

DEVELOPMENT AND VALIDATION OF A SCALE FOR MEASURING SECONDARY SCHOOL STUDENTS' PERCEPTIONS AND CHALLENGES OF ONLINE EDUCATION

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ABSTRACT

The rapid expansion of online education has transformed teaching-learning practices across educational institutions worldwide. While online learning offers flexibility and accessibility, it also presents several challenges that influence students' learning experiences and academic engagement. The present study aimed to develop and validate a comprehensive scale for measuring secondary school students' perceptions and challenges of online education. The scale development process followed a systematic mixed-method approach. Initially, qualitative interviews were conducted with 20 secondary school students, comprising 10 students from government schools and 10 students from private schools in Patiala District, Punjab. Thematic analysis of interview data identified five key dimensions: Technical Challenges, Health and Psychological Issues, Support Services and Communication, Cost Related Issues, and Quality of Teaching and Learning. Based on these themes and an extensive review of literature, an initial pool of 41 items was generated. Following content validation by three experts, 31 items were retained for empirical testing. A pilot study was conducted on 50 students to assess item clarity and comprehensibility. The final scale was administered to 300 secondary school students. Exploratory Factor Analysis (EFA) was performed on a sample of 150 students, while Confirmatory Factor Analysis (CFA) was conducted on an independent sample of 150 students. The EFA results revealed a five-factor structure explaining 68.6% of the total variance. The Kaiser-Meyer-Olkin value of .92 and significant Bartlett's Test of Sphericity confirmed data suitability for factor analysis. CFA demonstrated excellent model fit. Reliability and validity analyses supported the psychometric adequacy of the instrument. The findings indicate that the scale is a reliable and valid tool for assessing secondary school students' perceptions and challenges regarding online education.

Keywords: Online education, scale development, validation, perception, challenges, secondary school students, EFA, CFA.

INTRODUCTION

Over the last ten years, the use of digital technologies in education has made a major impact on the way learning and teaching activities are carried out. With the development of information and communication technology, a new pedagogical approach called "online education" has appeared, in which students have the chance to learn without leaving the classroom walls. Online learning has greatly facilitated flexible learning, made education resources more accessible, and made communication between the educators and learners more effective and accessible with the use of digital platforms (Dhawan, 2020; Pokhrel &

Chhetri, 2021; UNESCO, 2023). The integration of technology in the learning process has led to an increase in the use of technology-mediated instruction in educational institutions, which has made it important for educational research to gain knowledge about the experiences of students in an online learning environment (Gopal et al., 2021).

While there are many benefits to online learning, students may face a variety of barriers that can impact their learning outcomes, engagement, and educational experiences. The challenges faced are related to technology issue like unstable internet connection, lack of access to digital gadgets and technology failures (Almahasees et al., 2021; Muthuprasad et al., 2021). However, extended use of online learning spaces can also have a negative impact on physical and psychological health issues such as eye strain, fatigue, stress and decreased physical activity. Students may also be impacted by communication, support services, assessment and instructional quality issues. Several factors like technology, psychology, pedagogy, and socio-economic factors (Baber, 2022; Gopal et al., 2021) influence students' perceptions of online learning.

Previous studies have explored students' attitudes, perceptions, satisfaction and difficulties with online learning (Coman et al., 2020; Almahasees et al., 2021). The majority of literature, however, has been written about learners in higher education, and comparatively little work has been done to cover secondary school learners. Moreover, there are many existing instruments that measure only selected aspects of online learning, and don't include the multidimensional nature of students experiences. There is a lack of a comprehensive, psychometrically validated instrument, which is specifically designed for secondary school students, in education research (Vo et al., 2024).

Creating valid and reliable measurement instruments is crucial in evaluating educational phenomena and producing reasonable empirical evidence (DeVellis & Thorpe, 2021). The well-developed scale allows researchers, teachers, and decision makers to uncover the main challenges and opportunities of online education to inform evidence-based interventions and decision making. In secondary education, the learners have their unique developmental, social and education perspectives, which require an instrument that is relevant to the context and reflects their perceptions of as well as challenges associated with online education.

