

EFA Analysis of Factors Affecting the Success of Online Learning in Elementary Schools: An Exploratory Study in Elementary Schools with an International Curriculum

M. Habibi¹, Nurfaijah²

¹ Universitas Negeri Padang, Padang, Indonesia; habibie91@fip.unp.ac.id

² Politeknik Negeri Padang, Padang, Indonesia; nurfaijah@pnp.ac.id

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ABSTRACT

This study was motivated by the numerous variables influencing the success of online learning in elementary schools and the need to identify the most significant underlying factors. A quantitative design employing Exploratory Factor Analysis (EFA) was used. Data were collected from 108 teachers across four elementary schools (SD Islam Al Azhar 32 Padang, SD Telkom, Yari International School, and SafaMarywa Islamic International School). Initially, 23 variables were identified through a teacher opinion survey; however, validity testing retained 20 variables. Sampling adequacy was confirmed (KMO = 0.819), and Bartlett's test of sphericity was significant ($p = 0.001$), indicating suitability for factor analysis. The analysis extracted eight principal factors based on eigenvalues and rotated component matrices: (1) Psychological Readiness and Self-Regulation (3.152), (2) Support for Digital Learning Technology (2.264), (3) Teachers' Pedagogical and Professional Competence (1.663), (4) Quality of Learning Design and Materials (1.426), (5) Teachers' Instructional Communication (1.313), (6) Supportive Home Learning Environment (1.303), (7) Technological Capabilities of Teachers and Students (1.054), and (8) Students' Social and Academic Participation (1.030). These findings highlight that successful online learning in elementary education is multifactorial, integrating psychological, technological, pedagogical, and environmental dimensions. The identified factors provide a structured framework for educators to enhance online learning effectiveness and improve student outcomes.

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Corresponding Author:

M. Habibi

Universitas Negeri Padang, Padang, Indonesia; habibie91@fip.unp.ac.id

1. INTRODUCTION

Elementary schools in Indonesia that adopt a dual curriculum — namely the National Curriculum and the Cambridge Curriculum — had already implemented online learning through a blended learning approach even prior to the outbreak of the COVID-19 pandemic. The blended learning approach was deemed necessary, given that the instructional content covered is approximately twice as extensive and complex as compared to schools operating solely under the National Curriculum. Moreover, blended learning has been regarded as a balanced solution to address the

respective shortcomings of both online and offline instructional modalities (Faraniza 2021; Sharma et al. 2022). On the other hand, schools adopting a dual curriculum tend to exhibit greater readiness, as they possess their own dedicated learning platforms, interactive multimedia resources, and more robust technological support (Adilah et al. 2023; Chen 2023; Fadhilah and Husin 2023; Fan and Tian 2022). These schools have continued to implement online learning to the present day. In practice, content from the National Curriculum is sometimes delivered offline, while content from the Cambridge Curriculum is delivered online, or vice versa, depending on the subject matter, its urgency, the learning objectives, and time constraints (Kaliaskarova et al. 2022).

The success of online learning is shaped by a multitude of factors, including the quality of systems and technology, encompassing internet connectivity, multimedia devices, and other technical elements (Mohammed et al. 2024; Yuebo, Halili, and Razak 2024). Educators' mastery of technological, pedagogical, and content knowledge (TPACK) is critical for managing online learning effectively (Yuebo, Halili, and Razak 2023, 2024). Moreover, teacher support, interaction, and feedback within online learning environments exert a considerable influence on students' motivation and engagement (Hu and Xiao 2025; Kedia and Mishra 2023; Mohammed et al. 2024). The success of online learning is also influenced by learners' intrinsic motivation, which includes discipline, self-regulation, digital literacy, prior experience, time management, self-confidence, and adaptability (Hu and Xiao 2025; Kauffman 2015; Lastariwati et al. 2021). Instructional design and learning materials may serve as critical determinants of successful online learning, as several shortcomings of online education — particularly in the domains of knowledge and skills acquisition as well as social preferences — can be addressed through well-structured instructional strategies and appropriately designed materials (Lastariwati et al. 2021; Yu 2022). Furthermore, positive support from family, peers, and the broader social environment can assist students in overcoming challenges associated with online learning while fostering greater learning autonomy (Kauffman 2015; Kedia and Mishra 2023). These factors may also help to mitigate excessive anxiety and feelings of social isolation during online learning.

