IJRES International Journal of Research in Education and Science

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Development of an Online Education Evaluation Scale for Applied Courses in Primary and Secondary Education

Alime Hilal Nadi [1] *, Ayşe Oğuz Ünver [2]

[1] Muğla Sıtkı Koçman University, Turkiye, 0000-0002-6685-2973
[2] Muğla Sıtkı Koçman University, Turkiye, 0000-0003-2938-5269
* Corresponding author: Alime Hilal Nadi (hilalnadii59@gmail.com)

Article Info

Article History

Received:
7 November 2025

Revised:
2 March 2026

Accepted:
7 April 2026

Published:
1 July 2026

Keywords

Scale development
Distance learning
Educational assessment
Applied courses
Online education

Abstract

The aim of this study is to develop a valid and reliable scale for evaluating the online education process in applied courses at the primary and secondary education levels. Despite the advantages of online education, such as flexibility, accessibility, and innovation, studies indicate that the lack of material resources and the inability to engage in hands-on learning negatively affect student motivation and interest. In this context, the "Online Education Evaluation Scale for Applied Courses" scale has been developed. Research data were collected from 67 participants using a 35-item draft scale. Exploratory factor analysis was conducted on the pilot study data, resulting in a final version of the scale with three factors and 31 items. The identified factors are "Application and Learning Process," "Efficiency and Success," and "Advantages and Disadvantages." The internal consistency of the scale was assessed using Cronbach's Alpha, yielding an overall value of .87. The Cronbach's Alpha values for the sub-factors were .89, .82, and .73, respectively. Additionally, significant positive correlations were found between the total scale score and the sub-factor scores ($p < .001$). The findings suggest that the developed scale provides a valid and reliable tool for assessing the challenges of online education in applied courses.

Citation: Nadi, A. H. & Oğuz Ünver, A. (2026). Development of an online education evaluation scale for applied courses in primary and secondary education. *International Journal of Research in Education and Science (IJRES), 12*(3), 656-666. https://doi.org/10.46328/ijres.6020

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Introduction

Online education is a form of learning where students and instructors are physically separated, and instruction is delivered through various technological tools (Keegan, 2002). This educational model provides opportunities for reaching large participants, independent of time and space constraints. In online education, instructional materials are presented to students in digital formats, fostering independent study habits. In this context, online education aims to facilitate a more flexible learning process and accommodate students with varying learning steps (Davies, 1998). It serves as an innovative approach that meets the learning needs of the 21st century by offering educational opportunities to students not enrolled in traditional institutions (Faibisoff & Willis, 1987).

An effective online learning process requires active student participation and a structured developmental cycle for digital learning. Additionally, communication between students and instructors is critical for fostering a positive learning environment (Nistorescu et al., 2006). Therefore, adopting a student-centered approach and incorporating familiar instructional strategies to enhance motivation are essential. Despite its advantages such as accessibility and flexibility online education also presents several challenges that impact learning outcomes. Commonly cited difficulties include a lack of face-to-face interaction and limited feedback from instructors (Duman, 2023). Students often struggle with feelings of isolation, uncertainty in learning, and insufficient social interaction (Attri, 2012). Furthermore, inadequate technological infrastructure and digital literacy among both students and teachers negatively affect active participation in lessons (Dabaj, 2011). Low motivation and disengagement among students lead to a decline in both educational and social functions (Dzvinchuk, 2020). Technical issues and communication barriers are among the most prevalent problems in online education (Pardanjac et al., 2009). Additionally, deficiencies in hands-on practice hinder skill development and learning quality (Shahbazi & Nikkar, 2012). Moreover, not all students possess the necessary self-regulated learning skills required for online education (De Oliveira et al., 2018).

Literature on Online Science Education in Applied Learning Contexts

Online education in science has been explored across different age groups and instructional methods, with a notable increase in research since the early 2000s. Studies have highlighted both the potential benefits and challenges of remote learning, particularly in applied disciplines that rely on hands-on experimentation and laboratory work.

Challenges in Online Science Education

Burke and Greenbowe (1998) examined a collaborative online learning program within the Iowa Chemistry Education Alliance at the high school and university levels. Their qualitative study found that while interactive materials and group work enhanced student motivation, technical infrastructure issues and teachers' lack of preparedness in developing digital materials posed significant limitations. Similarly, Lagowski (1999) conducted a theoretical analysis of distance learning in chemistry education, emphasizing its flexibility and accessibility but also underscoring the difficulties in replicating laboratory-based learning experiences.

