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The Development and Validation of the Online Reading Engagement Scale (ORES): A New Tool for Digital Academic Contexts

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ABSTRACT

This study introduces and validates the Online Reading Engagement Scale (ORES), a multidimensional instrument designed to assess behavioural engagement, cognitive engagement, affective engagement, and social engagement in digital academic reading contexts. Grounded in the engagement model by Wigfield and Guthrie in 2000, this scale fills a research gap by providing a comprehensive tool specifically designed for university-level EFL students engaged in online reading. The instrument was developed through item generation and refinement informed by prior research and expert feedback. A sample of 668 Chinese undergraduates participated in the study, completing a 32-item questionnaire distributed on Wenjuanxing, an online survey platform. Exploratory factor analysis (EFA) revealed a four-factor structure, explaining 61.1% of the total variance. Confirmatory factor analysis (CFA) further supported the model with strong fit indices (e.g., RMSEA = 0.024, CFI = 0.986). Reliability and validity assessments confirmed internal consistency (Cronbach's $\alpha > 0.90$), convergent validity, and discriminant validity across all dimensions. The findings establish ORES as a reliable and valid instrument for assessing online reading engagement in academic settings, providing a theoretical and empirical foundation for future research and pedagogical interventions aimed at enhancing digital literacy and student engagement in higher education.

Keywords: Online Reading Engagement; Scale Development; Digital Academic Reading; English as a Foreign Language (EFL)

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ARTICLE INFO

Received: 23 July 2025 | Revised: 13 August 2025 | Accepted: 20 August 2025 | Published Online: 17 October 2025

DOI: <https://doi.org/10.30564/fls.v7i11.11213>

CITATION

Dang, C., Rawian, R., Jamali, M., 2025. The Development and Validation of the Online Reading Engagement Scale (ORES): A New Tool for Digital Academic Contexts. *Forum for Linguistic Studies*. 7(11): 57–72. DOI: <https://doi.org/10.30564/fls.v7i11.11213>

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1. Introduction

Engagement is recognized to comprise multiple interconnected dimensions such as behavioral involvement, cognitive effort, emotional connection, and social interaction^[1]. In language learning, engagement is a key factor for successful learning outcomes^[2,3], and active engagement in reading contributes greatly to reading comprehension^[4]. This study conceptualizes online reading engagement as an integrative construct that simultaneously captures behavioral, cognitive, affective, and social dimensions. Each dimension contributes uniquely to reading comprehension within digital reading contexts.

As reading practices increasingly shift from print to digital platforms, the nature of engagement also changes, bringing new cognitive demands, interactional patterns, and motivational challenges^[5]. While numerous studies have examined reading engagement in language learning contexts^[6–10], existing measures tend to focus on isolated aspects of engagement or on general online activities rather than on the specific demands of academic online reading^[11]. Accordingly, there is a notable gap in the literature regarding validated, multidimensional scales specifically designed to assess engagement in online academic settings^[12]. This gap is critical. In research, the lack of a validated multidimensional tool limits analysis of how behavioral, cognitive, affective, and social dimensions influence reading comprehension in online academic contexts. In pedagogy, it hinders accurate diagnosis of engagement and the design of targeted, evidence-based interventions for digital learning environments. Without such a tool, both domains risk relying on fragmented rather than comprehensive empirical data.

To fill this gap, this study focuses on designing and assessing the validity of the Online Reading Engagement Scale (ORES), a multidimensional tool for online academic contexts that systematically measures the behavioral, cognitive, affective, and social dimensions of engagement (**Appendix A**).

Accordingly, the following research questions were formulated:

RQ1: Can online reading engagement be empirically examined and validated across its behavioral, cognitive, emotional, and social domains?

RQ2: Do these dimensions demonstrate strong reliability and validity when analyzed independently?

2. Literature Review

2.1. Reading Engagement

Reading engagement, initially defined by Guthrie and Wigfield^[13], involves an internal drive to apply cognitive strategies within socially interactive, concept-focused learning contexts. Engaged readers intentionally utilize cognitive strategies to comprehend texts, driven by an inherent joy in reading^[14]. According to the engagement model^[15], effective reading engagement results from the interplay of motivation and strategies throughout the reading process, leading to improved comprehension, effective strategy use, and increased reading motivation. Engaged reading involves motivation, strategic approaches, knowledge-driven processes, and social interaction, extending beyond external incentives and involving the application of cognitive and metacognitive strategies^[13].

Unrau and Quirk^[16] expanded the definition of reading engagement to cover both behaviors and cognitive and emotional processes involved in reading. The OECD^[17] further extended the concept of reading engagement to include affective factors such as reading interests and cognitive factors like metacognition. Despite numerous attempts to define reading engagement, a consensus on its definition has not been reached, especially in an online context^[5]. In the present study, online reading engagement is defined within the engagement model by Wigfield and Guthrie^[15] as a process where readers actively interact with digital texts for academic purposes. It is characterized by deep cognitive involvement, consistent and purposeful behavioral activities, positive emotional connections, and meaningful social interactions.