Drawing on years of experience, elementary school teachers working in dual-curriculum institutions that continue to implement online learning - such as Islamic Elementary School of Al Azhar 32 Padang, Elementary School of Telkom Padang, Yari International School, and SafaMarwaa Islamic International School - possess substantial insight into the factors contributing to the success of online learning. The weaknesses identified in the implementation of online learning thus far can potentially be mitigated by optimizing these contributing factors. While the factors influencing online learning success, as described earlier, may apply in a general sense, they could manifest more specifically or even more variably at the elementary school level. Consequently, research that systematically examines these issues is warranted. The present study is highly relevant, as it aims to explore the factors influencing the success of online learning in elementary schools from the teachers' perspective.

International schools are relevant subjects for research to analyze the factors that influence the success of online learning because they generally have a full complement of professional instructors, well-established blended learning routines, and higher digital capacity than conventional schools. Teachers in international schools typically possess strong pedagogical competencies and technological literacy, in line with the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the effective integration of technology, pedagogy, and content as determinants of the quality of online learning (Li et al. 2025; Taranto et al. 2025). In addition, blended learning practices that have been integrated into the curriculum allow students to become accustomed to synchronous and asynchronous interactions, which in various studies have been shown to correlate positively with student learning outcomes and engagement (Issabayeva et al. 2025; Zhang, Beh, and Zhang 2024). The digital capacity of institutions, including technological infrastructure, device access, and online learning system support, is also a crucial factor that affects the effectiveness of e-learning implementation (Almaiah, Khasawneh, and Althunibat 2022). Furthermore, instructors' online teaching competencies and practices contribute significantly to student satisfaction and learning success in digital environments (Martin et al. 2019), so schools with international curricula provide a more stable,

controlled, and representative research context for testing the influence of instructor quality, blended routines, and digital capacity on the success of online learning.

The novelty of this study is underscored not only by its research objectives but also by its substantive emphasis. Among the most frequently cited studies on online learning in Indonesia, as indexed by Google Scholar and Scopus, there has been no dedicated investigation into the determinants of online learning success specifically at the elementary school level. Moreover, the existing literature has predominantly focused on the COVID-19 pandemic period, with virtually no studies to date explicitly addressing the implementation of online learning in the post-pandemic context (spanning 2024–2025), apart from those conducted at the junior high school, senior high school, and higher education levels. For example, Hamdani & Priatna (2020), with 390 citations, explored elementary students' acceptance of online learning from multiple dimensions. Whereas Winda & Dafit (2021), with 209 citations, examined the challenges associated with using platforms such as WhatsApp Groups, Zoom, and Google Classroom to support online learning. The study by Oktariyanti et al. (2021), which has garnered 124 citations, examined the development of online learning media; however, it did not address any aspects related to the determinants of online learning success. The study conducted by Minsih et al. (2020), The study conducted by Ariesca et al. (2021), which has received 82 citations, analyzed the difficulties encountered by teachers in the implementation of online learning.

Based on the above explanation, the research questions are: (1) What are the latent factors formed from various indicators that influence the success of online learning in elementary schools? (2) How much do each of the factors contribute to explaining the variance in the success of online learning in elementary schools? This study offers a significant contribution to the enhancement and future development of online learning implementation within elementary education. The results of the exploratory study of factors affecting the success of online learning in elementary schools can be used as a guide and maximized in practice by other elementary school teachers throughout Indonesia. In doing so, these findings can support the effective enactment of online learning practices.

2. METHODS

2.1. Research Design

This research employed a survey design to capture elementary school teachers' perceptions regarding the factors influencing the success of online learning. The data were analyzed using exploratory factor analysis (EFA), a statistical technique within the domain of multivariate analysis. Factor analysis aims to explain the interrelationships among observed variables by constructing a smaller number of latent factors that are more readily interpretable. In essence, EFA assists researchers in reducing complex datasets into a more parsimonious set of factors capable of explaining the overall variance within the data (Karimian and Chahartangi 2024; Sovey et al. 2022).