The transition to online learning has been particularly challenging in disciplines requiring practical application. Holden and Kurtz (2001) investigated university students' experiences in an online organic chemistry course, employing a mixed-methods approach. Their findings revealed that while remote learning offered flexibility and self-paced study opportunities, the lack of hands-on experimentation hindered conceptual understanding. This aligns with more recent research by Soares et al. (2020), who studied high school chemistry students in Rio de Janeiro during the COVID-19 pandemic. Their study identified key obstacles, including inadequate technical infrastructure, unstable internet connectivity, and the absence of a conducive home learning environment. Most critically, the lack of laboratory work reduced both engagement and learning effectiveness.

Motivational and Pedagogical Barriers

A recurring theme in the literature is the negative impact of online learning on student motivation, particularly in applied science courses. Sarıoğlan, Altaş, and Şen (2020) found that the inability to conduct experiments in remote settings diminished students' enthusiasm for science. This is compounded by limited teacher-student interaction, which further reduces engagement (Dzvinchuk, 2020). However, some studies suggest that innovative digital tools, such as virtual laboratories, can mitigate these challenges. Bozkurt and Sarıkoç (2008), for instance, demonstrated that well-designed simulations could sustain student interest and improve comprehension in the absence of physical labs. To address these limitations, researchers have proposed the integration of complementary methods, such as virtual labs that provide simulated, interactive experiments to replicate hands-on learning (Bozkurt & Sarıkoç, 2008), home lab kits that enable safe, small-scale experiments outside of traditional lab settings, interactive digital materials that increase engagement through multimedia, and adaptive learning platforms.

While online education offers flexibility and accessibility, its effectiveness in applied science courses remains constrained by technological and pedagogical barriers. Given these challenges, evaluating the effectiveness of online education particularly in applied courses that require hands-on learning is crucial. However, there is a lack of valid and reliable assessment tools specifically designed for this purpose. This study aims to develop a scale to evaluate the online education process in applied courses at primary and secondary education levels, addressing gaps in current research and providing educators with a structured assessment tool.

Method

The development of a valid and reliable assessment tool for evaluating online education in applied courses requires a systematic approach to scale construction, validation, and refinement. This study employed a rigorous methodological framework to develop the Online Education Evaluation Scale for Applied Courses, focusing on four key dimensions: (1) application and learning process, (2) efficiency and success, (3) technological resources, and (4) advantages and disadvantages. The scale was designed to address the unique challenges of hands-on learning in online environments, particularly in primary and secondary education settings. Following established psychometric principles, the development process included item generation based on literature review, expert validation, and pilot testing to ensure construct validity and reliability. A three-point Likert scale was adopted to optimize response accuracy among younger participants, as suggested by prior research on cognitive load and survey design (Chambers & Johnston, 2002). The subsequent sections detail the scale's development stages, from initial item pool construction to final refinement.

Scale Development Process

The Online Education Evaluation Scale for Applied Courses is a Likert-type instrument designed to assess the effectiveness of online learning in hands-on science subjects, such as kitchen chemistry. Likert scales are widely used to measure attitudes, perceptions, and judgments. However, prior research indicates that an excessive number of response options can lead to participant fatigue, reducing the accuracy of responses (e.g., Borgers, de Leeuw & Hox, 2000; Chambers & Johnston, 2002; Semiz & Altunışık, 2016). To mitigate this, a 3-point Likert scale (Disagree, Neutral, Agree) was adopted, as younger participants (e.g., primary and secondary students) respond more reliably to simplified scales.

An initial item pool was generated by reviewing existing literature on distance education and applied science courses. Expert feedback was then used to refine items, ensuring alignment with the study's objectives. The scale was structured around four hypothesized dimensions:

1. Application and Learning Process: Assessing hands-on engagement and instructional effectiveness.
2. Efficiency and Success: Measuring perceived learning outcomes and productivity.
3. Technological Resources: Evaluating access to and usability of digital tools.
4. Advantages and Disadvantages: Identifying strengths and limitations of online applied learning.

Item Pool Development

Application and Learning Process Factor. This subscale was developed by drawing upon existing evaluation instruments to assess the effectiveness of online education, identify challenges, and determine the efficacy of instructional practices. Initially comprising 18 items, the scale items were inspired by Çolakoğlu's (2022) work. Following expert review, items 6 and 7 were reclassified under the efficiency and success factor, while Items 10, 12, and 15 were eliminated due to redundancy or poor fit with the construct. The remaining items (1, 2, 3, 4, 5, 8, 9, 14, 16, 17, 18) were developed originally by the researchers. Additionally, items 11 and 13 were modified based on expert feedback to improve clarity and relevance.

Efficiency and Success Factor. This subscale was designed to evaluate the perceived productivity of online education and its impact on student achievement. The initial 9 item pool underwent expert review, resulting in the removal of Items 20, 25, and 27 due to conceptual overlap. Items 21 and 23 were reclassified under the application and learning process factor, while items 19, 24, 26, and 28 were retained without modification. Item 22 was revised based on expert recommendations to enhance precision.