2.2. Multifaceted Nature of Reading Engagement

Engagement in reading has been explored extensively with various terminologies and components, and is defined as the simultaneous involvement of motivations and strategies in reading activities, involving intentional cognitive approaches to understanding texts^[3,4,13,18,19]. This multifaceted concept is influenced by both cognitive and emotional involvement, as proposed by Wigfield et al.^[20]. Fredricks and McColskey^[21] developed a comprehensive framework cat-

egorizing reading engagement into behavioral, emotional, and cognitive dimensions. According to this framework, engaged readers actively participate in reading tasks with enthusiasm and employ high-level strategies for deep understanding, which aligns with the definition of reading engagement in PISA 2009 as reading interest, behaviors, and proficiency^[17,22].

Researchers further categorized these dimensions by defining behavioral engagement through observable reading behaviors, cognitive engagement through mental effort and metacognitive strategies^[16,23], and affective engagement through emotional reactions such as enjoyment and interest^[24,25]. A fourth dimension, social engagement, was later added by Fredricks et al.^[1] and other researchers like Svalberg^[26], emphasizing the role of social interactions, collaborative activities, and discussions in enhancing the reading experience and motivation^[3,5,26]. This comprehensive understanding of reading engagement with affective, behavioral, cognitive, and social aspects highlights the vital role of emotions, actions, mental strategies, and collaborative practices in the reading process. Consequently, the present study classifies online reading engagement into four dimensions: behavioral, cognitive, affective, and social reading engagement.

2.3. Measures of Reading Engagement

Given the inherently interrelated aspects of reading engagement, empirical studies on their complex and interactive connections are essential^[27]. Over the past decades, a few instruments measuring reading engagement have been thoroughly developed and applied. Initially, reading engagement was assessed using students' self-reports on motivation with the Motivations for Reading Questionnaire^[13]. Subsequently, Wigfield et al.^[20] developed the Reading Engagement Index (REI), which has been widely employed in numerous reading studies^[6,8,28–30]. Despite the REI's comprehensiveness, it is limited by its reliance solely on teachers' perspectives, overlooking the learners' viewpoints.

Another widely used scale is the reading-related items used in PISA assessments^[17], which have been employed to measure students' reading engagement in various studies^[22,31–34]. These assessments categorize reading engagement into emotional, behavioral, and cognitive dimensions, reflected in questions about the pleasure of reading, the vari-

ety and reading activities, and metacognitive reading strategies. However, since PISA is intended to study students aged 15, the items in the questionnaire may not be appropriate for university students.

Recently, McGeown and Smith^[35] developed the Reading Engagement Scale to understand children's engagement in reading books, considering behavioral, cognitive, affective, and social factors. Though well-designed with detailed instruction for using the scale, this instrument is administered to whole classes of children in elementary school when reading in free time while not for academic purpose. Cubillos et al.^[36] developed and validated the Teacher-Reported Reading Engagement Survey (TRRES), a reliable teacher-reported survey showing reading engagement as a multidimensional construct with behavioral, cognitive, and social facets. This tool offers a practical alternative to self-reports, enhancing how educators assess reading engagement in real-world settings.

Meanwhile, while numerous scales exist for assessing learning engagement in online contexts^[12,37–42], there is a notable lack of scales specifically examining engagement in the online reading context for EFL university students.

Despite the growing interest in reading engagement, existing instruments display critical limitations in scope, population relevance, and digital specificity. For instance, the Reading Engagement Index (REI)^[20] primarily emphasizes motivation constructs from the teacher's viewpoint, overlooking learner agency in digital environments. Similarly, the reading-related items from the Programme for International Student Assessment (PISA) offer behavioral and affective metrics but target 15-year-old students, thus lacking contextual validity for university learners^[17,32]. In contrast, recent developments such as the Teacher-Reported Reading Engagement Survey (TRRES)^[36] offer strong psychometric properties but remain teacher-reported, and thus may not capture the complicated self-regulated reading behaviors typical in online academic contexts.

Furthermore, although McGeown and Smith^[35] proposed a multidimensional Reading Engagement Scale for children, including affective, behavioral, cognitive, and social domains, it is designed for recreational book reading during school hours and lacks alignment with academic digital reading tasks. These gaps highlight the need for instruments that reflect the evolving digital reading landscape, partic-

ularly in university level English-as-a-Foreign-Language (EFL) settings, where learners engage with texts beyond entertainment, often requiring strategic, collaborative, and emotional interaction with academic material.

2.4. Need for This Study

Although existing research has thoroughly explored engagement as a complex framework that integrates behavioral, cognitive, emotional, and social components, there remains a gap in measurement tools for digital academic reading contexts, particularly among university-level EFL learners. As educational environments increasingly shift toward online platforms, tools that accurately capture how learners interact with digital texts are urgently needed.

Recent studies have made great efforts in assessing engagement in online learning^[12,37,39,42]. However, these instruments often measure general engagement across broad learning platforms, overlooking the specific complexity of online academic reading engagement, a domain where textual interaction, strategy application, emotional responses, and peer communication intersect in complex ways.

