Psychometric properties of a scale to measure online teaching styles in university teachers

Propiedades psicométricas de una escala para medir estilos de enseñanza en línea en docentes universitarios

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Abstract

Teaching styles are related to students' academic engagement and motivation. They significantly influence their satisfaction and perception of the online learning process. This highlights the need for psychometrically robust instruments that reflect the particularities of online education environments. The literature review showed that there are multiple scales on teaching styles designed for face-to-face contexts; however, there are limited specific proposals for virtual environments. The study aimed to analyze the psychometric properties of a scale designed to measure online teaching styles (OTS) in university teachers. A total of 240 teachers participated, completing a 28-item scale organized into four dimensions (designer, corrector, mediator, and facilitator) and evaluated with a five-point Likert scale. Content validity was established by a judgment of three experts, obtaining a content validity index (S-CVI) of .99. Confirmatory Factor Analysis (CFA) showed a satisfactory fit for a 16-item scale (CFI=.97, TLI=.96, RMSEA=.03), confirming the four theoretical dimensions. In addition, evidence of factorial invariance between sexes was found. Cronbach's alpha and McDonald's omega coefficients ranged between .67 and .71 (.84 overall), reflecting acceptable internal consistency. In conclusion, a scale with solid evidence of validity and reliability is presented, which positions it as a useful tool to evaluate online teaching styles and contribute to the improvement of pedagogical practices in digital environments.

Keywords: online education, teaching styles, university teachers, measurement, validity.

Resumen

Los estilos de enseñanza se relacionan con el compromiso académico y la motivación de los estudiantes, e influyen de forma significativa en su satisfacción y su percepción sobre el proceso de aprendizaje en línea. Esto destaca la necesidad de contar con instrumentos psicométricamente robustos, que reflejen las particularidades de los entornos de educación en línea. La revisión de

literatura mostró que existen múltiples escalas sobre estilos de enseñanza diseñadas para contextos presenciales; sin embargo, son limitadas las propuestas específicas para ambientes virtuales. El objetivo del estudio fue analizar las propiedades psicométricas de una escala diseñada para medir los estilos de enseñanza en línea (EEL) en docentes universitarios. Participaron 240 docentes, quienes completaron una escala de 28 ítems organizada en cuatro dimensiones (diseñador, corrector, mediador y facilitador) y evaluada con una escala Likert de cinco puntos. La validez de contenido fue establecida mediante un juicio de tres expertos, obteniendo un índice de validez de contenido (S-CVI) de .99. El Análisis Factorial Confirmatorio (AFC) mostró un ajuste satisfactorio para una escala de 16 ítems (CFI=.97, TLI=.96, RMSEA=.03), confirmando las cuatro dimensiones teóricas. Además, se encontró evidencia de invarianza factorial entre sexos. Los coeficientes alfa de Cronbach y omega de McDonald oscilaron entre .67 y .71 (.84 global), reflejando consistencia interna aceptable. En conclusión, se presenta una escala con evidencias sólidas de validez y fiabilidad, lo que la posiciona como una herramienta útil para evaluar los estilos de enseñanza en línea y contribuir al mejoramiento de las prácticas pedagógicas en entornos digitales.

Palabras clave: **educación en línea, estilos de enseñanza, docentes universitarios, medición, validez.**

INTRODUCTION

Teaching styles refer to the set of beliefs, values, attitudes, and skills that teachers employ in the educational process. These styles combine ideas, techniques, and teaching methods that provide coherence and consistency to teaching work and influence how teachers present content, interact with students, assign tasks, monitor progress, and guide learning (González-Peiteado et al., 2012; Grasha, 1994; Laudadío, 2012). In the field of online education, Lozano-Rodríguez and Flores-Fahara (2010) describe online teaching styles (OTS) as the behavioral patterns that teachers exhibit during their educational activities, involving aspects related to instructional design, task correction, pedagogical mediation, and learning facilitation, all framed within interactions carried out through digital platforms.

The study of OTS is particularly relevant in a context where virtual education has experienced accelerated growth (Leino et al., 2024), driven both by advancements in digital technologies and the need to adapt to new teaching modalities, especially after the COVID-19 pandemic, which forced educational institutions to transition to virtual environments (Arenas-Martinez & Ramírez-Martinez, 2024). Additionally, it is important to analyze how technology has been incorporated into teachers' professional development (Soussi, 2020).

Various studies have linked teaching styles to variables such as academic achievement and engagement, motivation, satisfaction with online teaching, perceived learning, and the types of skills developed by students (Bartholomew et al., 2018; Franker, 2016; Hidalgo-Cabrillana & Lopez-Mayan, 2018; Shaari et al., 2014; Zante & Klasen, 2021). They have also connected teaching styles to teachers' epistemological beliefs (Soleimani, 2020), their competencies, sense of self-efficacy, and commitment (González et al., 2018).

Moreover, it has been found that teaching styles not only influence students' academic performance but also significantly affect their perception of the online learning process (Vikas & Mathur, 2022). Additionally, authors such as Kebritchi et al. (2017) indicate that some of the issues associated with online education are related to the teaching styles adopted by educators. In this sense, understanding OTS is important for contributing to the improvement of teaching and learning quality in digital educational environments (Noguez Ortiz, 2024; Wang et al., 2024), recognizing that the transition between modalities (face-to-face to virtual) impacts teachers' pedagogical practices (El-Soussi, 2022).