Technological Resources Factor. This subscale assessed the influence of internet access, technology usage, and availability of digital tools on the online learning experience. The initial 3 item pool was refined after expert consultation: Item 29 was eliminated for poor discriminative validity, while Items 33 and 34 were reclassified under the application and learning process factor. Items 30, 31, and 32 were retained in their original form.

Advantages and Disadvantages Factor. This subscale measured perceived benefits and limitations of online education. Following expert evaluation, items 36 and 38 were reclassified under the efficiency and success factor, and item 37 was moved to the application and learning process factor. Item 42 was revised for improved construct alignment, while Items 35, 39, 40, and 41 were retained as originally formulated. After systematic refinement based on expert feedback, the final scale comprised 35 items distributed across the four theoretical dimensions. This iterative process ensured content validity and conceptual clarity while eliminating redundant or poorly fitting items.

Pilot Study

The research data were collected using a draft "Online Education Evaluation Scale for Applied Courses" developed to assess the distance education process. The online education evaluation scale consists of 35 items. The pilot study was administered to 67 middle school students. Reliability and exploratory factor analysis (EFA) were conducted with the pilot study data. As a result of the analyses, the items were separated into factors and the scale reached its final form with 3 factors and 31 items. In Table 1 the draft scale's Kaiser-Meyer-Olkin (KMO) coefficient was found to be .73 with p=.000. These results indicated good significance values ($p > .001$).

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Sample Adequacy		0.730
Bartlett's Test of Sphericity	Chi-Square Value	958
	Degrees of Freedom	465
	p-value	.000

In the initial factor analysis, the scale was found to consist of 3 sub-dimensions. In the first analysis, it was decided to remove 2 items from the scale because they loaded on multiple dimensions and the difference between their values was less than 0.10. Additionally, 2 other items were removed because they did not load sufficiently on any dimension in the initial analysis values. After removing these 4 items, a new factor analysis was conducted with the remaining 31 items using the oblimin technique. The 31-item scale was found to cluster into 3 sub-dimensions, and examination of the items in each sub dimension showed that the sub-dimensions were meaningfully grouped. As shown in Table 2, the total variance explained by the three factors is 37.4%.

Table 2. Resulting Factors and Their Explained Total Variance Amounts

Factor	Eigenvalue	% of Variance	Cumulative %
1	5.96	19.24	19.2
2	3.06	9.88	29.1
3	2.56	8.25	37.4

Table 3 presents the distribution of retained scale items across factors and their factor loadings following the factor analysis. After this stage, the scale items grouped under each factor were examined according to Table 3, and the factors were named. The first factor was labeled "Application and Learning Process," the second factor "Efficiency and Success," and the third factor "Advantages and Disadvantages."

Table 3. Rotated Component Matrix from Factor Analysis Results

Items	Factors		
	1	2	3
1	.541		
2	.521		
3	.717		
4	.606		
5	.661		
7	.639		
13	.542		
19	.717		
20	.672		
21	.632		
23	.485		
24	.557		
32	.590		
10		.509	
25		.440	
26		.515	
27		.476	
28		.457	
29		.734	
31		.564	
33		.446	
6			.321
8			.557
9			.438
11			.450
12			.462
14			.645
16			.472
17			.462
22			.422
30			.460

Internal Consistency Analysis

To assess reliability, internal consistency was evaluated using Cronbach's alpha. The overall Cronbach's alpha coefficient for the scale was determined to be .87. As shown in Table 4, the subdimensions of the scale demonstrated the following reliability coefficients: application and learning process factor .89, efficiency and success factor .82, advantages and disadvantages factor .73. Correlation analysis between the total scale score and all subdimension scores revealed statistically significant positive relationships ($p < .001$).

Table 4. Online Education Evaluation Scale for Applied Courses and Sub-Factor

Sub-Factor Distribution	Factor Value
Factor 1. Application and Learning Process (α=.89)	
Item 1 Experiments and activities are sufficient in online courses.	.887
Item 2 Online courses are more enjoyable than face-to-face education.	.888
Item 3 Activities in online courses increase learning motivation.	.877
Item 4 Activities in online courses contribute to taking responsibility for learning.	.886
Item 5 Activities in online courses help me to be motivated towards the lessons.	.882
Item 7 Online courses are fun.	.882
Item 13 The content shared in online courses is rich.	.885
Item 19 Online lessons help me to learn permanently.	.881
Item 20 I learn topics and concepts in applied science lessons conducted online as effectively as in face-to-face lessons.	.884
Item 21 Online lessons are as efficient as face-to-face lessons.	.885
Item 23 I believe that the online lessons are productive.	.887
Item 24 Online courses improve my self-evaluation skills.	.886
Item 32 I think that online courses are no different from face-to-face education.	.889
Factor 2. Efficiency and Success (α=.82)	
Item 10 I can actively participate in the practices in online courses.	.806
Item 25 Online courses improve my technology skills.	.811
Item 26 The opportunity to watch the online lessons again positively affects success.	.784
Item 27 Preparing for and studying after online courses takes less time than face-to-face courses.	.798
Item 28 I do not have difficulty in obtaining the necessary materials for the practices in online courses.	.813
Item 29 I have the necessary technological tools to participate in online courses.	.800
Item 31 I can spend more time for my individual studies in online courses.	.795
Item 33 It is easier to take notes in online courses than in face-to-face courses.	.797
Factor 3. Advantages and Disadvantages (α=.73)	
Item 6 Online lessons negatively affect classroom interaction.	.725
Item 8 The teacher cannot provide classroom management in online lessons.	.694
Item 9 The applications in online courses do not interest me.	.712