Moreover, the limited representation of the four engagement dimensions within a single unified framework remains a notable shortcoming. Scales like the REI^[20] and PISA reading items^[17] emphasize motivation and basic behaviors but fail to fully capture emotional and social engagement, especially in digital environments. Tools such as the TRRES^[36] and Reading Engagement Scale by McGeown and Smith^[36] offer promising multidimensional frameworks but target younger or non-academic populations, thus restricting their applicability in higher education.

In response to these theoretical and practical limitations, this study aims to develop and validate the ORES, a context-sensitive instrument systematically investigating how behavioral, cognitive, affective, and social factors contribute to engagement within online academic reading settings. Grounded in the engagement model by Wigfield and Guthrie^[15] and enriched by recent studies^[3,5], the ORES addresses the unique needs of EFL university students who engage with digital texts for academic purposes. It serves as a comprehensive, empirically validated resource for researchers and educators who seek to understand and improve digital reading practices in higher education.

3. Methodology

3.1. Participants and Data Collection

This study was conducted with the participation of 668 undergraduate students from universities in Northern China. Participants were invited through digital student discussion forums and social media platforms, using a convenience sampling approach. The composition of the sample reflected the gender distribution often observed in EFL-related programmes, with 538 females (80.54%) and 130 males (19.46%).

All participants met nationally recognized benchmarks for English proficiency. Specifically, each had completed no fewer than ten years of formal English instruction and had successfully passed the National College Entrance Examination. Moreover, all were engaged in a mandatory College English course within their first two years of study, ensuring consistency in academic context and exposure to online reading tasks.

Before gathering data, participants received an overview of the study objectives and were notified that their responses would remain anonymous and voluntary. Participants were selected based on their self-reported familiarity with digital reading environments and prior experience accessing academic materials online. Common activities included reading scholarly articles, participating in text-based online assignments, and navigating institutional learning platforms.

Data were gathered on Wenjuanxing, a widely used online survey tool in China that offers a secure and user-friendly interface for academic research. The sampling strategy and use of an online survey platform were intentionally aligned with the study focus on digital engagement, ensuring that data collection occurred within the same environment being studied. Demographic distributions, including participants' gender and year of study, are summarized in **Table 1**.

Table 1. Demographics of the participants ($N = 668$).

Characteristics	Items	Percentage
Gender	Male	19.46%
	Female	80.54%
Grade	Year 1	41.77%
	Year 2	36.98%
	Year 3	21.26%

3.2. Item Generation and Instrument Development

To generate items, a thorough review of related literature was done. Specifically, the four dimensions of the scale were informed by the engagement model by Wigfield and Guthrie^[15] as well as the systematic review study by Lee et al.^[5]. Items in this instrument were initially constructed based on previous studies on the online learning context by Deng et al.^[37] and Hoi and Hang^[40]. Wording adjustment of some items was made to align with the EFL context of online reading for academic purpose. For example, items referencing “video lectures” or “MOOC tasks” were revised to focus on “academic texts” and “online reading tasks”.

Besides, new items were generated after reviewing previous studies on digital reading. Drawing from Singer and Alexander^[43], items addressed behaviors like organizing digital materials and using online tools (e.g., bookmarks, highlighters). Cognitive strategies such as summarizing and analyzing texts were informed by Delgado et al.^[44], highlighting the importance of strategic regulation in digital settings. Emotional engagement focused on confidence and accomplishment^[45,46], while social engagement reflected peer interaction and instructor feedback. The initial pool consisted of 40 items rated on a five-point Likert scale, ensuring a comprehensive measure of digital reading strategy use and learner engagement in self-regulated online learning environments.

Next, two sessions were conducted to enhance the validity of the questionnaire. The first session involved six teachers who had been delivering EFL reading courses. All teachers held master’s degrees in Applied Linguistics, with a

background exceeding five years in online teaching and survey design, and with an interest in studying reading and learning engagement. The second session included ten EFL university students, randomly selected from reading courses taught by the first author. All students had at least one semester of online reading experience during the EFL reading course. During these sessions, participants were informed about the objectives, the definition and components of online reading engagement, and the items designed to measure each component. Teachers and students were subsequently asked to share their perspectives on the clarity, interpretability, and relevance of each item, aiming to confirm that the questionnaire effectively represented the four dimensions of reading engagement. Through repeated revisions, this process led to the development of a finalized 32-item instrument, with eight items corresponding to each dimension.

Finally, a pilot study was carried out with a sample of 50 EFL undergraduates to examine the clarity, relevance, and reliability of the 32-item questionnaire. This preliminary evaluation provided valuable insights that informed subsequent refinements to item wording and structure. The pilot study, administered on Wenjuanxing to maintain consistency with the main data collection method, required participants to complete the survey and offer brief feedback on the comprehensibility and wording of each item. Quantitative analyses, including item-total correlations and preliminary reliability checks (Cronbach’s $\alpha = 0.85$), were conducted to identify any items that performed poorly or caused confusion. Based on these results, minor revisions were made to further optimize the item wording and sequencing, ensuring balanced representation across the four dimensions. **Table 2** presents an overview of the final scale.