There are significant differences between face-to-face and online teaching style models. The most relevant ones are related to teacher-student interaction, as in face-to-face teaching, instructors can directly engage with students, managing time and space differently than in virtual environments (Silva, 2017). Teaching occurs without intermediaries. On the other hand, in virtual settings, a technological interface exists between the teacher and students. The efforts of the teacher to instruct students are not always synchronous, meaning that teaching can occur at different times. This requires students to develop greater self-regulation and time management skills to participate and remain engaged in a virtual course (Silva-Vera et al., 2023).

Measurement of online teaching styles

The assessment of teaching styles in online education has required the creation and adaptation of specific instruments that reflect the particularities of this environment. In this regard, the Grasha-Riechmann Teaching Style Inventory (GRTSI) proposed by Grasha (1996) and the Teaching Style Inventory in Higher Education (TSIHE) developed by Abello et al. (2020) are the most refined instruments for evaluating teaching styles in digital environments (Abell et al., 2016; Malay et al., 2024; Malay et al., 2022; Sanje & Varnali, 2014).

These scales allow for identifying the prevalence of styles such as facilitator, delegator, or student-centered approaches and their impact on variables like student engagement and academic success in online education

contexts. However, they do not precisely capture the specific dynamics that emerge in technology-mediated educational interactions, as they were not developed for that purpose.

The literature review reveals a significant number of studies on teaching styles in face-to-face contexts, reporting the psychometric properties of various scales and a wide range of approaches (Table 1). These studies employ both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), as well as internal consistency analysis to assess the scales, providing robust evidence of their validity and reliability (Abello et al., 2020; Arbabisarjou et al., 2020; Espada et al., 2019; Hurriyetoglu & Kilicoglu, 2020; Merino-Barrero et al., 2017). However, this highlights a significant gap in studies focused on analyzing the psychometric properties of scales designed specifically for digital environments.

Table 1
Studies analyzing the psychometric properties of teaching style scales for face-to-face environments

Author	Method of Analysis	Validity Evidence	Dimensions
Arbabisarjou et al. (2020)	Confirmatory Factor Analysis (CFA) and Internal Consistency.	AFC: RMSEA = .075, 90% CI, GFI = .74; Reliability: dimensions α = .68 – .75, full test α = .72	Formal authority, personal model, facilitator, and delegator.
Abello et al. (2020)	Confirmatory Factor Analysis (CFA) and Internal Consistency	AFC: χ^2 = 1284.13, df = 346, p < .001, χ^2/df = 3.7, TLI = 0.96, CFI = 0.96, RMSEA = 0.079; Reliability: ω = 0.94 - 0.96	Teacher-student interaction, decision-making negotiation, teaching structuring, behavior control
Hurriyetoglu & Kilicoglu (2020)	Confirmatory Factor Analysis (CFA) and Internal Consistency	AFC: RMSEA = 0.06, CFI = 0.95, NNFI = 0.93, NFI = 0.97, GFI = 0.95; Reliability: α = 0.88 (general), subfactors: 0.82 (visual), 0.76 (auditory), 0.65 (kinesthetic)	Visual, auditory, kinesthetic
Espada et al. (2019)	Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Internal Consistency	AFC: χ^2 = 3743.96; df = 1375; p = .000; χ^2/df = 2.72; RMSEA = 0.07; Reliability: α = .78	Direct instruction, practice, reciprocal teaching, self-evaluation, inclusion, guided discovery, problem-solving, individualized, student-initiated, free exploration, self-teaching
Merino-Barrero et al. (2017)	Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Internal Consistency	AFC: χ^2 = 200.41; df = 158; p = 0.013; χ^2/df = 1.26; IFI = 0.94; CFI = 0.93; TLI = 0.92; RMSEA = 0.04; Reliability: α = .79	Traditional, individualizing, participatory and socializing, cognitive and creative
Batista et al. (2015)	Exploratory Factor Analysis (EFA) and Internal Consistency	Reliability: α = .70	Dynamic, analytical, systematic, and practical
González-Peiteado et al. (2012)	Exploratory Factor Analysis (EFA) and Internal Consistency	Reliability: α = .89	Reflective, cooperative, academic, individualizing, innovative, investigative
Laudadío (2012)	Exploratory Factor Analysis (EFA) and Internal Consistency	Reliability: α = .81	Teacher-centered and student-centered

Leung et al. (2003)	Exploratory Factor Analysis (EFA) and Internal Consistency	Reliability: α = .73-.83	Assertive, suggestive, collaborative, facilitator

Note: α = Cronbach's Alpha, ω = McDonald's Omega

One of the gaps identified in the specialized literature is that teaching styles have not been thoroughly studied from a virtual or online perspective. Although Vieira Barros et al. (2008) classified and identified four styles of virtual space usage, they did not specify whether these were from a learning or teaching perspective, leaving the possibility open. In this regard, García-Aranda et al. (2017) revisited the styles of virtual space usage to focus on high school teachers, aiming to improve teaching-learning processes in virtual environments. Along the same lines, studies were also found that applied face-to-face teaching style instruments to virtual or online environments (Deseo et al., 2024; Rakha, 2023).

In the documentary research, only three instruments specifically developed to analyze online teaching styles were identified. The first, developed by Arslan et al. (2014), was designed based on the literature on teaching styles and consists of four dimensions: designer, evaluator, innovator, and facilitator. The second and third, proposed by Mori et al. (2023) and Romero-Félix (2023), were based on the theoretical model of online teaching styles by Lozano-Rodríguez and Flores-Fahara (2010), who established a construct with four dimensions: designer, assessor, mediator, and facilitator.