2.2. Participants

The study population consisted of elementary school teachers actively engaged in the implementation of online learning modalities. For the purposes of this research, particular emphasis was placed on teachers employed at schools offering a dual curriculum, given that these institutions have sustained online learning practices through blended instructional models. Within the province of West Sumatra, four elementary schools operate under a dual-curriculum framework. Accordingly, teachers from these schools were purposively selected as research participants, yielding a total sample of 108 respondents, distributed as follows: 30 teachers from Islamic Elementary School of Al Azhar 32 Padang, 30 teachers from Elementary School of Telkom, 24 teachers from Yari International School, and 24 teachers from SafaMarwa Islamic International School

2.3. Instrument Data

Data collection was conducted via an online questionnaire distributed through Google Forms, encompassing 23 variables/items designed to capture dimensions of successful online learning implementation at the elementary school level. Teachers were asked to respond to each item using a

five-point Likert scale, anchored as follows: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). The full set of the 23 measured variables is detailed in Table 1.

2.4. Data Analysis

The data were analyzed using SPSS version 26 and Jeffreys's Amazing Statistics Program (JASP). Data processing adhered to the standard procedures of exploratory factor analysis (EFA). Initially, the dataset underwent validity and reliability testing. Once confirmed as valid and reliable, the data proceeded to the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-MSA) and Bartlett's test of sphericity to assess its suitability for factor analysis. The analysis then continued with the determination of the number of factors, aimed at reducing the set of observed variables into a smaller and more parsimonious number of factors capable of explaining the total variance. The appropriate number of factors was identified through examination of the scree plot, with factors retained based on eigenvalues > 1 . Subsequently, variables were allocated to the extracted factors according to their highest factor loading values, with a factor loading value threshold > 0.60 . Finally, the resulting factors were labeled in accordance with the characteristics of their constituent variables.

3. FINDINGS AND DISCUSSION

3.1. Findings

3.1.1. Validity Test

Validity testing serves to establish whether the data collected effectively measure the intended constructs and accurately reflect the latent information inherent to the variables under investigation. This assessment is typically conducted using the Pearson product-moment correlation coefficient, with a significance level set at 5% (0.05). The determination of data validity is guided by both the Sig (2-tailed) value or $R_{\text{calculated}}$ and R_{table} . Following established statistical standards, data are considered valid if the Sig (2-tailed) value is less than ($<$) 0.05, thereby indicating statistical significance. Alternatively, data may also be classified as valid if the $R_{\text{calculated}} > R_{\text{table}}$; however, should the $R_{\text{calculated}} < R_{\text{table}}$, the data cannot be considered valid (Humphreys et al. 2019; Izah, Sylva, and Hait 2024; Wijaya and Klopung 2021)

Based on the data in Table 1, 20 variables were declared valid because they had a Sig (2-tailed) value less than ($<$) 0.05 and their $R_{\text{calculated}}$ value greater than ($>$) R_{table} . Meanwhile, variables SF7, SF8, and SF20 were declared invalid because the Sig (2-tailed) values of these three variables were greater than ($>$) 0.05 and their $R_{\text{calculated}}$ values were less than ($<$) R_{table} . Thus, only 20 variables met the criteria to proceed to the reliability test.

Table 1. Validity Test

Variables	Code	Sig (2-tailed)	$R_{\text{calculated}}$	R_{table}	Criteria
Students' Learning Motivation	SF1	0.000	0.753	0.189	valid
Students' Digital Literacy Skills	SF2	0.000	0.639	0.189	valid
Self-Efficacy (confidence in completing tasks)	SF3	0.000	0.606	0.189	valid
Self-Directed Learning (self-management and time management)	SF4	0.000	0.727	0.189	valid
Student Interaction in Learning	SF5	0.000	0.607	0.189	valid
Students' Mental and Emotional Health	SF6	0.000	0.614	0.189	valid
Learning Styles	SF7	0.055	0.155	0.189	invalid
Awareness of Learning Needs	SF8	0.112	0.154	0.189	invalid
Teachers' Creativity	SF9	0.000	0.646	0.189	valid
Instructional and Learning Material Design (content, videos, media)	SF10	0.003	0.482	0.189	valid
Teachers' Technological Proficiency	SF11	0.001	0.510	0.189	valid
Teaching Skills (pedagogical competence)	SF12	0.000	0.595	0.189	valid