Hence, the aim of the current study was to create and validate an integrated scale of secondary students' perceptions and challenges of online learning. Through qualitative inquiry and literature review, five dimensions were found: Technical Challenges, Health and Psychological Issues, Support Services and Communication, Cost Related Issues, and Quality of Teaching and Learning.

Objective of the Study

To develop and validate a reliable and psychometrically sound scale for measuring secondary school students' perceptions and challenges of online education.

METHODOLOGY

Research Design

The study adopted an instrument development and validation design employing both qualitative and quantitative approaches. The scale development process consisted of item generation, content validation, pilot testing, exploratory factor analysis, confirmatory factor analysis, and reliability and validity assessment.

Participants

The study was conducted among secondary school students enrolled in government and private schools of Patiala District, Punjab, during the year 2025. The scale development process involved multiple stages. Initially, qualitative interviews were conducted with 20 students, including 10 students from government schools and 10 students from private schools. A pilot study was subsequently conducted on 50 secondary school students to evaluate the clarity and comprehensibility of the instrument.

For psychometric validation, a total sample of 300 secondary school students was selected. The sample was divided into two independent groups. Exploratory Factor Analysis was conducted on data collected from 150 students, while Confirmatory Factor Analysis was performed on a separate sample of 150 students. Students from both government and private schools were represented in each group.

Instrument Development

The development of the Students' Perception and Challenges of Online Education Scale (SPCOES) followed a systematic multi-stage procedure. In the first stage, qualitative interviews were conducted to explore students' experiences related to online education. Thematic analysis of the interview responses led to the identification of five major themes: Technical Challenges, Health and Psychological Issues, Support Services and Communication, Cost Related Issues, and Quality of Teaching and Learning.

An extensive review of literature on online education was conducted to support the qualitative findings and generate relevant scale items. Based on the themes identified and literature reviewed, an initial pool of 41 items was developed. The draft instrument was submitted to three experts in the field of education and educational research for content validation. The experts evaluated the relevance, clarity, language appropriateness, and representativeness of each item. Based on their suggestions, modifications were made and the scale was reduced to 31 items.

A pilot study was subsequently conducted on 50 students to assess item clarity, readability, and comprehensibility. Feedback received from participants was incorporated into the final version of the instrument. The final scale consisted of 31 items measured on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

Data Collection Procedure

Prior permission was obtained from the concerned school authorities before data collection. Students were informed about the purpose of the study, and participation was entirely voluntary. Confidentiality and anonymity of responses were assured. Informed consent was obtained from participants, and parental consent was secured wherever required. The questionnaires were administered personally by the researcher, and respondents were encouraged to provide honest and unbiased responses.

Data Analysis

Data analysis was carried out using appropriate statistical procedures. Exploratory Factor Analysis was employed to identify the underlying factor structure of the scale. The suitability of data for factor analysis was assessed through the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. Principal component extraction with Varimax rotation was used to obtain the factor structure. Factors with eigenvalues greater than one were retained (Hair et al., 2022).

Subsequently, Confirmatory Factor Analysis was performed on an independent sample to validate the factor structure identified through EFA. Model fit was evaluated using multiple

fit indices, including Chi-square/degrees of freedom ratio, Comparative Fit Index, Tucker-Lewis Index, Root Mean Square Error of Approximation, Standardized Root Mean Square Residual, and Parsimony Goodness-of-Fit Index (Kline, 2023). Reliability was assessed through Composite Reliability, while convergent and discriminant validity were examined using Average Variance Extracted and the Fornell-Larcker criterion (Hair et al., 2022; Fornell & Larcker, 1981).

RESULTS

Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was conducted to check the item level structure of the students' scale. (Fabrigar et al., 1999; Floyd & Widaman, 1995; Kaiser, 1974). KMO Measure of Sampling Adequacy, KMO value to be 0.92.

Bartlett's Test of Sphericity results suggest within range value, which fulfil the assumption check for this scale and data adequacy.

