the rest of the scientific community and professionals of evidence-based clinical practice. The reports as evidence are elaborated to serve as a tool to help professionals and groups involved in the evaluation and positioning of a subject in question. The elaboration of the synthesis report requires delimiting and making explicit the evaluation process, guaranteeing scientific rigor and methodological quality. These reports are a decision-making tool used in activities related to evidence-based scientific practice.

At the educational level, the report is used as a tool to assess student competencies and knowledge acquisition. Hence, the abundant student evaluation reports that each university implements. This tool is used with greater

emphasis at the virtual level. Its objective is to make known various actions and conditioning factors that occur in a given environment, which will allow to take and develop appropriate actions (Hernández et al., 2021).

Another important strategy is Project Based Learning as Evidence (ABPE) considered as a methodological strategy of design and programming that implements a set of tasks based on the resolution of questions or problems (challenges), through a process of research or creation by students who work in a relatively autonomous context and with a high level of involvement and cooperation among them, culminating in a final product that is presented (or disseminated) to all the others. The global situation of education involves continuous change, which implies educating from uncertainty through experiential situations and building shared knowledge generated from interaction to which is added the promotion of autonomy on the part of students at the time of doing their part of the project. Perhaps this is the key to its success and its expansion as a model that is being used by many teachers in various universities around the world. Relevant and sustainable learning is developed through cultural exchange with the shared creation of culture in multiple directions to implement a more active education focused on "know-how" (Sanguineti, 2023).

Therefore, the validation of an instrument that measures didactics in digital environments is important to ensure the ability to collect reliable data that reflect the reality of university students. A valid and reliable instrument allows generating generalizable and comparable results in different educational contexts. For Martínez & Prendes, (2021) it is in digital education, where interactions and pedagogical strategies are mediated by technologies, and the validation of an instrument ensures that key factors related to people's learning are considered. In addition, a process that includes content analysis, validity and reliability, contributes to the development of effective educational models that improve the quality of teaching and learning processes (García-Peñalvo et al., 2019).

## 3. Method

### *3.1 Design*

The research was of a non-experimental cross-sectional type, because it describes the variables without manipulation because the psychometric particularities of a tool will be determined (Sánchez and Reyes 2003). According to the intention and analysis the instrumental design will be used. (Hernández et al., 2014) since a series of procedures and techniques will be followed to store and study all relevant information, allowing to achieve the purposes of the exploration.

### *3.2 Participants*

A total of 379 students from Peruvian public universities located in Lima and in the interior of the country participated in this study. The instrument called Development of the non-attendance class session was applied to this population of students in order to assess reliability using the split-half and internal consistency methods, well as to evaluate the validation of the instrument using the Exploratory and Confirmatory Factor Analysis method.

### *3.3 Instrument*

The instrument called "Development of the non face-to-face class session", is a virtual questionnaire of self-recording that was applied to university students, initially had 4 dimensions D1: Frequent activities (5 items), D2: Process of the synchronous non face-to-face sessions (14 items), D3: Process of asynchronous non-face-to-face sessions (10 items) and D4: Closing of the session with evidences and products (4 items), all items under the Likert scale (1: Never, 2: Almost never, 3: Sometimes, 4: Almost always, 5: Always) validated by expert judgment.

### *3.4 Procedure and Data Analysis*

The first analysis was the Exploratory Factor Analysis, and with the purpose of contrasting the model, the Confirmatory Factor Analysis was developed, using AMOS23 for SPSS. Multiple indicators were used to evaluate the model fit (Hu & Bentler, 1995). Chi-square was used on the degrees of freedom (CMIN/DF), the comparative fit index (CFI), the global goodness of fit index (GFI) and the root mean squared error of approximation (RMSEA).

Two confirmatory analyses were performed in the study, one for the initial model and the other for the final model. The CFA was determined to corroborate the relevance of each item to the components found in the exploratory factor analysis, which proposes 4 components.