Variables	Code	Sig (2-tailed)	R _{calculated}	R _{table}	Criteria
Effective Communication	SF13	0.001	0.505	0.189	valid
Ability to Provide Reinforcement and Feedback	SF14	0.003	0.485	0.189	valid
Internet Access	SF15	0.000	0.592	0.189	valid
Availability of Technological Devices	SF16	0.000	0.550	0.189	valid
Quality of Learning Platforms	SF17	0.018	0.427	0.189	valid
Family and Parental Support	SF18	0.024	0.417	0.189	valid
Physical Learning Environment	SF19	0.000	0.553	0.189	valid
School Policies Regarding Online Learning	SF20	0.099	0.260	0.189	invalid
Variety of Learning Models, Strategies, and Methods	SF21	0.001	0.528	0.189	valid
Continuous Assessment	SF22	0.005	0.466	0.189	valid
Collaboration and Group Work	SF23	0.036	0.402	0.189	valid

3.1.2. Reliability Test

Reliability testing is conducted to ascertain the degree to which the dataset yields consistent and stable information across repeated measurements. Demonstrating reliability constitutes a fundamental prerequisite prior to undertaking exploratory factor analysis. This assessment commonly employs Cronbach's alpha coefficient as an indicator of internal consistency. Following statistical standards, a Cronbach's alpha value greater than ($>$) 0.6 signifies that the data possess adequate reliability, whereas a value below ($<$) 0.6 denotes insufficient reliability, rendering the dataset unsuitable for further factor analysis (Izah, Sylva, and Hait 2024; Pentapati et al. 2025). Based on the data presented in Table 2, the Cronbach's alpha coefficient for all variables was 0.747, exceeding ($>$) 0.6. Accordingly, the dataset can be deemed reliable and satisfies the required criteria for internal consistency.

Table 2. Reliability Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Item	N of Items
0.747	0.758	20

3.1.3 Keiser Mayer Olkin (KMO) & Bartlett's Test

The KMO and Bartlett's tests serve to evaluate the adequacy of a dataset prior to conducting factor analysis. This adequacy can be assessed by examining the cumulative KMO MSA value and the significance level of Bartlett's test of sphericity. According to statistical conventions, a KMO MSA value greater than ($>$) 0.50 combined with a Bartlett's test of sphericity significance level below ($<$) 0.05 indicates the presence of positive correlations among variables, thereby confirming the data's suitability for factor analysis. Conversely, a KMO MSA value below ($<$) 0.50 and a Bartlett's test significance level exceeding ($>$) 0.05 suggest that the data are not appropriate for factor analysis, as the inter-variable correlations are insufficient (Dirgatama 2024; Nabhan and Habók 2025). Based on the data presented in Table 3, the cumulative KMO MSA value is 0.819, which exceeds ($>$) 0.50. Furthermore, the cumulative value of Bartlett's test of sphericity is 0.001, which is below ($<$) 0.50. These results indicate that the dataset meets the necessary assumptions and is highly suitable for factor analysis.

Table 3. KMO-MSA & Bartlett's Test

Keiser Mayer Olkin Measures of Sampling Adequacy		0.819
Bartlett's test of Sphericity	Apporx. Chi-Square	437.789
	Df	190.000
	Sig.	<0.001

3.1.4 Determination of the Number of Factors

A critical stage in exploratory factor analysis (EFA) involves determining the optimal number of factors to be extracted from the observed variables. This determination is guided by the initial eigenvalues and the scree plot analysis. Factors with initial eigenvalues exceeding ($>$) 1 are deemed suitable for retention, as they explain a sufficient proportion of the data variance. In contrast, components with initial eigenvalues below ($<$) 1 are considered inadequate for factor interpretation, as they fail to account for a meaningful share of the variance within the dataset. (Braeken and Van Assen 2017; Yim 2019).