Bartlett's Test of Sphericity		
χ^2	Df	P
7260	496	< .001

For this scale, Varimax was used as Rotation method. For this scale, Criteria for factor retention was Eigenvalue > 1 and scree plot shown in figure1. (Cattell, 1966; Horn, 1965; Velicer, 1976)

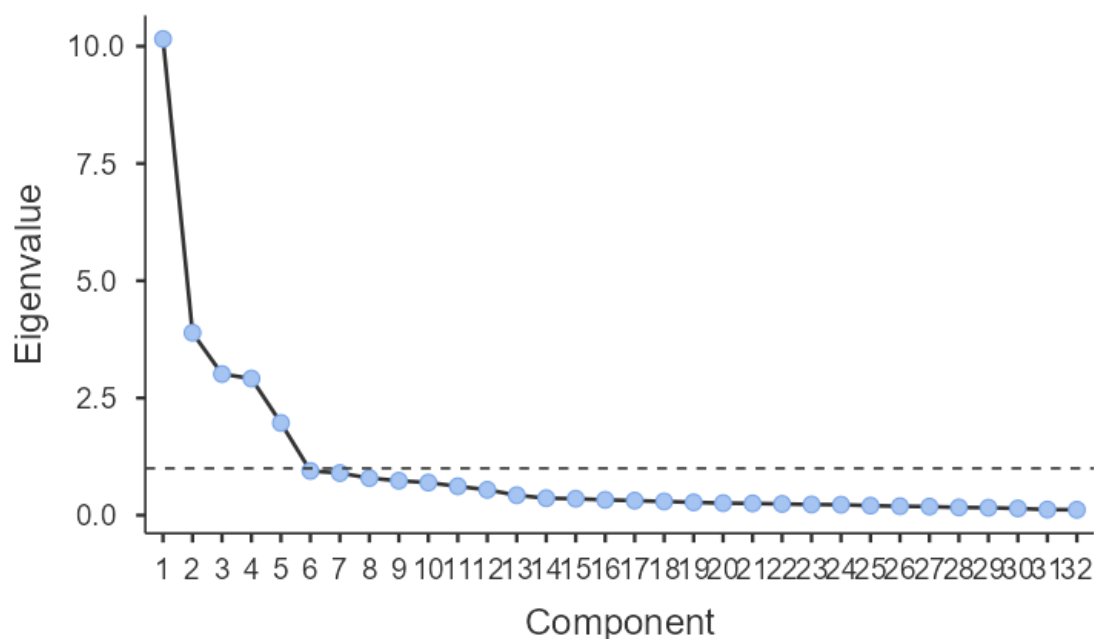


Figure 1: Scree Plot (students' scale)

Table 1: Factor loadings with items, loadings, and Uniqueness factor.

SCALE'S constructs and loadings						
	1	2	3	4	5	Uniqueness

TC-1				0.82		0.26
TC-2				0.847		0.206
TC-3				0.788		0.279
TC-4				0.809		0.277
TC-5				0.8		0.306
TC-6				0.581		0.631
TC-7				0.501		0.71
HPI-1			0.85			0.245
HPI-2			0.864			0.196
HPI-3			0.861			0.186
HPI-4			0.814			0.306
HPI-5			0.865			0.183
HPI-6			0.551			0.689
HPI-7			0.522			0.703
SSC-1		0.898				0.15
SSC-2		0.888				0.161
SSC-3		0.89				0.179
SSC-4		0.839				0.259
SSC-5		0.887				0.144
SSC-6		0.856				0.205
SSC-8		0.548				0.647
CRI-1					0.805	0.269
CRI-2					0.814	0.262
CRI-3					0.649	0.551
QTL-1	0.877					0.162
QTL-2	0.825					0.217
QTL-3	0.877					0.161
QTL-4	0.815					0.276
QTL-5	0.787					0.324
QTL-6	0.843					0.214
QTL-7	0.872					0.141

The above-mentioned table displays standardized factor loadings and uniqueness values for the five latent constructs derived from the measurement model. Consistent with the recommendations of Hair et al. (2019), all factor loadings exceed the minimum acceptable threshold of 0.60 for convergent validity, except for a few items (TC-6 = 0.581, TC-7 = 0.501, HPI-6 = 0.551, HPI-7 = 0.522, SSC-8 = 0.548, CRI-3 = 0.649, CRI-4 = 0.649) which, while lower, still surpass the minimal cut-off for retention in social science research.