Table 2. Constructs and Sample Items in ORES.

Construct	Number of Items	Sample Item
A	8	I enjoy discussing what I read online with others.
B	8	I set aside a regular time each week to engage in online academic reading.
C	8	I search for additional resources to better understand difficult concepts in my reading.
S	8	I share my insights from the online text with teachers during online session.

Note. A stands for Affective Engagement, B for Behavioral Engagement, C for Cognitive Engagement, and S for Social Engagement.

3.3. Data Analysis

Data analysis was carried out to ensure the validity and reliability of the scale. First, Exploratory Factor Analysis (EFA) was conducted using SPSS 29 to evaluate the

underlying factor structure and confirm the dimensionality of the instrument. Items with factor loadings over 0.60 were acceptable^[47]. This step provided a clear and interpretable structure for the scale and informed the subsequent analyses.

Next, Confirmatory Factor Analysis (CFA) was performed using SmartPLS 4.0 to test the hypothesized four-factor model. Model fit was evaluated by examining multiple indices: the standardized root mean square residual (SRMR, with values ≤ 0.08 indicating acceptable fit), the normed fit index (NFI, with values ≥ 0.90 indicating adequate fit), and the coefficient of determination (R^2), which indicates how much variance is explained^[48]. In addition, commonly reported indices such as the Root Mean Square Error of Approximation (RMSEA) and Comparative Fit Index (CFI) were also used, with RMSEA values ≤ 0.08 and CFI values ≥ 0.90 indicating acceptable model fit^[49].

To further assess the validity of the scale, SmartPLS 4.0 was used to examine convergent and discriminant validity, following Fornell-Larcker criteria^[50]. Convergent validity was assessed by calculating composite reliability and Average Variance Extracted (AVE), ensuring that composite reliability values exceeded 0.70 and AVE values surpassed 0.50. Discriminant validity was verified in accordance with the Fornell—Larcker criterion, wherein the square root of each construct’s AVE surpassed its correlations with all other constructs^[50], confirming conceptual distinctiveness. In ad-

dition, Cronbach’s alpha was employed to assess internal consistency, and all dimensions achieved coefficients above 0.70, meeting the reliability standards recommended by Hair et al.^[47].

4. Results

4.1. Exploratory Factor Analysis (EFA)

To ensure the appropriateness of the data for factor analysis, the suitability of the dataset was evaluated. The Kaiser-Meyer-Olkin (KMO) measure was used to assess whether the sample size was adequate, typically with a value over 0.50 being acceptable^[51]. Additionally, Bartlett’s test of sphericity was used to check for significant correlations among the variables; a p -value less than 0.05 suggested that the data were appropriate for factor analysis^[52]. In this study, the KMO value was 0.968 and a significant result from Bartlett’s test ($p < 0.05$) verified that the sample size was adequate and the variables were sufficiently correlated, as shown in **Table 3**. These results supported that the dataset met the criteria needed for factor analysis.

Table 3. KMO and Bartlett’s Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.968
Bartlett's Test of Sphericity	Approx. Chi-Square	12088.490
	df	496
	Sig.	<0.001

Next, to find out the potential dimensions of the scale, both the scree test and Kaiser-Guttman criterion were applied. A scree plot is a graphical representation of eigenvalues in descending order with the elbow point indicating the optimal number of factors to retain^[53]. The Kaiser-Guttman approach, as proposed by Kaiser^[54], suggests that only factors with eigenvalues above one should be retained. In this study, the scree plot in **Figure 1** showed that there were mainly four potential dimensions with their component eigenvalues being 12.840, 2.430, 2.286, and 1.989 respectively. Description of the four formed factors are presented in **Table 4**. The first four components together explain approximately 61.1% of the total variance, greater than the

acceptable 50% cutoff index by Hair et al.^[47], indicating that these components captured a substantial part of the variability in the data.

Finally, to explore the latent structure of the dataset, a factor analysis employing principal axis factoring with varimax rotation was performed, facilitating the identification of distinct engagement dimensions through optimized factor loading patterns. Hair et al.^[47] stated that, typically, loadings above 0.5 were considered acceptable, while those above 0.7 indicate strong validity. In this study, all 32 indicator loadings were between 0.617 and 0.716 as shown in **Table 5**. Accordingly, a four-factor structure was identified, comprising 32 items and demonstrating strong structural validity.