The data presented in Table 4 indicate that eight components can be retained as factors, as they exhibit Initial Eigenvalues greater ($>$) than 1. Specifically, Factor 1 has an eigenvalue of 3.152, Factor 2 an eigenvalue of 2.264, Factor 3 an eigenvalue of 1.663, Factor 4 an eigenvalue of 1.426, Factor 5 an eigenvalue of 1.313, Factor 6 an eigenvalue of 1.303, Factor 7 an eigenvalue of 1.054, and Factor 8 an eigenvalue of 1.030. Collectively, these factors account for 82.019% of the total variance of the variables. The extracted factors can also be observed in the scree plot presented in Figure 1, in which only eight data extraction points are located above the eigenvalue threshold line.

Table 4. Factor Characteristics

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.152	18.760	18.760	3.152	18.760	18.760
2	2.264	12.318	31.077	2.264	12.318	31.077
3	1.663	10.316	41.393	1.663	10.316	41.393
4	1.426	9.132	50.525	1.426	9.132	50.525
5	1.313	8.563	59.088	1.313	8.563	59.088
6	1.303	8.513	67.601	1.303	8.513	67.601
7	1.054	7.269	74.870	1.054	7.269	74.870
8	1.030	7.150	82.019	1.030	7.150	82.019

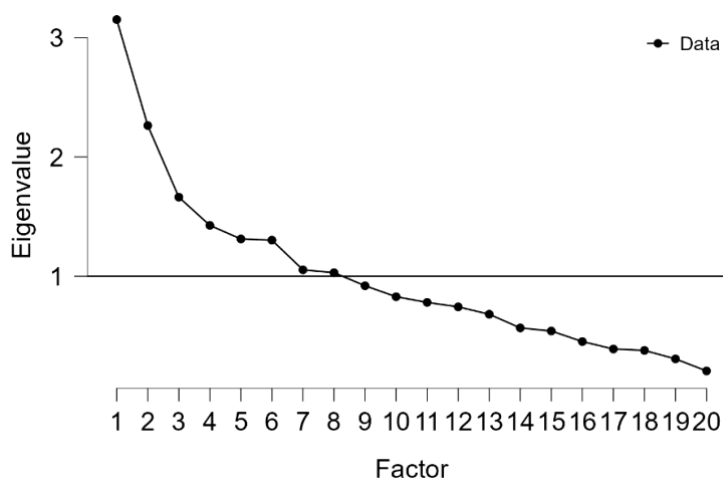


Figure 1. Scree Plot

3.1.5 Rotated Component Matrix

After establishing that the maximum number of main factors that could be extracted was eight, the twenty investigated variables were distributed among these main factors. The assignment of each variable to a particular factor was determined based on its highest factor loading value. For example, if the factor loading of variable A on Factor 1 was higher than its loading on any other factor, then that variable was allocated to Factor 1. According to statistical conventions, an acceptable factor loading — one that adequately explains the corresponding factor — is greater than or equal to (\geq) 0.6. If a variable's

factor loading is below 0.6, it cannot be retained for further analysis (Nabhan and Habók 2025). The distribution of these twenty variables is presented in Table 5.

Table 5. Rotated Component Matrix

Variables	Extracted Factors							
	1	2	3	4	5	6	7	8
SF1	.661	.226	.342	.034	.125	.247	.084	.170
SF2	.247	.404	-.080	.240	.075	-.255	.697	-.153
SF3	.792	.049	-.162	.265	.164	-.122	.422	.093
SF4	.688	.009	-.103	.182	.456	.198	.124	.250
SF5	.055	-.081	.310	-.101	.011	.012	-.028	.818
SF6	.743	-.209	.029	.039	.006	.286	-.036	.030
SF9	.166	-.022	.763	-.125	.131	.067	-.010	.124
SF10	.021	.030	.028	.870	.137	.002	-.027	-.032
SF11	-.125	.069	-.086	.305	.345	-.405	.648	.160
SF12	.152	.130	.706	-.171	-.084	-.029	.327	.262
SF13	.004	-.132	.043	.270	.690	.077	-.176	.027
SF14	-.111	.108	.170	-.147	.749	.096	.163	-.195
SF15	-.166	.647	.092	.244	.030	.005	.140	.362
SF16	.033	.830	.000	.079	.005	-.017	.017	-.067
SF17	-.054	.776	-.065	.044	-.016	.197	.037	.034
SF18	-.243	.353	-.065	-.082	.343	.652	-.018	-.238
SF19	.267	.415	.145	-.234	-.109	.622	-.449	.148
SF21	.138	.343	.220	.792	-.127	-.147	-.202	-.114
SF22	.011	.001	.088	.745	.086	.168	-.023	.025
SF23	.026	.070	.142	-.097	-.027	.015	-.011	.821