TC construct shows strong item representation, with loadings ranging from 0.501 to 0.847 and low-to-moderate uniqueness values (0.206–0.71), indicating that over 50% of the variance in most items is explained by the underlying factor.

Similarly, **HPI** includes five strong items with loadings between 0.522 and 0.865, supporting theoretical alignment and internal consistency, though two items (HPI-6, HPI-7) show comparatively higher measurement error.

SSC comprises six items, most with strong loadings (0.548–0.898) except SSC-8, which may require scrutiny in future model refinement.

CRI is measured by four items (0.649–0.814) with moderate uniqueness, reflecting acceptable construct validity.

QTL includes seven items, all with high loadings (0.781–0.877) and low uniqueness values (0.141–0.324), indicating strong indicator reliability.

The uniqueness values across constructs remain within acceptable limits (<0.50 for most items), suggesting adequate explanatory power of the latent variables. These findings indicate satisfactory convergent validity and support the retention of most items for subsequent CFA.

Overall, the factor structure aligns with theoretical expectations, and the measurement properties satisfy psychometric criteria for scale development (Fornell & Larcker, 1981; Hair et al., 2019), making the instrument suitable for advanced confirmatory analysis.

Table2: Percentage of variance explained by each factor and cumulative variance.

CONSTRUCTS/ FACTORS	SS Loadings	% of Variance	Cumulative %
1	5.4	16.87	16.9
2	5.3	16.57	33.4
3	4.61	14.39	47.8
4	4.26	13.31	61.1
5	2.37	7.41	68.6

The above table shows that the five extracted factors together explain 68.6% of the total variance, which is acceptable given the complexity of human behavior and attitudes (Hair et al., 2019). Factor 1 account for the highest variance (16.87%), followed by Factors 2–5 with progressively smaller contributions (16.57%, 14.39%, 13.31%, and 7.41%, respectively). The cumulative variance surpasses the 50% threshold commonly recommended for exploratory factor analysis in social sciences, suggesting that the retained factors cover a substantial proportion of the underlying construct variance. This supports the adequacy of the factor solution for further CFA.

Confirmatory Factor Analysis

For Confirmatory Factor Analysis (CFA), the following tables are given as per the guidelines given by Hu & Bentler (1999), Bentler (1990), Tucker & Lewis (1973), and Steiger, 1990).

Table 3: Fit indices

Fit Indices	Recommended Value	Value
χ^2/df	≤ 5	1.074
P	Non-significant	0.132
SRMR	≤ 0.08	0.0362
RMSEA	≤ 0.06	0.0158
CFI	≥ 0.90	0.995
TLI	≥ 0.90	0.95
PGFI	Range of 0.50–1.00	0.7

Interpretation of Model Fit

The model fit indices indicate that the tested measurement model demonstrates an acceptable to excellent fit with the observed data:

As Chi-square / degrees of freedom ($\chi^2/df = 1.074$) is well below the upper threshold of 5, this suggests a good relative fit of the model. The p-value is non-significant ($p = 0.132$), which further supports that the model's implied covariance structure is not significantly different from the observed data.

For Standardized Root Mean Square Residual (SRMR = 0.0362), the value is below the recommended cut-off of 0.08, indicating small average residuals between the observed and predicted correlations.

In the case of Root Mean Square Error of Approximation (RMSEA = 0.0158), the value is well below the recommended maximum cut-off (≤ 0.06), suggesting a very close model fit to the population covariance matrix.

Comparative Fit Index (CFI = 0.995) and Tucker-Lewis Index (TLI = 0.95) both exceed the minimum recommended threshold of 0.90, supporting the model's incremental fit over a baseline independence model. The Parsimony Goodness-of-Fit Index (PGFI = 0.70) lies within the acceptable range (0.50–1.00), indicating a balance between model fit and model simplicity.