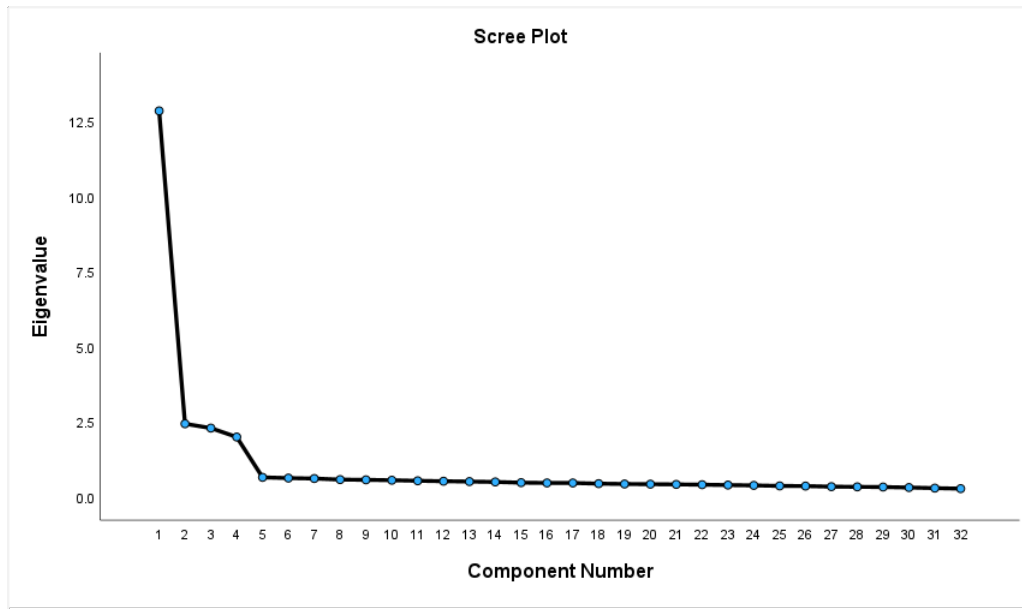


Figure 1. Scree Plot Analysis.

Table 4. Extraction Sums of Squared Loadings.

Component	Total	% of Variance	Cumulative %
1	12.840	40.126	40.126
2	2.430	7.594	47.719
3	2.286	7.142	54.862
3	1.989	6.215	61.076

Extraction Method: Principal Component Analysis.

Table 5. Rotated Factor Matrix.

	Factor 1 Affective Engagement	Factor 2 Behavioral Engagement	Factor 3 Cognitive Engagement	Factor 4 Social Engagement
A1	0.645			
A2	0.690			
A3	0.646			
A4	0.668			
A5	0.654			
A6	0.658			
A7	0.617			
A8	0.643			
B1		0.709		
B2		0.683		
B3		0.640		
B4		0.644		
B5		0.716		
B6		0.682		
B7		0.619		
B8		0.641		
C1			0.655	
C2			0.661	
C3			0.659	
C4			0.621	
C5			0.685	

Table 5. Cont.

	Factor 1 Affective Engagement	Factor 2 Behavioral Engagement	Factor 3 Cognitive Engagement	Factor 4 Social Engagement
C6			0.653	
C7			0.686	
C8			0.682	
S1				0.661
S2				0.702
S3				0.668
S4				0.633
S5				0.656
S6				0.702
S7				0.633
S8				0.662

Extraction Method: Principal Axis Factoring.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

4.2. Confirmatory Factor Analysis (CFA)

Building upon the EFA findings, CFA was conducted to confirm the suitability of the identified four-factor structure. CFA evaluated the fit of the predefined factor model to the observed data, verifying construct validity within the

measurement model^[55]. As shown in **Table 6**, the model fit results were satisfactory, with the $\chi^2/DF = 1.378$, RMSEA = 0.024, SRMR = 0.028, and CFI, TLI, GFI and NFI all above the cut-off criteria of 0.90. These results revealed that the four-factor model derived from EFA demonstrated superior alignment with the observed data.

Table 6. Goodness of Model Fit Indices.

Fit Index	Value	Cut-Off Criteria
Chi-square divided by degrees of freedom (χ^2/DF)	1.378	≤ 5
Root Mean Square Error of Approximation (RMSEA)	0.024	≤ 0.08
Standardized Root Mean Square Residual (SRMR)	0.028	≤ 0.08
Comparative Fit Index (CFI)	0.986	≥ 0.90
Tucker-Lewis Index (TLI)	0.984	≥ 0.90
Goodness of Fit Index (GFI)	0.946	≥ 0.90
Bentler-Bonett Normed Fit Index (NFI)	0.949	≥ 0.90

Additionally, as shown in **Figure 2**, all indicators across the four dimensions: social engagement (S), behavioral engagement (B), cognitive engagement (C), and affective engagement (A), exhibited outer loadings above 0.70, confirming strong item-to-construct relationships and reinforcing the integrity of the proposed factor structure. These CFA results supported and refined the factor model initially identified through EFA, which reported item loadings exceeding 0.60 (as shown in **Table 5**). Slight numerical differences between the two analyses were anticipated due to the distinct methodological approaches. EFA was designed to uncover latent patterns within the data, whereas CFA eval-

uated a predetermined structure under specific theoretical assumptions^[48].

4.3. Convergent and Discriminant Validity and Reliability Assessment

Further analyses examined the construct reliability and validity of each subscale. The results in **Table 7** showed that Composite Reliability (CR) values for the behavioral, cognitive, affective, and social dimensions ranged from 0.905 to 0.913, exceeding the recommended threshold of 0.70^[50,56]. In addition, Cronbach's alpha coefficients (≥ 0.90) indicated strong internal consistency^[57].