### *3.5 Ethical Aspects*

This study had the necessary ethical aspects for all research, guaranteeing respect for the rights of the participants and scientific integrity. Informed consent was used, ensuring that they understood the purpose, procedures, benefits, as well as their right to withdraw at any time without consequences. In addition, the confidentiality and anonymity of the data

collected was guaranteed. Finally, all investigators maintained transparency in the reporting of results, avoiding any form of falsification or bias.

## 4. Results

### *4.1 Reliability of Instruments using the Split-Half Method*

The total items of the instrument were divided into two parts and the results were then compared; the coefficients used were Pearson's correlation and Cronbach's alpha.

**Table 1.** Reliability Through the Test of Two Halves

| *Pearson's correlation in split halves* | | Sum of Pairs |
|---|---|---|
| Odd Sum | Pearson correlation | 0,954** |
| | Sig. (bilateral) | 0,000 |
| | N | 379 |

**. Correlation is significant at the 0.01 level (bilateral).

In Table 1, Pearson's correlation coefficient (0.954) indicates that the instrument has a very high reliability, with a high relationship between the sum of the even-numbered items and the sum of the odd-numbered items.

**Table 2.** Reliability to Split-Half Statistics with Guttman's Test

| **Statistical reliability of two halves** | | | |
|---|---|---|---|
| Cronbach's alpha | Part 1 | Value | 0,947 |
| | | N of elements | 17[a] |
| | Part 2 | Value | 0,947 |
| | | N of elements | 16[b] |
| | Total N of elements | | 33 |
| Correlation between forms | | | 0,873 |
| Spearman-Brown Coefficient | Equal length | | 0,932 |
| | Uneven length | | 0,932 |
| Guttman coefficient of two halves | | | 0,932 |

a. The elements are: P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17.

b. The elements are: P18, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28, P29, P30, P31, P32, P33.

Table 2 shows the Cronbach's Alpha coefficients for both parts (0.947) indicating that it is highly reliable. Along with this there is also a high correlation (0.873) between the parts, even a higher correlation (0.932) between equal and unequal length, finally ratified by the Guttman coefficient (0.932).

### *4.2 Reliability of the Instruments by Means of Internal Consistency Mean*

The Cronbach's Alpha coefficient was applied, reaching a value of 0.97, indicating that it is also a highly reliable instrument. In this section it can be seen that if item P10 were eliminated, the Cronbach's Alpha coefficient would reach a value of 0.971.

### *4.3 Validity of the Instrument by Means of Exploratory Factor Analysis*

Complying with data normality, homoscedasticity and multicollinearity, the KMO (Kaiser-Meyer-Olkin) and Bartlett's test were used:

**Table 3.** Sampling Adequacy with KMO and Bartlett's Test

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin measure of sampling adequacy | | 0,966 |
| Bartlett's test for sphericity | Approx. chi-square | 9240,108 |
| | Gl | 528 |
| | Sig. | 0,000 |

Table 3 shows the KMO coefficient (0.966), which indicates a very good model fit value, and Bartlett's test of sphericity showed statistical significance (0.000). These analyses allow us to continue with the Factor Analysis.

The analysis of total variance explained for each of the 33 items found 4 components that describe up to 63.183% of the total variance, component 1 explains 17.899% of the variance, component 2 17.122%, component 3 14.972% and component 4 13.190% of the variance.