However, the reviewed information highlights some limitations:

a. Two of the three instruments identified for analyzing online teaching styles (OTS) do so only at an exploratory level (Arslan et al., 2014; Mori et al., 2023), while one does so at a confirmatory level (Romero-Félix, 2023). Therefore, further studies are needed to contribute to the analysis of the proposed structures, as validity and reliability analysis of these instruments is essential to ensure they accurately measure what they intend to assess (Valdés-Cuervo et al., 2019).
b. The study by Arslan et al. (2014) analyzes the psychometric properties of its scale based on a pilot test with 39 teachers, whereas Mori et al. (2023) conducts the study from the perspective of students. Thus, the only instrument providing more validity evidence specifically for university teachers is the proposal by Romero-Félix (2023). However, this last scale is based on preferences rather than observable actions.
c. No studies were found that examine measurement invariance by gender. However, research has indicated that men and women may have different pedagogical approaches in teaching practice (Arabit García et al., 2021; Navarro-Patón et al., 2020). Therefore, invariance analysis is key to ensuring the comparability of measurements between genders (Krosnick & Presser, 2010).
d. No studies were found that analyze concurrent validity, an important aspect for evaluating the extent to which the instrument's scores correlate with other scales measuring similar or theoretically related constructs (American Educational Research Association et al., 2014).
e. No robust studies on online teaching styles in Mexico were found that provide information on their psychometric properties.

Concurrent validity

To ensure concurrent validity, it is essential to analyze the relationship between the OTS scale and other theoretically related constructs. In this case, subjective happiness was selected as the reference variable, defined as the habitual experience of positive emotions (Lyubomirsky et al., 2005), and considered an indicator of teachers' quality of life, which influences their willingness to teach and interact positively with students (Chan, 2009).

Previous studies have demonstrated that teachers' emotions impact their behavior (Frenzel, 2014), their teaching styles (Burel et al., 2021), and the roles they perform in the educational field (Yirci et al., 2018). These relationships allow for analyzing concurrent validity by exploring the connection between subjective happiness and the OTS scale.

Theoretical model

The theoretical framework was based on the proposal by Lozano-Rodríguez and Flores-Fahara (2010), who developed a model examining the relationship between teachers' experiences in their online classes and five philosophical approaches grounded in Zinn's theory (2004): behavioral, liberal, progressive, humanistic, and radical. This model identified four teaching styles based on university teachers' perceptions of online teaching strategies, operating under the assumption that teaching styles are not fixed but adapt to instructors' needs, personalities, and preferences (Sternberg, 1997). The four styles are described below:

Designer: An innovative and adaptable educator focused on students' ethical and pragmatic development. They prioritize activities tailored to students' needs, communicate through forums, and employ humanistic and progressive educational methods. They adjust their teaching design based on student feedback.

Corrector: A teacher who emphasizes excellence and task structure, promotes interaction through forums and synchronous communication. Their approach aligns with behaviorism and liberal arts, fostering clear and empathetic communication and structural adaptability.

Mediator: A humanist educator who emphasizes student trust and conflict resolution through negotiation and the common good. They promote social justice and use online forums to interact with students. Their teaching style is collaborative and adaptive, with constructive feedback.

Facilitator: A teacher who recognizes each student as unique in their development. They offer personalized guidance and counseling, balancing support with independence, valuing both human aspects and task completion. They use synchronous tools and interactive forums, guiding students with progressive and liberal arts principles, complemented by various pedagogical methods and formative assessment processes.

This theoretical model guides the analysis of teaching styles in an online education context, considering the use of technology as the foundation of the educational process, the different types of interaction and communication (synchronous or asynchronous) that occur in a virtual learning environment, and the model's development from the perspective of university faculty.

Based on this model, Romero-Félix (2023) initially designed a 32-item scale, later reduced to 12 items after validity and reliability analysis. However, a review of the instrument revealed that the item wording was oriented toward teacher preferences and that the Likert scale used had four points. Therefore, the instrument was revised and modified to shift the focus from preferences to observable actions to obtain more objective and precise data on teachers' behavior. Additionally, the Likert scale was changed to a five-point scale.

This adjustment was made considering that preference-based items, typically framed in terms of agreement or liking, are useful for measuring attitudes, beliefs, and internal dispositions (Ajzen, 2005). However, such constructs may not always correlate directly with actual behaviors (Krosnick & Presser, 2010). To achieve a more direct and reliable measurement of performance or everyday practices, it is preferable to use items that capture the frequency with which subjects perform observable and concrete actions (Podsakoff et al., 2003).

According to Bandura (1997), self-reported actions provide a more accurate way to assess behavior in specific contexts, allowing for more effective interventions in education. Thus, this transformation strengthens the questionnaire's validity by better reflecting real teaching practices (Furr, 2011). Additionally, using a five-point or higher Likert scale is recommended in psychometric literature, as it increases instrument sensitivity, captures finer response variations, and improves internal consistency (Lozano et al., 2008).

Therefore, this study proposes analyzing the psychometric properties of a scale designed to measure online teaching styles (OTS) in higher education faculties. To achieve this objective, the study includes content

validity analysis through expert judgment, internal structure validity evaluation using Confirmatory Factor Analysis (CFA) (Figure 1), measurement invariance analysis for both sexes, concurrent validity analysis, and reliability evidence assessment for the scale.