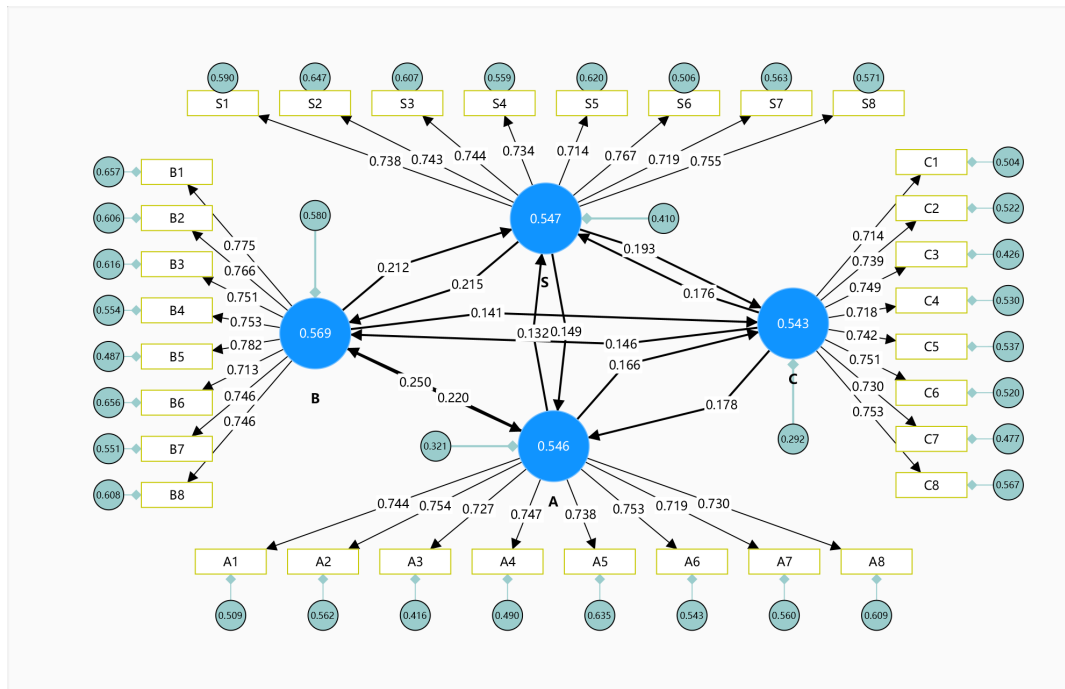


Figure 2. Confirmatory Factor Analysis Model.

Table 7. Construct Reliability and Validity.

Indicator	Cronbach's α	CR	AVE
Affective Engagement	0.905	0.906	0.546
Behavioral Engagement	0.913	0.913	0.569
Cognitive Engagement	0.905	0.905	0.543
Social Engagement	0.906	0.906	0.547

Convergent validity was supported by standardized outer loadings above 0.70 (refer to **Table 8**) and AVE values above the recommended threshold of 0.50 (refer to **Table 7**), reflecting that each construct effectively captured the variance of its associated indicators, ensuring the convergent validity^[50].

Table 8. Factor Loadings Matrix.

	Affective Engagement (A)	Behavioral Engagement (B)	Cognitive Engagement (C)	Social Engagement (S)
A1	0.744			
A2	0.754			
A3	0.727			
A4	0.747			
A5	0.738			
A6	0.753			
A7	0.719			
A8	0.730			
B1		0.775		
B2		0.766		
B3		0.751		
B4		0.753		
B5		0.782		
B6		0.713		
B7		0.746		
B8		0.746		
C1			0.714	
C2			0.739	

Table 8. Cont.

	Affective Engagement (A)	Behavioral Engagement (B)	Cognitive Engagement (C)	Social Engagement (S)
C3			0.749	
C4			0.718	
C5			0.742	
C6			0.751	
C7			0.730	
C8			0.753	
S1				0.738
S2				0.743
S3				0.744
S4				0.734
S5				0.714
S6				0.767
S7				0.719
S8				0.755

To assess discriminant validity, the Fornell–Larcker criterion and HTMT ratio were employed. As indicated in **Table 9**, the square root of AVE for each construct exceeded its correlations with other constructs, thereby supporting discriminant validity in line with the Fornell–Larcker criterion^[50]. Complementary evidence from **Table 10** showed that all HTMT indices remained below the 0.85 threshold, meeting the conservative threshold recommended in recent literature^[56], and further confirming the distinctiveness of each dimension. These results confirmed that each construct is internally reliable, conceptually coherent, and empirically distinct from the others.

Table 9. Fornell–Larcker Criterion Matrix for Discriminant Validity.

	A	B	C	S
A	0.739			
B	0.651	0.754		
C	0.606	0.572	0.737	
S	0.583	0.603	0.597	0.740

Note. A stands for Affective Engagement, B for Behavioral Engagement, C for Cognitive Engagement, and S for Social Engagement.