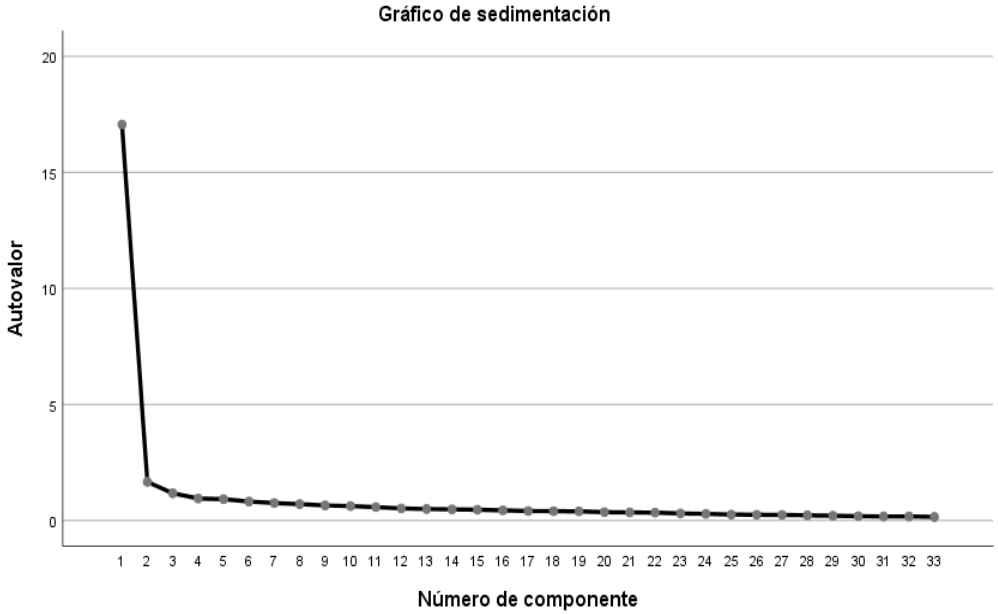


**Figure 1.** Sedimentation of Total Explained Variance

Figure 1 shows the break point in the percentage of variance, which occurs from component 2 onwards, with the value decreasing more and more. In addition, the values of the communalities were analyzed; item P6 shows a very low coefficient (0.294) being a candidate for extraction, since it shares only 29.4% of the common variance with the other items.

The following analysis carried out includes the values in the rotated component matrix, through the extraction method of principal component analysis, and the rotation method as Varimax with Kaiser normalization, finding convergence in 11 interactions. Likewise, in Table 4, items P6, P7, P9, P17 and P 23 that were found in more than one component were eliminated, the final result is shown below:

**Table 4.** Rotated Component Matrix

| original items | Selected items |
|---|---|
| P1 | C2 |
| P2 | C2 |
| P3 | C1 |
| P4 | C2 |
| P5 | C1 |
| P6 | Deleted |
| P7 | Deleted |
| P8 | C2 |
| P9 | Deleted |
| P10 | C2 |
| P11 | C2 |
| P12 | C3 |
| P13 | C2 |
| P14 | C1 |
| P15 | C1 |
| P16 | C1 |
| P17 | Deleted |
| P18 | C1 |
| P19 | C1 |
| P20 | C1 |
| P21 | C1 |
| P22 | C1 |
| P23 | Deleted |
| P24 | C3 |
| P25 | C3 |
| P26 | C3 |
| P27 | C3 |
| P28 | C3 |
| P29 | C1 |
| P30 | C4 |
| P31 | C4 |
| P32 | C4 |
| P33 | C4 |

Table 5 allows us to conclude that initially the instrument was made up of 33 items, after the analysis of the rotated component matrix, the final instrument would be composed of 28 items organized by 4 components or dimensions. The first dimension ***frequent activities or identified as starting moment*** with items (P12, P13, P14, P15, P16, P17), second dimension ***execution of synchronous sessions*** (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11), third dimension ***monitoring of asynchronous activities*** (P18, P19, P20, P21, P22, P23, P24) and the fourth dimension ***evaluation of the session with evidence or products*** (P25, P26, P27, P28).

**Table 5.** Final Recoded Items or Reagents

| Recoded items - FINAL | |
|---|---|
| C1-P3 | P1 |
| C1-P5 | P2 |
| C1-P 14 | P3 |
| C1-P 15 | P4 |
| C1-P 16 | P5 |
| C1-P18 | P6 |
| C1-P19 | P7 |
| C1- P20 | P8 |
| C1-P21 | P9 |
| C1-P22 | P10 |
| C1-P29 | P11 |
| C2-P1 | P12 |
| C2-P2 | P13 |
| C2-P4 | P14 |
| C2-P8 | P15 |
| C2-P10 | P16 |
| C2-P11 | P17 |
| C2-P13 | P18 |
| C3-P12 | P19 |
| C3-P24 | P20 |
| C3-P25 | P21 |
| C3-P26 | P22 |
| C3-P27 | P23 |
| C3-P28 | P24 |
| C4-P30 | P25 |
| C4-P31 | P26 |
| C4-P32 | P27 |
| C4-P33 | P28 |