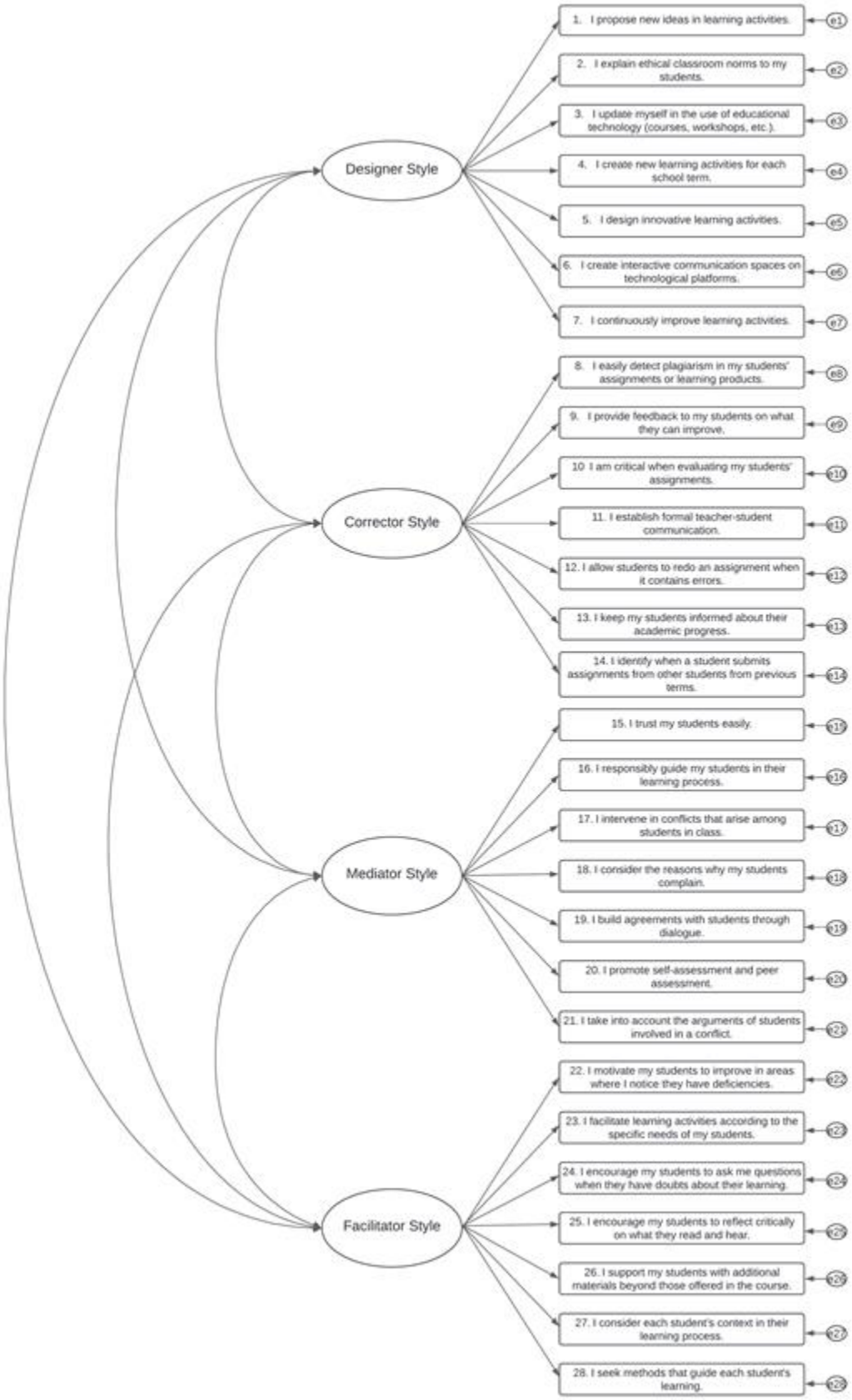

Figure 1
Theoretical model for measuring online teaching styles

METHOD

Participants

The study included 240 higher education teachers from a municipality in southern Sonora, Mexico. The sampling was conducted using a non-probabilistic convenience approach, and only teachers who had taught at least one online course in the years 2022 and 2023 participated. Of the participants, 48.8% (n = 117) were women, 49.5% (n = 119) were men, and 1.7% (n = 4) preferred not to specify. Their ages ranged from 25 to 75 years (M = 44.5 years, SD = 10.14). The average teaching experience was 15.8 years (SD = 9.4), while their experience teaching online courses averaged five years (SD = 4.78).

Instruments

Online teaching styles

The OTS instrument consists of 28 items with a five-point Likert-type response scale (0 = Never, 1 = Almost never, 2 = Sometimes, 3 = Almost always, 4 = Always), distributed across four dimensions with seven items each: designer style (e.g., I propose new ideas in learning activities); corrector style (e.g., I provide feedback to my students on what they can improve); mediator style (e.g., I responsibly guide my students in their learning process); and facilitator style (e.g., I support my students with additional materials beyond those offered in the course).

Subjective happiness

The adapted version of the Subjective Happiness Scale by Valdez (2022), originally proposed by Lyubomirsky and Lepper (1999), was used. This scale measures the overall perception of happiness through statements that participants evaluate personally or in comparison to others (e.g., In general, I consider myself very happy). The instrument consists of six items, assessed using a five-point Likert scale (0 = Strongly disagree, 1 = Disagree, 2 = Neither agree nor disagree, 3 = Agree, 4 = Strongly agree).