Sub-Factor Distribution	Factor Value
Item 11 It is difficult to conduct experiments in online courses.	.710
Item 12 Experiments cannot be conducted in online courses.	.708
Item 14 There are problems/problems in the use of tools and equipment in the applications made in online courses.	.686
Item 16 Technical problems in online courses decrease motivation.	.707
Item 17 Online courses decrease my motivation due to my lack of technology skills.	.721
Item 22 Not being able to use the tools effectively in the applications made in online courses negatively affects my success.	.721
Item 30 It is difficult to provide internet access for participation in online courses.	.715

* Item numbers refer to the 35-item draft scale.

After the pilot study, the item numbers were arranged as in Table 5.

Table 5. Exploratory Factor Analysis item Pre-factor Numbers and New Numbers

Pre-Factor Analysis Item Numbers	New Item Numbers	Pre-Factor Analysis Item Numbers	New Item Numbers	Pre-Factor Analysis Item Numbers	New Item Numbers
1	1	24	12	8	23
2	2	32	13	9	24
3	3	10	14	11	25
4	4	25	15	12	26
5	5	26	16	14	27
7	6	27	17	16	28
13	7	28	18	17	29
19	8	29	19	22	30
20	9	31	20	30	31
21	10	33	21		
23	11	6	22		

Consequently, exploratory factor analysis was initially conducted on the pilot study data and the 'Online Education Evaluation Scale for Applied Courses' data. Cronbach Alpha values were then examined to assess internal consistency. Following these analyses, all items were categorized into factors, and the redundant items were eliminated. Following the exploratory factor analysis, the scale was reduced from four factors to three factors, and four items of the 35 items were eliminated. This process resulted in a final version comprising 31 items.

Conclusion

This study developed and validated the Online Education Evaluation Scale for Applied Courses to assess the effectiveness of remote learning in primary and secondary education settings, particularly for hands-on disciplines. The scale demonstrated strong psychometric properties, with a three-factor structure (application and learning process, efficiency and success, and advantages and disadvantages) explaining 37.4% of the total variance. High internal consistency was confirmed ($\alpha = .87$ overall; subscales $\alpha = .73 - .89$), and all subscales showed significant positive correlations with the total score ($p < .001$). The final 31 item scale addresses critical gaps in evaluating online applied education by: Measuring practical learning challenges (e.g., experiment limitations, motivation loss), assessing technological and pedagogical barriers (e.g., tool accessibility, interaction deficits) and providing a reliable tool for educators to optimize online course design.

The development of the Online Education Evaluation Scale for Applied Courses provides a crucial tool for assessing online learning in hands-on subjects, yet its implementation requires careful consideration. Educators are encouraged to utilize this scale to identify specific challenges students face in applied online courses, particularly regarding practical skill development and technological barriers. Researchers may employ this instrument to systematically compare different instructional approaches in remote applied education. However, the study's limitations must be acknowledged, including its initial validation with only 67 middle school students, which necessitates further testing across diverse educational contexts and age groups. Additionally, while the scale effectively measures perceived learning experiences, future research should examine its correlation with objective performance measures to establish stronger validity. These focused recommendations and limitations emphasize the scale's immediate utility while highlighting necessary directions for its continued development and application in online education research.

Statements and Declarations

Acknowledgments/Notes: The present article is derived from a part of the Alime Hilal Nadi's Master Thesis (MA). This work was also initially published as an abstract in the proceedings of the ICETOL 2025 Conference. This study was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 2224-B (Application Number: 1919B022502968) Domestic Scientific Event Participation Support Program.

During the preparation of this article, the authors did not use ChatGPT.

Supplementary Materials: Not applicable.

Funding: Not applicable.

Data Availability: Not applicable.

Ethics Approval: All methods were performed in accordance with the study protocol and ethical guidelines and regulations.

Informed Consent: Informed consent was obtained from all participants involved in the study.

Conflicts of Interest: The authors declare no conflicts of interest.

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