*4.4 Validity of the Instrument by Confirmatory Factor Analysis*

The CFI comparative fit index (0.905) indicates that the model has an adequate fit, as does the TLI index (0.896), which expresses the proportion of the variance explained by the factorial model, indicating that the model still needs to be improved with components considered. In addition, the root mean square approximation index RMSEA (0.072) was found to require an improvement in the model. Another index that should be paid attention to is the AIC information criterion index, which is used to compare models; the model with the lowest value is better (see Figure 3).

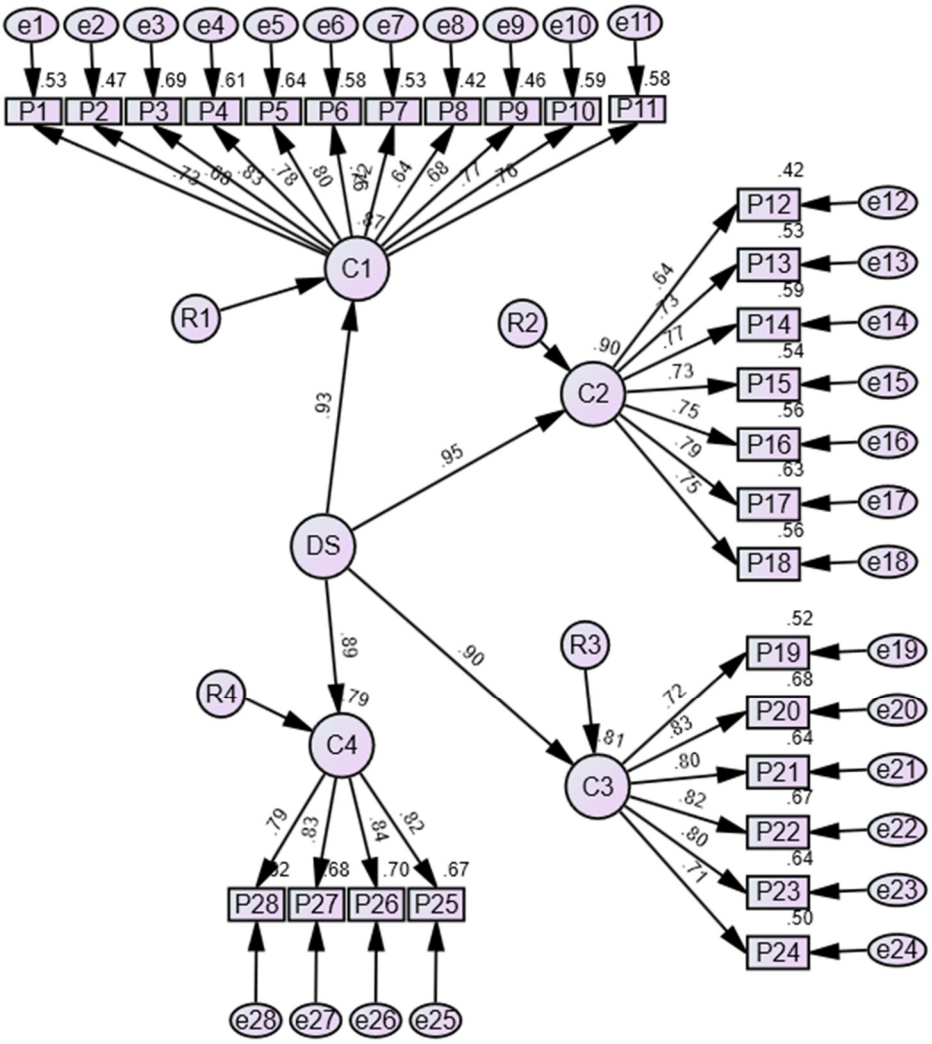


**Figure 3.** Model of the Online Classroom Development instrument

For the improved model, one or more analyses are again performed in search of better values with respect to the first model; the results of the improved model are shown below (see Table 6)