Overall, the combination of low SRMR, excellent RMSEA, and high incremental fit indices (CFI, TLI) confirms that the model is well-specified and fits the data exceptionally well. The results support the construct validity of the measurement model, making it suitable for further use in structural modeling or hypothesis testing.

Reliability and Validity Analysis

As given in the table below, Composite Reliability (CR) and Average Variance Extracted (AVE) for each construct are within specified limits (Cronbach, 1951; Raykov, 1997; Hayes & Coutts, 2020)

Table 4: Composite Reliability (CR) and Average Variance Extracted (AVE) for each construct.

Factor	Indicator	Stand. Estimate	AVE	Composite Reliability
TC	TC-1	0.831	0.555	0.892
	TC-2	0.882		
	TC-3	0.814		
	TC-4	0.817		
	TC-5	0.804		
	TC-6	0.536		
	TC-7	0.394		
HPI	HPI-1	0.839	0.592	0.905
	HPI-2	0.884		
	HPI-3	0.9		
	HPI-4	0.792		
	HPI-5	0.897		
	HPI-6	0.454		
	HPI-7	0.462		

SSC	SSC-1	0.912	0.712	0.944
	SSC-2	0.899		
	SSC-3	0.883		
	SSC-4	0.834		
	SSC-5	0.916		
	SSC-6	0.87		
	SSC-8	0.524	0.467	0.766
CRI	CRI-1	0.828		
	CRI-2	0.84		
	CRI-3	0.491		
	CRI-4	0.486	0.75	0.954
QTL	QTL-1	0.906		
	QTL-2	0.865		
	QTL-3	0.902		
	QTL-4	0.813		
	QTL-5	0.781		
	QTL-6	0.863		
	QTL-7	0.924		

For Discriminant validity (Fornell-Larcker criterion, HTMT ratio). (Fornell & Larcker, 1981; Henseler et al., 2015), the values are within specified limits

Table 5: Discriminant validity of the constructs.

	TC	HPI	SSC	COST	QTL
TC	0.69				
HPI	0.31	0.67			
SSC	0.372	0.259	0.71		
COST	0.349	0.294	0.284	0.68	
QTL	0.374	0.416	0.367	0.288	0.7

DISCUSSION

The present study aimed to develop and validate a comprehensive instrument for measuring secondary school students' perceptions and challenges of online education. The findings demonstrated that the Students' Perception and Challenges of Online Education Scale (SPCOES) possesses satisfactory psychometric properties and provides a reliable and valid measure of students' experiences in online learning environments.

The qualitative phase of the study identified five major themes that emerged directly from students' experiences with online education. These themes formed the conceptual basis of the scale and were subsequently supported through quantitative validation. The emergence of Technical Challenges as a distinct factor highlights the continued importance of internet connectivity, technological infrastructure, and digital accessibility in shaping online learning experiences (Dhawan, 2020; Pokhrel & Chhetri, 2021). Similarly, the Health and Psychological Issues dimension reflects growing concerns regarding the physical and

emotional consequences associated with prolonged online learning and increased screen exposure (Vasconcellos et al., 2025).

The factors relating to Support Services and Communication and Quality of Teaching and Learning emphasize the critical role of teacher–student interaction, instructional effectiveness, and learner engagement in online educational settings (Martin & Bolliger, 2018; Gopal et al., 2021). Previous research has consistently demonstrated that meaningful interaction and social presence significantly contribute to students' engagement, satisfaction, and learning outcomes in online environments (Ong & Quek, 2023). The Cost Related Issues factor further demonstrates that students consider accessibility, affordability, flexibility, and financial implications when evaluating online education (Aristovnik et al., 2020; Fabito et al., 2020).

The EFA results confirmed the multidimensional nature of students' perceptions and challenges, while CFA provided strong evidence supporting the stability and validity of the five-factor structure. The excellent model fit indices and satisfactory reliability and validity measures suggest that the instrument can be confidently used in future educational research and practice. The findings support the view that students' online learning experiences are influenced by multiple interconnected dimensions that encompass technological, psychological, pedagogical, communicative, and economic factors.