Table 10. HTMT Ratio Matrix for Discriminant Validity.

	A	B	C	S
A				
B	0.653			
C	0.607	0.571		
S	0.585	0.603	0.596	

Note. A stands for Affective Engagement, B for Behavioral Engagement, C for Cognitive Engagement, and S for Social Engagement.

Overall, these results demonstrated that ORES is a multidimensional instrument with well-supported psychometric properties. The EFA confirmed a clear four-factor structure,

while the dimension-specific CFA results provided strong evidence of acceptable fit indices for each latent construct. Convergent and discriminant validity analyses, as well as reliability assessments, further supported the quality of the scale.

5. Discussion

This study introduced and empirically validated ORES, a multidimensional instrument for evaluating four aspects of engagement: behavioral, cognitive, affective, and social. Through exploratory factor analysis (EFA), a stable four-factor structure emerged, explaining 61.1% of the total variance, thereby demonstrating strong representation of the underlying constructs^[57]. Confirmatory factor analyses (CFA) for each subscale yielded excellent fit indices, including RMSEA = 0.024 and CFI = 0.986. The RMSEA value, far below the commonly accepted threshold of 0.05, indicates minimal discrepancy between the model and the data, while the CFI value, approaching the ideal of 1.00, demonstrated near-perfect alignment between observed and expected covariance structures. Together, these values signified exceptional model fit quality.

These results are consistent with Fredricks et al.’s^[25] theoretical model, which characterizes engagement as comprising multiple dimensions and emphasizes the interplay among behavioral, cognitive, emotional and social dimensions. The findings also align with recent validation efforts in reading engagement research^[35,36,58].

Unlike earlier scales like the REI or PISA items, which either favored teacher-reported perspectives or focused on motivational indicators^[17,20], ORES offers a context-specific

assessment rooted in academic digital reading. This shift responds to calls for tools that address real-time behaviors, emotional involvement, and collaborative reading practices within university EFL populations^[59,60].

The results further highlight the importance of treating online reading engagement as a multifaceted construct. Each dimension emerged as statistically independent and conceptually coherent, supporting convergent validity through strong Composite Reliability (CR) and Average Variance Extracted (AVE) values^[50,61], and discriminant validity through both the Fornell–Larcker criterion and HTMT ratios^[56]. This confirms the structural soundness of ORES and its utility in isolating distinct behavioral, cognitive, affective, and social components of engagement^[1,35,60]. This result also aligns with the instruments such as the TRRES^[36] and the Reading Engagement Scale^[60].

Notably, the inclusion of social engagement highlights the growing relevance of peer interaction and instructor feedback in digital contexts, which is often overlooked in prior tools focused solely on individual metrics^[3,26]. Unlike general social interaction, which may be informal or unstructured, social engagement in academic online reading context can involve peer annotations, structured discussion boards, or collaborative text analysis. These activities are goal-oriented and mediated by academic norms^[9,16]. This distinction presents both opportunities and challenges for measurement, as the quality, depth, and relevance of such interactions may be more critical than their frequency.

The development of ORES holds substantial implications for both research and pedagogical practice in digital academic contexts. For researchers, the ORES offers a rigorously validated, multidimensional tool for empirically capturing behavioral, cognitive, affective, and social dimensions of online reading engagement within established theoretical frameworks^[25]. It enables detailed learner profiling, cross-context and cross-cultural comparisons, and longitudinal tracking of engagement^[62]. The scale adds precision and credibility to research for testing theoretical models, examining mediators and moderators in engagement–achievement links, and investigating underexplored areas such as social engagement in academic online reading, which is different from general social interaction due to its academically focused, often asynchronous nature^[63,64].

From a pedagogical perspective, the ORES addresses an urgent need for educators to diagnose engagement profiles in academic online reading with greater accuracy and depth. By capturing multiple dimensions, it allows teachers to identify learners' strengths and weaknesses across behavioral, cognitive, affective, and social domains, informing the design of targeted interventions that meet specific needs^[64,65]. In practical terms, this can guide adaptive instructional strategies, personalized feedback, and resource allocation that prioritize students most at risk of disengagement. Such insights are particularly valuable in higher education's increasingly digitalized landscape, where sustaining meaningful learner engagement remains a persistent challenge.

Several limitations of this study should be acknowledged. Since the sample was taken from a particular group of EFL undergraduates, whether the findings can be generalized to other educational or language proficiency contexts remains to be tested. The cross-sectional design restricts the ability to capture its dynamic and evolving nature of engagement. Furthermore, although the validation process employed multiple methods to ensure construct validity, further testing is needed across different cultural, disciplinary, and technological settings to confirm the structural integrity and consistency of ORES. The reliance on self-reported data rather than integrating multimodal or behavioral trace measures may also limit the precision of capturing actual engagement behaviors.