**Table 6.** Comparative Aspects of the Parameters in the Adjustment of the Models

| Model | Absolute adjustment measures | | Incremental adjustment measures | | | Parsimony adjustment measures | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Statistician** | **Chi-square** | **RMSEA** | **IFC** | **TLI** | **NFI** | **PRATIO** | **PCFI** | **PNFI** | **AIC** |
| **Model1** | **0.000** | **0.072** | **0.905** | **0.896** | **0.864** | **0.919** | **0.831** | **0.793** | **1287.708** |
| Model 2 | 0.000 | 0.071 | 0.906 | 0.897 | 0.867 | 0.915 | 0.829 | 0.794 | 1239.76 |

After this confirmatory factor analysis, the items that will make up the final instrument are established and it is composed of 4 organized components (see table 7).

**Table 7.** Final Instrument: Items after Validity and Reliability

| | **Components to evaluate the development of online sessions** |
|---|---|
| | *Frequent activities* |
| 12 | The teacher monitors student attendance through class participation using technological resources (videoconferencing, virtual classroom, social networks, apps, internal applications, etc.). |
| 13 | The teacher uses technological resources (videoconference, virtual classroom, videos, audios, infographics, maps, etc.) to awaken interest before beginning the explanation of the topics to be covered. |
| 14 | The teacher uses various strategies to maintain interest and constant attention (telling anecdotes, breaking the monotony of the monologue, encouraging participation, debate, etc.), making use of digital resources or tools. |
| 15 | The teacher investigates the student's previous learning through *brainstorming*, using the videoconferencing platform and other virtual tools. |
| 16 | The teacher's exploration of previous knowledge through digital tools is related to the topic to be covered. |
| 17 | The teacher uses virtual materials and tools that are consistent with the course syllabus. |
| | *Execution of synchronous sessions* |
| 01 | The teacher promotes interaction among students through interaction channels (online chat, video calls, online tutorials, etc.) to solve situations or exercises related to the subject. |
| 02 | The teacher proposes the exchange of information among students for the completion of the assigned tasks online, using different virtual tools. |
| 03 | During the implementation of an educational strategy, the teacher assigns clear roles to each member of the group, using the videoconferencing platform and other digital tools. |
| 04 | The teacher creates online forums, questions-answers, which require the student to make summaries and comments through online tools. |
| 05 | The teacher explains the theoretical aspects clearly using different strategies and virtual tools. |
| 06 | The teacher uses educational strategies that allow the student to apply or practice the acquired knowledge in real situations presented through virtual environments. |
| 07 | The teacher presents videos, links and other resources and their evaluation rubrics, which allow the consolidation of online learning. |
| 08 | The teacher promotes practical activities and social interaction, using virtual tools to strengthen thinking. |
| 09 | The teacher assigns work in which the student leads discussions and debates, using digital tools. |
| 10 | The teacher promotes activities that allow group and individual reflection on video conference platforms. |
| 11 | The teacher presents problematic situations and case studies that allow students to transfer what they have learned to real contexts through virtual environments. |
| | *Monitoring of asynchronous activities* |
| 18 | The teacher shares sources of mandatory and complementary information on the topics to be covered located on the platform. |
| 19 | The resources and activities that the teacher places in the digital platform are clear and concise. |
| 20 | The teacher schedules the questionnaires through the online platform according to the subject matter. |
| 21 | The teacher schedules the online forums related to the topic according to the syllabus. |
| 22 | The teacher reviews and gives feedback on the virtual forums, commented by the students. |
| 23 | The teacher student participation in the virtual forums and provides feedback. |
| 24 | The teacher evaluates the points of view according to the topics covered on the virtual platform. |
| | *Evaluation of the session with evidence* |
| 25 | The teacher assigns the elaboration of diagrams using virtual resources for the consolidation of learning. |
| 26 | The teacher provides a situation for the resolution of cases that allows the consolidation of learning through virtual environments. |
| 27 | The teacher assigns the elaboration of reports of the tasks performed to allow the consolidation of learning. |
| 28 | The teacher assigns the development of projects through virtual environments for the consolidation of learning. |

## 5. Discussion

The objective of this research was to demonstrate the psychometric properties of an evaluation instrument to measure the development of online sessions in the context of teaching and learning, identifying indicators that reflect the effectiveness of learning sessions in virtual environments. The sample of 379 students from fourteen Peruvian universities provided a solid basis for evaluating the validity and reliability of the instrument, allowing the generality of the results.