The CFA results indicate that the theoretical model fits the data well ($X^2 = 12.44$, df = 7, p = .087; SRMR = .03; AGFI = .95; TLI = .98; CFI = .99; RMSEA = .06, 90% CI [.00, .11]) (Blunch, 2013; Byrne, 2010; Valdés-Cuervo et al., 2019). Additionally, the scale demonstrated adequate reliability, with a McDonald's omega coefficient of .78 (Katz, 2006).

Procedure

Data collection

Authorization from the institutional ethics committee was requested to conduct the research, as well as permission from educational authorities for data collection. The administration of the instrument was carried out as follows: a) in person through a booklet applied in faculty cubicles and rest areas at two university campuses; b) via an online questionnaire distributed in academic WhatsApp groups; and c) by distributing the online questionnaire through institutional email. In all cases, an invitation to participate voluntarily in the research was extended, including a description of the study's objective and the informed consent.

Expert validity

To evaluate expert validity, the instrument was emailed to a group of nine research professors. Of these, only three responded: two men and one woman, all holding doctoral degrees and averaging 20 years of experience in the field of "Teaching Styles." The evaluation was conducted in four categories using twelve indicators: clarity (e.g., The item is clear), coherence (e.g., The item is fully related to the dimension it measures), relevance (e.g., The item is relevant and should be included), and sufficiency (evaluated by dimension, e.g., The items are suitable and sufficient).

The collected data were analyzed using the content validity index (CVI), which represents the proportion of experts rating the items as 3 or 4 on a four-point Likert scale (1 = Does not meet the criterion; 2 = Low level; 3 = Moderate level; 4 = High level), following the methodology of Almanasreh et al. (2019).

This approach establishes specific criteria based on the number of experts involved and evaluates the degree of agreement among them regarding each item using the individual content validity index (I-CVI) (Castillo Salcido et al., 2024). Additionally, the overall quality of the scale was assessed using the average scale content validity index (S-CVI/ave). To determine agreement among the judges, the following reference values were used: I-CVI equal to or greater than 0.78 for each item and S-CVI/ave equal to or greater than 0.90 for the complete scale (Polit et al., 2007).

The analysis revealed a high level of agreement regarding the validity of the instrument's items, with an I-CVI = 1 for all 28 items in the categories of clarity and sufficiency, 27 in relevance, and 26 in coherence. However, two items obtained an I-CVI of .67 in the coherence category and one in relevance, leading to modifications based on the evaluators' suggestions to retain them in the scale. Regarding the S-CVI/ave, the results showed values above .90 in all evaluated categories: .99 in relevance, 1 in clarity, .97 in coherence, and 1 in sufficiency. This confirmed the content validity of the OTS scale in its four dimensions (each consisting of seven items), with an average S-CVI of .99.

Data analysis

Normality of the data was assessed by calculating descriptive statistics (mean, standard deviation, skewness, and kurtosis) using SPSS software. Skewness values between -2 and 2 and kurtosis values between -7 and 7 were considered indicators of a normal distribution (Bandalos & Finney, 2019; Muthén & Kaplan, 1985). To evaluate the degree of fit of the data to the proposed theoretical model, a Confirmatory Factor Analysis (CFA) was conducted based on a pre-established model, allowing verification of the internal structure of the scale. Additionally, this analysis enabled the calculation of factorial invariance, which verifies whether the scale maintains its factorial structure across different population groups, ensuring measurement equivalence and valid comparisons between groups (Furr, 2022).

The Confirmatory Factor Analysis was performed using AMOS software, employing the Maximum Likelihood method and the Bootstrap method (500 repetitions, 95% CI) (Byrne, 2010; Hancock & Liu, 2012). The following goodness-of-fit indices were considered to evaluate the model's fit to the data: Chi-square with associated probability (X^2, $p > .001$), degrees of freedom ($df > 0$), root mean square residual (SRMR ≤ .05), adjusted goodness-of-fit index (AGFI ≥ 0.90), Tucker-Lewis index (TLI ≥ 0.90), comparative fit index (CFI ≥ 0.95), and root mean square error of approximation (RMSEA ≤ 0.08) (Blunch, 2013; Byrne, 2010; Valdés-Cuervo et al., 2019). JASP statistical software was used to calculate McDonald's omega reliability coefficients ($\omega \geq 0.65$) and Cronbach's alpha ($\alpha \geq 0.65$) to assess the reliability of the measures (Katz, 2006).

Concurrent validity analysis was conducted using Pearson's correlation between OTS scale scores and the subjective happiness measure, collected simultaneously. This approach was used to assess whether the OTS scale dimensions and overall score correlated with subjective happiness, verifying whether the scale measures constructs theoretically related to it (Furr, 2022). Correlations with a p-value < .01 were considered significant (Funder & Ozer, 2019). The analysis was performed using SPSS software. The correlations were interpreted to determine the magnitude and direction of the relationship, considering that positive and significant correlations would provide evidence of concurrent validity for the OTS scale.

To examine measurement invariance of the scale for male and female participants, several nested models were developed. Each model was progressively compared: the first model without restrictions (configural invariance), the second with restrictions on regression coefficients (metric invariance), the third with restrictions on factor loadings and intercepts (scalar invariance), and the fourth with restrictions on factor loadings, intercepts, covariances, and residual variances (residual invariance). Invariance indicators included ΔX^2 with $p > .001$, ΔCFI less than .01, and ΔRMSEA less than .015 (Blunch, 2013; Byrne, 2010).