Future research could address these limitations by applying ORES to more diverse learner groups and adopting longitudinal or mixed-method designs to better capture changes in engagement over time. In addition, further studies could examine the complicated ways social engagement manifests in online academic reading, considering its unique communicative and collaborative demands. Cross-disciplinary applications such as in STEM or professional reading contexts may reveal distinctive engagement patterns. Researchers are also encouraged to explore adapting ORES for integration with different learning platforms, including MOOCs, mobile-assisted reading tools, and AI-supported learning environments, where real-time analytics could be used to combine perceptual, behavioral, and performance-based measures.

6. Conclusions

This study introduced and validated ORES, a multidimensional instrument designed to measure university-level EFL learners' engagement with academic texts in digital environments. Drawing on the engagement framework by Wigfield and Guthrie^[15], the ORES systematically evaluates four interrelated dimensions: behavioral, cognitive, affective, and social engagement.

Developed through a comprehensive sequence of item generation, expert review, pilot testing, and statistical validation, the scale demonstrated strong psychometric properties. Both exploratory and confirmatory factor analyses confirmed the structural integrity of the four-factor model, while internal reliability and construct validity further confirmed its strong empirical support.

Theoretical contributions of the study lie in extending engagement research to the domain of online academic reading, moving beyond general online learning behaviors to capture domain-specific engagement patterns. From a pedagogical perspective, the scale provides a diagnostic framework for educators and researchers to assess and support learner engagement more systematically in digital contexts. The inclusion of affective and social dimensions alongside behavioral and cognitive ones highlights the multifaceted nature of academic reading in online environments.

As reading practices continue to evolve with technological change, instruments like the ORES will be essential for promoting learner-centered learning, an approach in which instructional design, feedback, and support are guided by data on individual learners' behavioral, cognitive, affective, and social engagement patterns. The scale also informs evidence-based digital pedagogy and enables precise research on how these dimensions interact to influence reading comprehension.

Author Contributions

The study was conceptualized and designed mainly by R.R.. M.J. led the literature review and item generation for the Online Reading Engagement Scale (ORES). C.D. managed data collection and statistical analyses, including both exploratory and confirmatory factor analyses. All authors contributed to instrument refinement and theoretical framework development. All authors collaboratively examined

the results, contributed meaningful insights during the revision process, and gave final approval for the manuscript submission.

Funding

This study was conducted without financial support from any public, private, or nonprofit funding bodies.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Universiti Utara Malaysia (UUM/CAS/AHSGS/906612 07 October 2024).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data used in this study are available from the corresponding author upon reasonable request.

Acknowledgments

The authors would like to acknowledge the valuable contributions of teachers and students involved in the item generation and instrument development phases. Their insights and collaborative efforts played a key role in enhancing the conceptual clarity and practical relevance of the instrument.

Conflict of Interest

No potential conflict of interest was reported by the authors.

Appendix A

Online Reading Engagement Scale (ORES)

Affectional Engagement

A1. I feel motivated to expand my knowledge through online

academic reading.

A2. I find online academic reading interesting and enjoyable.

A3. I feel a sense of accomplishment after completing an online reading task.

A4. I feel inspired to explore more about the topics I read online.

A5. I feel confident in my ability to understand academic texts online.

A6. I look forward to engaging in online academic reading activities.

A7. I feel satisfied with my progress in online academic reading.

A8. I enjoy discussing what I read online with others.

Behavioral Engagement

B1. I set aside a regular time each week to engage in online academic reading.

B2. I take notes while reading academic materials online.

B3. I revisit my notes when preparing for academic tasks or assessments.

B4. I stay focused while reading academic texts online.

B5. I complete all assigned online reading tasks on time.

B6. I organize my online reading materials for easy access and review.

B7. I use tools (e.g., highlighters, bookmarks) to mark important parts of the text.

B8. I set specific goals for my online academic reading sessions.

Cognitive Engagement

C1. I try to connect what I read online with my prior knowledge.

C2. I search for additional resources to better understand difficult concepts.

C3. I reread sections of the text when I do not understand them the first time.

C4. I summarize the main ideas of the text after reading it online.

C5. I analyze the structure and arguments of the text while reading.

C6. I reflect on how the text relates to my academic goals.

C7. I try to understand my mistakes when I misinterpret something in the text.

C8. I evaluate the credibility of the sources I read online.

Affectional Engagement

A1. I feel motivated to expand my knowledge through online

academic reading.

A2. I find online academic reading interesting and enjoyable.

A3. I feel a sense of accomplishment after completing an online reading task.

A4. I feel inspired to explore more about the topics I read online.

A5. I feel confident in my ability to understand academic texts online.

A6. I look forward to engaging in online academic reading activities.

A7. I feel satisfied with my progress in online academic reading.

A8. I enjoy discussing what I read online with others.

Social Engagement

S1. I share interesting academic reading materials with my classmates.

S2. I participate in online discussions about the academic texts I read.

S3. I respond to classmates' questions about the reading materials in online forums.

S4. I collaborate with peers to understand difficult parts of the text.

S5. I ask my teachers for clarification when I do not understand something in the text.

S6. I build on others' ideas during online discussions about the reading materials.

S7. I seek feedback from teachers on my understanding of the text.

S8. I share my insights from the text with teachers during online sessions.

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