The exploratory factor analysis (EFA) evidenced a robust structure. The structural validity was supported by the factor analysis, the KMO indexes and Bartlett's test indicated appropriate data for this type of analysis and the varimax rotation facilitated the interpretation of the factors with a clear grouping of the dimensions. The literature supports the importance of considering integrating synchronous and asynchronous sessions within virtual learning environments (Arango-Vásquez & Manrique-Losada, 2023; Reyes-Zambrano & Vegas-Meléndez, 2024).

The **confirmatory factor analysis** (CFA) made it possible to compare two models to determine the best indicators of fit, demonstrating that the instrument is capable of specifying that the dimensions and items of each factor are significantly correlated. This type of analysis makes it possible to identify the essential function of constructs in educational psychometrics, offering a stricter and more quantifiable validation (Chávez et al., 2022; Hernández-Suarez et al., 2024).

The analysis of the items provided information on the nature of online teaching and learning activities. One of the key indicators found refers to the execution of synchronous sessions, the monitoring of asynchronous activities and the evaluation through evidence of learning. The evaluation of products allows a more tangible and direct measurement of learning outcomes, aligning with contemporary pedagogical approaches that prioritize performance-based evaluation (Gilma et al., 2021; Pavié et al., 2022; Valenti, & Duarte, 2022).

Regarding the reliability of the instrument, they confirmed a high internal consistency of the questionnaire. These results are consistent with previous studies that highlight the importance of high reliability to ensure the accuracy of measurements in the educational context (Martínez & Nevárez, 2021; Gallardo-Echenique et al., 2023). These indicators suggest that the instrument is reliable and capable of consistently measuring the proposed dimensions, which is essential for the validation of any educational tool.

The psychometric evidence of this instrument has practical implications for the field of higher education. First, it provides a useful tool for teachers to assess the effectiveness of their online pedagogical practices, with a particular focus on interaction, monitoring and evaluation of student learning. It can also be used to make adjustments to the structure of online learning sessions. This type of research establishes a solid foundation for future longitudinal studies analyzing the evolution of didactics in digital environments. Future opportunities will allow the development of versions adapted to the context of inclusive education or learning using artificial intelligence, as well as the integration of mixed methodologies.

This research has some limitations. The sample was limited to university students in Peru, so it would be necessary to replicate the study in different cultural and educational contexts to assess the generalizability of the results. In addition, although the instrument showed high reliability and validity, the evaluation focused only on psychometric characteristics; future studies could explore performance on the instrument with other variables of interest.

## 6. Conclusions

Initially the instrument was made up of thirty-three items, after the analysis of the rotated component matrix the final instrument would be composed of twenty-nine items organized by four components. The first component called frequent activities or identified as starting moment with twelve items, second, execution of synchronous sessions with seven items, third, follow-up of asynchronous activities with six items and evaluation of the session with evidences or products with four items.

The validity of instruments and reliability of the items, first, went through the content validity through expert judgment for the reliability was used the method of split halves with Pearson's correlation (0.954), Cronbach's alpha for both parts (0.947) and that the instrument is highly reliable. In addition, there is also a high correlation (0.873) between the parts, including a higher correlation (0.932) between equal and unequal length, which is finally ratified by the Guttman coefficient (0.932).

Two models were tested to compare the best indicators and approved in the four-component model through the exploratory factor analysis according to the Kaiser-Meyer-Olkin (KMO) contrast and Bartlett's test, the rotation

method for convergence with Varimax with Kaiser normalization, as well as the confirmatory factor analysis through the AMOS23 tool.

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