EDUCATIONAL IMPLICATIONS

The validated Students' Perception and Challenges of Online Education Scale (SPCOES) offers several important implications for educational practice, policy, and research. First, the scale provides educational administrators and policymakers with a comprehensive tool for assessing students' experiences in online learning environments. The identification of Technical Challenges as a major dimension highlights the need for improved digital infrastructure, reliable internet connectivity, and equitable access to technological resources, particularly for students from disadvantaged backgrounds.

Second, the Health and Psychological Issues dimension underscores the importance of addressing the physical and emotional well-being of students participating in online education. Educational institutions should incorporate strategies aimed at reducing screen fatigue, promoting healthy study habits, and providing psychological support services to students experiencing stress and anxiety related to online learning.

Third, the emergence of Support Services and Communication as a significant factor indicates the necessity of strengthening teacher-student interaction and communication mechanisms within virtual learning environments. Schools should encourage regular feedback, interactive teaching strategies, and timely academic support to enhance student engagement and learning outcomes.

The dimensions related to Cost Related Issues and Quality of Teaching and Learning further suggest that educational institutions must focus on designing learner-centered online experiences that are accessible, convenient, and pedagogically effective. The scale can serve as a valuable diagnostic tool for identifying areas requiring improvement and monitoring the effectiveness of online education initiatives over time.

LIMITATIONS OF THE STUDY

Despite its contributions, the present study is subject to certain limitations. First, the scale was developed and validated using a sample of secondary school students from government and private schools located in Patiala District, Punjab. Consequently, the generalizability of

the findings to students from other geographical regions, educational levels, or cultural contexts may be limited.

Second, the study relied on self-reported responses, which may be influenced by social desirability bias or subjective interpretation of questionnaire items. Third, although the scale demonstrated satisfactory psychometric properties, the validation process was confined to a specific educational context and period. Additional validation studies involving larger and more diverse samples are required to further establish the robustness of the instrument.

FUTURE SCOPE

Future studies may examine the applicability of the scale across different educational settings, states, and countries to assess its cross-cultural validity. Researchers may also investigate measurement invariance across demographic variables such as gender, school type, socio-economic status, and urban-rural background.

Longitudinal studies may utilize the scale to examine changes in students' perceptions and challenges over time as educational technologies continue to evolve. Furthermore, future research may explore the relationship between students' perceptions of online education and variables such as academic achievement, motivation, digital literacy, self-regulated learning, and psychological well-being.

The scale may also be adapted and validated for use among higher education students, teachers, and other stakeholder groups to facilitate broader investigations into online education.

CONCLUSION

The present study developed and validated the Students' Perception and Challenges of Online Education Scale (SPCOES) for secondary school students. The scale development process was grounded in both qualitative and quantitative methodologies. Qualitative interviews with secondary school students enabled the identification of five key dimensions related to online education, namely Technical Challenges, Health and Psychological Issues, Support Services and Communication, Cost Related Issues, and Quality of Teaching and Learning. These dimensions formed the conceptual basis for item generation and subsequent psychometric evaluation, consistent with recommendations for instrument development that emphasize deriving scale items from participants' lived experiences and contextual realities (DeVellis & Thorpe, 2021).

The results of Exploratory Factor Analysis confirmed a five-factor structure explaining a substantial proportion of the total variance. Confirmatory Factor Analysis further established the adequacy of the measurement model through excellent model fit indices. Reliability, convergent validity, and discriminant validity analyses provided additional evidence supporting the psychometric soundness of the instrument (Hair et al., 2019; Kline, 2023).

The findings indicate that SPCOES is a reliable and valid instrument for assessing secondary school students' perceptions and challenges regarding online education. The scale offers a useful tool for researchers, educators, administrators, and policymakers seeking to evaluate students' experiences and develop strategies for enhancing the effectiveness of online learning environments. Given the increasing integration of digital technologies in education, the instrument may contribute to evidence-based decision-making aimed at improving the quality, accessibility, and inclusiveness of online learning experiences for secondary school students (Dhawan, 2020; Pokhrel & Chhetri, 2021).

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