Based on the data presented in the above table, all variables were eligible for further analysis, as they demonstrated factor loadings greater than or equal to (\geq) 0.6. Factor 1 was formed by variables SF1, SF3, SF4, and SF6; Factor 2 by SF15, SF16, and SF17; Factor 3 by variables SF9 and SF12; Factor 4 by variables SF10, SF21, and SF22; Factor 5 by variables SF13 and SF14; Factor 6 by variables SF18 and SF19; Factor 7 by variables SF2 and SF11; and Factor 8 by variables SF5 and SF23.

3.1.6 Factor Labeling

The naming of the extracted factors was based on the characteristics of their constituent variables. This approach was intended to ensure that each factor's nomenclature is appropriate and consistent with the variables from which it was derived. The factor labeling process is presented in Table 6.

Table 6. Factor Labeling

Factors	Formative Variables	LF	Factor Name
1	Students' Learning Motivation (SF1)	0.661	Psychological Readiness and Self- Regulated Learning
	Self-Efficacy (confidence in completing tasks) (SF3)	0.792	
	Self-Directed Learning (self-management and time management) (SF4)	0.688	
	Students' Mental and Emotional Health (SF6)	0.743	
2	Internet Access (SF15)	0.647	Support for Digital Learning Technologies
	Availability of Technological Devices (SF16)	0.830	
	Quality of Learning Platforms (SF17)	0.776	
3	Teachers' Creativity (SF9)	0.763	Teachers' Pedagogical and Professional Competence
	Teaching Skills (pedagogical competence) (SF12)	0.706	
4	Instructional and Learning Material Design (content, videos, media) (SF10)	0.870	Quality of Instructional Design

	Variety of Learning Models, Strategies, and Methods (SF21)	0.792	and Learning
	Continuous Assessment (SF22)	0.745	Materials
	Effective Communication (SF13)	0.690	Teachers'
5	Ability to Provide Reinforcement and Feedback (SF14)	0.749	Instructional Communication
	Family and Parental Support (SF18)	0.652	Supportive Home
6	Physical Learning Environment (SF19)	0.622	Learning Environment
	Students' Digital Literacy Skills (SF2)	0.697	Technological
7	Teachers' Technological Proficiency (SF11)	0.648	Capabilities of Teachers and Students
	Student Interaction in Learning (SF5)	0.818	Students' Social and
8	Collaboration and Group Work (SF23)	0.821	Academic Participation

The factor analysis of variables influencing the success of online learning in primary schools, based on the perceptions of teachers at Islamic Elementary School of Al Azhar 32 Padang, Elementary School of Telkom Padang, Yari International School, and SafaMarwa Islamic International School, has been completed. From the 20 variables identified by teachers as potential contributors to successful online learning, the Exploratory Factor Analysis (EFA) produced eight main factors: (1) Psychological Readiness and Self-Regulated Learning, (2) Support for Digital Learning Technologies, (3) Teachers' Pedagogical and Professional Competence, (4) Quality of Instructional Design and Learning Materials, (5) Teachers' Instructional Communication, (6) Supportive Home Learning Environment, (7) Technological Capabilities of Teachers and Students, and (8) Students' Social and Academic Participation.

3.2. Discussion

Online learning at the primary school level has emerged as an important alternative, particularly during emergencies such as the COVID-19 pandemic. Unfortunately, many primary schools in Indonesia have now abandoned online learning simply because the pandemic has ended. Online learning constitutes an effective solution when teachers are unable to be physically present for conventional face-to-face instruction. Moreover, it can serve as a preferred option for completing learning materials amidst time constraints and the extensive scope of subject matter that must be delivered (Alzahrani 2022; Dhawan 2020). Online learning can also enhance the effectiveness and efficiency of teachers' performance while simplifying administrative tasks. This, in turn, allows teachers to devote greater focus to student interaction and the monitoring of learners' progress (Tantowi et al. 2023).