RESULTS

Descriptive analysis

The descriptive analysis of the scale data allows us to observe that the responses of the teachers (n=240) tend to be "almost always," with a mean range from 2.9 points (Item 3, SD=0.99) to 3.72 points (Item 7, SD=0.53) (Table 2). Additionally, the skewness and kurtosis analysis suggests that the data exhibit behavior resembling normality (skewness +/-2, kurtosis +/-7) (Bandalos & Finney, 2019).

Table 2

Mean, standard deviation, skewness, and kurtosis of the OTS scale items

Items	*M*	*SD*	Skewness	Kurtosis
1. I propose new ideas in learning activities.	3.18	0.76	-0.42	-0.77
3. I update myself in the use of educational technology (courses, workshops, etc.).	3.43	0.73	-1.05	0.38
6. I create interactive communication spaces on technological platforms.	2.90	0.99	-0.52	-0.45
7. I continuously improve learning activities.	3.29	0.69	-0.61	-0.16
9. I provide feedback to my students on what they can improve.	3.56	0.56	-0.81	-0.38
10. I am critical when evaluating my students' assignments.	3.51	0.63	-1.13	1.16
11. I establish formal teacher-student communication.	3.72	0.53	-1.95	3.83
13. I keep my students informed about their academic progress.	3.51	0.63	-1.23	1.83
16. I responsibly guide my students in their learning process.	3.70	0.52	-1.49	1.32
17. I intervene in conflicts that arise among students in class.	3.06	1.00	-0.94	0.40
18. I consider the reasons why my students complain.	3.62	0.57	-1.17	0.38
21. I take into account the arguments of students involved in a conflict.	3.45	0.72	-1.39	2.44
23. I facilitate learning activities according to the specific needs of my students.	3.45	0.70	-1.12	0.76
26. I support my students with additional materials beyond those offered on the course.	3.43	0.71	-1.05	0.54
27. I consider each student's context in their learning process.	3.13	0.78	-0.44	-0.61
28. I seek methods that guide each student's learning.	3.12	0.82	-0.73	0.28

Note: *M* = Mean; *SD* = standard deviation; item numbering corresponds to the initial theoretical model.

Confirmatory Factor Analysis

The literature suggests that item factor loadings should be greater than .40. Therefore, during the analysis process, items that did not meet this criterion were removed, resulting in a final scale with four dimensions, each containing four items (Brown, 2015; Hair et al., 2010; Kline, 2016).

When conducting the CFA with the study sample (n = 240), the results demonstrated a good fit of the measurement model, confirming the theoretical structure (X^2 = 126.48, df = 98, p = .028; SRMR = .05; AGFI = .92; TLI = .96; CFI = .97; RMSEA = .03, 90% CI [.01, .05]). Factor loadings for each dimension ranged as follows: designer style, .59 - .68; corrector style, .44 - .70; mediator style, .51 - .67; and facilitator style, .46 - .80, all of which were significant (p < .001). Correlations between dimensions ranged from .54 to .63 (Figure 2).