Although online learning offers flexibility and broader access to educational opportunities, its success is inextricably linked to a range of factors, including technological devices, adequate internet access, teachers' competencies, students' learning motivation, the quality of online learning materials, technological skills and literacy, as well as parental and family support (Kauffman 2015; Kedia and Mishra 2023; Lastariwati et al. 2021; Mohammed et al. 2024; Yuebo, Halili, and Razak 2023) and numerous other, more specific factors. The sheer number of variables influencing the success of online learning, particularly at the primary school level, underscores the need for scientific research capable of systematically identifying the structural relationships among these variables affecting online learning success in primary education.

One approach that can be utilized for this purpose is Exploratory Factor Analysis (EFA). As a branch of multivariate statistics, EFA assists researchers in reducing a large set of variables into a smaller number of principal (grand) factors that are simpler and capable of explaining the overall variance within the data (Karimian and Chahartangi 2024; Sovey et al. 2022). In this context, EFA was

employed to analyze the entire set of variables influencing the success of online learning in primary schools, and to extract these variables through various computational procedures into many principal factors affecting online learning success at the primary level. Overall, factor analysis serves as a crucial approach for constructing a structured understanding of the dynamics of online learning in primary education.

Based on a survey conducted among teachers at the Islamic Elementary School of Al Azhar 32 Padang, Elementary School of Telkom Padang, Yari International School, and SafaMarwa Islamic International School, a total of 23 variables were identified as potentially influencing the success of online learning in primary schools (see Table 1). Following validity testing, however, variables SF7 (0.055), SF8 (0.112), and SF20 (0.099) were deemed invalid due to having Sig. (2-tailed) values greater (>) than 0.05. As a result, these three variables could not be further processed, leaving 20 variables available for factor analysis.

In the KMO & Bartlett's test, the cumulative MSA value for the 20 variables was 0.819, exceeding the (>) 0.05 threshold. This value falls within the meritorious category, indicating that the dataset is highly suitable for factor analysis. The elevated cumulative MSA reflects the presence of positive correlations among the variables. Each variable demonstrated a mutually beneficial association with at least some other variables, even if not with all. Importantly, none of the 20 examined variables lacked a positive correlation with other variables. This prerequisite must be satisfied, as factor analysis aims to identify latent factors capable of explaining the correlation patterns among variables. If the investigated variables are uncorrelated, no underlying structure or factors could be meaningfully extracted (Krijnen 2024; Mujiyana and Elissa 2023).

The extraction of 20 variables based on Initial Eigenvalues yielded eight factors. The use of Eigenvalues in determining the number of factors is justified by the fact that Eigenvalues measure the total variance accounted for by a factor across all variables. An Eigenvalue threshold greater than one (> 1) is required, as a meaningful factor must explain more variance than would be contributed by a single variable. Allowing Eigenvalues below one (< 1) would result in factors that explain less variance than that contributed by an individual variable, rendering them substantively insignificant (Braeken and Van Assen 2017; Yim 2019). In this case, the eight extracted factors were able to account for the variance of their respective constituent variables. If additional factors were introduced without adhering to the Eigenvalue criteria, these extra factors would merely serve as overlaps, since their constituent variables could be explained more robustly by other, stronger factors.

Psychological readiness and self-regulated learning (SRL) are critical factors influencing the success of online education. Research by Faza & Lestari (2025) demonstrates that students with high SRL capabilities – including learning planning, time management, emotional regulation, and self-evaluation – tend to achieve superior online learning outcomes. These learners actively monitor their learning processes, leverage digital feedback, and adapt to the challenges inherent in online education. Additionally, Makhno et al. (2022) found that students' psychological readiness, such as intrinsic motivation and emotional resilience, can buffer the impact of stress during online learning. Learners with strong self-regulation skills exhibited a 40% higher completion rate of online learning tasks compared to those with weaker self-regulation abilities.

Digital learning technology support also contributes significantly to the success of online education. The use of digital devices, internet access, learning platforms, and interactive applications enables personalized learning, enhances student engagement, and broadens access to learning resources. Research by Haleem et al. (2022) & Zou et al. (2025) indicates that digital technology not only supports and improves learning outcomes and motivation, but also assists teachers in monitoring students' progress and providing targeted interventions. Furthermore, high-quality learning platforms can facilitate interaction, expand access to educational resources, and enable learning to proceed effectively despite constraints of time and distance.

Teachers' pedagogical and professional competencies also play a crucial role in determining the success of online learning. Research by Y. Liu et al. (2022) asserts that teachers who possess advanced

pedagogical and professional competencies are better equipped to deliver meaningful instruction, optimally manage learning interactions, and effectively harness technology to foster students' comprehension and engagement. Moreover, their study demonstrates that teachers' competencies in the context of online learning not only exert a significant influence on students' academic outcomes but also enhance teachers' resilience in navigating the inherent challenges of distance education, which can frequently be perceived as monotonous.

The quality of instructional design and learning materials — encompassing the selection and organization of content, the use of interactive elements, and the appropriate presentation of multimedia — can enhance student engagement, motivation, and learning outcomes. Research by Wright et al. (2023) indicates that the quality of instructional design, including the clarity of structure, the diversity of delivery methods, and the ease of accessing materials, is a primary factor in determining the success of online learning. Furthermore, instructional design aspects such as the user-friendliness of e-modules and the structured organization of learning materials strongly influence both students' academic and non-academic achievement (Czerkowski and Lyman 2016).

Teachers' instructional communication is also a key factor in determining the success of online learning. Kannareth (2022) explains that teachers who apply effective communication strategies — whether through learning media, presentations, online question-and-answer forums, or direct interaction via chat or video calls — are able to ensure that students truly understand the material being delivered. Good communication not only strengthens students' comprehension of the learning content but also builds connections between teachers and students, thereby enhancing student engagement and learning motivation.

Supportive home learning environments influence children's comfort during online learning. A systematic review study by Alberto et al. (2023) concluded that the physical and social conditions of the home environment — such as the availability of a comfortable study space, parental support, and minimal distractions — play a crucial role in sustaining students' motivation, concentration, and engagement during online learning. The study also highlighted that children living in supportive home environments, for example, with adequate study spaces and a conducive atmosphere, tend to report higher levels of happiness, lower levels of fatigue, and better academic achievement.

The ability to operate digital devices, access learning platforms, and utilize educational applications is a key prerequisite for creating an effective and meaningful learning process. Teachers' technological proficiency influences the quality of planning, implementation, and assessment in online learning, while students' ability to use technology determines their engagement and learning outcomes (Timotheou et al. 2023). A research by Holik et al. (2023) & Jung et al. (2024) also revealed that low digital literacy among both teachers and students can serve as a major barrier to online learning, whereas improving digital competence can promote pedagogical innovation and strengthen interaction.

Students' social and academic participation is also a factor that cannot be overlooked. Active student engagement in discussions, group interactions, and online collaboration can strengthen their sense of belonging, reduce feelings of isolation, and enhance learning satisfaction (Miao and Ma 2022). In addition, the level of student participation and engagement, both socially and academically, is positively correlated with motivation and academic achievement in online learning (Sang 2024).

4. CONCLUSION

This study aimed to analyze the variables influencing the success of online learning in elementary schools based on teachers' perceptions and to extract these variables using an EFA approach, thereby identifying the main factors that can account for the overall variables affecting the success of online learning in elementary schools. After a series of EFA analysis stages, eight main factors were identified: (1) Psychological Readiness and Self-Regulation in Learning, (2) Support for Digital Learning Technology, (3) Teachers' Pedagogical and Professional Competence, (4) Quality of Learning Design and Materials, (5) Teachers' Instructional Communication, (6) Supportive Home Learning

Environment, (7) Technological Capabilities of Teachers and Students, and (8) Students' Social and Academic Participation. These findings are valuable for elementary school teachers, as they can serve as guidelines for designing more effective online learning by taking these influencing factors into account. The limitations of this study lie in the sample, which was drawn from only four elementary schools (the reasons for this have been explained). Ideally, to obtain more valid results, the sample should have been drawn from several different regions. Furthermore, this study did not attempt to verify whether the identified factors truly have a significant influence. The conclusions were based on previous studies related to these factors. Therefore, it is recommended that future research specifically examine the contribution of these eight factors to the success of online learning in elementary schools.

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