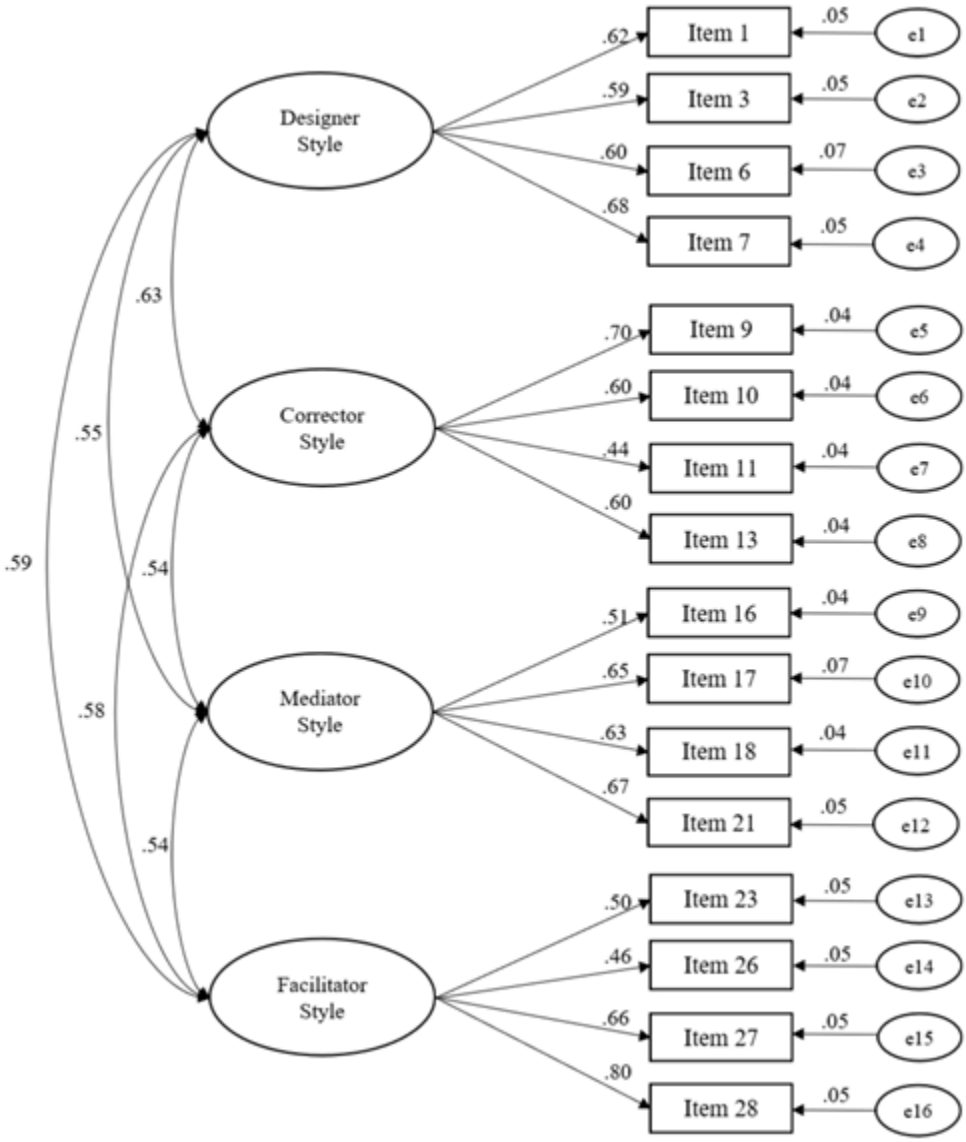

Figure 2
CFA results for the model measuring online teaching styles

Measurement invariance by gender

The findings of the multi-group analysis indicate that the factorial model maintains its invariance for the compared groups, as the fit indices demonstrate that the baseline model retains a similar factorial structure for both groups (X^2 = 279.85, df = 196, p = .000; SRMR = .08; CFI = .91; TLI = .88; RMSEA = .04, 90% CI [.03, .05]). When factor loadings were constrained to be equal across groups (metric invariance), the differences in CFI and RMSEA values were less than .01 and .015, respectively, suggesting the presence of metric invariance. When additional constraints were applied to intercepts across groups (scalar invariance), no significant differences were found in CFI and RMSEA values. Similarly, when comparing the baseline model with the residual invariance model, the values also met the equality criteria (Table 3).

Table 3
Goodness-of-fit indices for invariance models

Measure	Model	X^2	*df*	ΔX^2	*Δdf*	*p*	*ΔCFI*	ΔRMSEA
Online Teaching Styles	M1 Configural Invariance	279.85	196					
	M2 Metric Invariance	288.35	212	8.50	16	.933	.008	-.004
	M3 Scalar Invariance	309.53	228	21.18	16	.172	-.006	<.000
	M4 Residual Invariance	339.15	250	29.62	22	.128	-.008	<.000

Concurrent validity

The concurrent validity analysis was conducted using Pearson's correlation between the dimensions of the OTS scale and subjective happiness, measured simultaneously. The results show a positive and significant relationship ($p < .01$) between the overall OTS scale score, its dimensions, and subjective happiness. Specifically, the corrector dimension presented the highest correlation ($r = .27$), followed by designer ($r = .22$), facilitator ($r = .18$), and mediator ($r = .13$). The positive relationship between both variables supports the concurrent validity of the scale, indicating that online teaching styles are associated with teachers' happiness (Table 4).

Table 4
Correlations between the OTS scale, its dimensions, and subjective happiness

Variables	*M*	*SD*	1	2	3	4	5	6
1. Subjective Happiness	3.38	0.59	—					
2. OTS Designer	3.20	0.58	.22**	—				
3. OTS Corrector	3.58	0.42	.27**	.45**	—			
4. OTS Mediator	3.46	0.42	.13**	.38**	.40**	—		
5. OTS Facilitator	3.28	0.55	.18**	.45**	.43**	.38**	—	
6. OTS Global	3.38	0.39	.26**	.78**	.72**	.72**	.76**	—

Note: ** = p < .01, OTS = Online Teaching Styles; *M* = Mean; *SD* = Standard Deviation.

Reliability analysis

The reliability of the OTS scale was analyzed using McDonald's omega (ω) and Cronbach's alpha (α) coefficients. The results show that the values of both statistics are acceptable (Katz, 2006) (Table 5).

Table 5
Reliability coefficients of the OTS scale and its dimensions

Online Teaching Styles Scale	ω	α
OTS Global	.84	.84
OTS Designer	.71	.70
OTS Corrector	.68	.67
OTS Mediator	.71	.68
OTS Facilitator	.71	.68

Note: OTS = Online Teaching Styles, α = Cronbach's Alpha, ω = McDonald's Omega.

DISCUSSION

The OTS scale presents strong psychometric properties, supporting its validity and reliability as a tool for evaluating teaching styles in digital environments. The results of the confirmatory factor analysis showed a satisfactory model fit (CFI = .97, TLI = .96, RMSEA = .03), indicating a good correspondence between the proposed four-dimensional theoretical structure (designer, corrector, mediator, and facilitator) and the empirical data. These values exceed the recommended minimum thresholds for measurement models (CFI ≥ .95, TLI ≥ .95, RMSEA ≤ .06), reinforcing the construct validity of the scale (Hu & Bentler, 1999; Kline, 2016).

In comparison with previous research, the findings align with studies that have validated assessment instruments in digital environments, such as the Grasha-Riechmann Teaching Styles Questionnaire adapted to online contexts (Abell et al., 2016) and the Teaching Styles Inventory in Higher Education (TSIHE) (Malay et al., 2024). These studies also reported multidimensional structures and satisfactory fit, although with variations in specific dimensions. However, the inclusion of the designer, corrector, mediator, and facilitator dimensions in the OTS scale expands the theoretical framework (Grasha, 1996; Sanje & Varnali, 2014; Mori et al., 2023; Romero-Félix, 2023), adapting it to the pedagogical demands of online education.

On the other hand, the internal consistency coefficients (Cronbach's alpha and McDonald's omega) ranged between .67 and .71 (.84 global). Although these values are at the lower limit of acceptability, they are considered adequate for instruments in early validation stages (DeVellis, 2017). While the obtained coefficients are lower than those reported in other teaching styles scales (Abello et al., 2020; González-Peiteado et al., 2012), they are comparable to those found in scales such as those by Arbabisarjou et al. (2020), Hurriyetoglu and Kilicoglu (2020), and Merino-Barrero et al. (2017). However, the overall internal consistency value of the analyzed scale was higher than these, suggesting greater stability in the total score. Furthermore, the results are consistent with those obtained in instruments designed for digital contexts, where variability in teacher-student interaction may affect response homogeneity (Scherer et al., 2019).

The concurrent validity analysis provides empirical evidence on the relationship between online teaching styles and teachers' subjective happiness, supporting the usefulness of the OTS scale for evaluating these styles in the digital context. According to Furr (2022), concurrent validity is established when an instrument shows significant associations with theoretically related variables. In this regard, the positive and significant correlation between the overall OTS scale score and subjective happiness ($p < .01$) supports its validity, suggesting that adopting certain online teaching styles could be linked to teachers' emotional well-being. This finding is consistent with previous research demonstrating that teachers' emotions influence their behavior, teaching styles, and roles in the learning process (Burel et al., 2021; Frenzel, 2014; Yirci et al., 2018).

Regarding factorial invariance by gender, the scale demonstrated configural, metric, scalar, and residual equivalence, allowing meaningful comparisons between men and women. This aligns with studies suggesting

that differences in teaching styles are not so much due to gender but to teacher role expectations (Eagly & Wood, 2012) or different pedagogical approaches (Arabit García et al., 2021; Navarro-Patón et al., 2020). In this sense, previous studies indicate gender differences in the development of teachers' digital competencies (Palacios-Rodríguez et al., 2025), possibly influenced by gender role perception concerning technology (Usart et al., 2021). Therefore, exploring these differences with the OTS scale could provide valuable insights into the influence of gender on online teaching practices.

Theoretical and practical implications

The results of this study have significant theoretical and practical implications. In applied terms, this research expands the study of teaching styles beyond face-to-face environments by incorporating a specific analysis of their development in virtual contexts. The COVID-19 pandemic highlighted the need to adapt teaching to online modalities, emphasizing the importance of ensuring educational quality in remote settings. Factors such as feedback, student support, and supervision play a crucial role when face-to-face interaction is replaced by technological platforms. In this regard, teacher evaluation should not only consider subject matter expertise but also pedagogical strategies and preferences in digital environments (Deseo et al., 2024).

Additionally, teaching styles have been found to be influenced by teacher preparation and emotional state. During the pandemic, the abrupt transition to online teaching caused various psychological effects in both teachers and students (Cuadra-Martínez et al., 2020; Delgado, 2023), reinforcing the importance of analyzing online pedagogical practices.

From a theoretical perspective, this study reaffirms that teaching in virtual environments is not equivalent to face-to-face teaching, meaning that traditional pedagogical principles cannot be applied without adaptations. Previous research has indicated that online teaching requires specific methodological adjustments to ensure effective learning and student interaction (Garrison & Cleveland-Innes, 2010). Thus, the OTS scale provides a suitable framework for evaluating how teachers adjust their pedagogical practices to the demands of digital environments, which can serve as a foundation for future research and teacher training programs.

CONCLUSIONS

The present study aimed to analyze the psychometric properties of a scale designed to measure teaching styles in online education among higher education faculty. The research results confirm that the Online Teaching Styles Scale is a psychometrically robust instrument, providing strong evidence of validity and reliability for assessing teaching styles in digital environments. The confirmatory factor analysis revealed an adequate fit for the four-dimensional model (CFI = .97, TLI = .96, RMSEA = .03), supporting the proposed theoretical structure. Content validity, established through expert judgment, showed exceptional indices (S-CVI = .99), while reliability coefficients (α and ω ranging from .67 to .71) reflect acceptable internal consistency, considering that this is an instrument in its initial validation stage.

The factorial invariance analysis indicated that the scale is equivalent for both male and females, allowing for valid comparisons between groups. Additionally, concurrent validity showed significant positive correlations with teachers' subjective happiness, suggesting that online teaching styles may be linked to faculty emotional well-being. These findings reinforce the importance of having specific instruments for virtual contexts that can help improve pedagogical practices and promote educational quality in digital environments.

Despite the contributions of this study to measuring online teaching styles with a useful scale for research in this field, some limitations must be considered. First, the instrument's responses were obtained through self-reporting by faculty, which may have been influenced by social desirability bias. Second, the participants were educators from a municipality in southern Sonora, so a larger and more geographically diverse sample is needed to generalize the results. Furthermore, this study examined teaching styles solely from the perspective

of faculty members; therefore, future research could explore students' perspectives on their teachers' teaching styles to identify potential discrepancies and similarities.

Therefore, the results of this study provide evidence of a reliable and valid scale for assessing teaching styles in online education. The four-dimensional theoretical model, specifically developed for the digital context, offers an accurate measure of the teaching styles construct, adapted to the particularities of online education.

Finally, a brief instrument with acceptable validity evidence is proposed, which significantly contributes to measuring the construct in university instructors, thereby expanding the tool's applicability and usefulness in evaluating and improving teaching in digital environments. Furthermore, new avenues are opened for future research aimed at exploring in greater depth the influence of teaching styles on academic performance and students' experience on online platforms.

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